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EXECUTIVE SUMMARY

This deliverable targets to consolidate the common and regional pathways based on the analyses of the Integrated National Energy and Climate Plans (NECPs) of the Member States in Task 2.1 of the SUPEERA project. Although the original due date of this deliverable was in M12 (December 2020), with an updated version in M36, the Covid-19 pandemic posed several important obstacles in the execution of the activities which have eventually been slowed down or hindered from the planned. Therefore, at its current form, this is an interim report of *Deliverable 2.1 Consolidated common and regional pathways in NECPs and stakeholders mapping* presenting the current status of analysis of the planned energy measures (which will be consolidated for the next deliverable D2.5); the identified common and regional pathways in the NECPs; plans for defining the framework and prioritizing of the piloting pathways. The activities will continue in the second half of 2021 and beyond, and the work will be accomplished through dialogue with SUPEERA stakeholders, within the limits and possibilities of online meetings and, expectantly, in physical workshops.

This Task is the first part of the Work Package 2 “Accelerating innovation and uptake by industry”, and the NECP analysis is based on the objectives of this work package: 1) to establish a dialogue with key industrial stakeholders and facilitate transnational cooperation; 2) to analyse the proposed energy measures in the mid and long-term plans and strategies including sectoral specific as well as cross-cutting and systemic measures; 3) to define national and regional key industrial clusters due for realisation; 4) to promote a dialogue and cooperation model between regional industrial clusters, energy experts, SET Plan Implementation Working Groups, European industrial organisations, and related platforms; and finally, 5) to deliver sectorial, cross-sectorial and systemic recommendations on R&I priorities, at regional and transnational level, to support uptake of new technologies by the industry and the implementation of National Energy and Climate Plans (NECPs) and the SET Plan (Recommendations).

LIST OF ACRONYMS

CCS - Carbon Capture and storage

CEM - Clean Energy Ministerial

CESEC - Central and South Eastern Europe Energy Connectivity

CHP - Cogeneration Heat and Power

CSP - Concentrated Solar Power

DHS - District Heating System

DSM - Demand-side management

DSO - Distribution System Operators

DSR - Demand-side response

EC - European Commission

EE - Energy Efficiency

EERA - European Research and Energy Alliance

ESI - Energy System Integration

ETIP - European Technology and Innovation Platform

EU - European Union

IEA - International Energy Agency

IP - (SET Plan) Implementation Plan

IRENA - International Renewable Energy Agency

IWG - Implementation Working Group

JP - (EERA) Joint Programme

LTS - Long Term Strategy

NECP - National Energy and Climate Plan

NER - Nordic Energy Research

NSEC - North Seas Energy Cooperation

MI - Mission Innovation

PV - Photovoltaics

RE - Renewable Energy

RED II - Renewable Energy Directive

RES - Renewable Energy Sources

R&D - Research and Development

R&I - Research and Development and Innovation

SET Plan - Strategic Energy Technology Plan

SMS - smart metering systems

SN - Smart networks

SUPEERA - Support to the coordination of national research and innovation programmes in areas of activities of the European Energy Research Alliance

TSO - Transmission System Operator

I ANALYSIS OF PLANNED ENERGY MEASURES

1.1 Background on the analysis of the NECPs

As laid down in the REGULATION (EU) 2018/1999 (11 December 2018), the integrated national energy and climate plans address all five dimensions of the Energy Union; (a) energy security; (b) internal energy market; (c) energy efficiency; (d) decarbonisation; and (e) research, innovation and competitiveness, are necessary tools for more strategic energy and climate policy planning. The Member States had to provide NECPs for the period 2021 to 2030 and set out the main pillars of the governance mechanism. The NECPs are a tool to ensure that the EU meets the energy and climate targets for 2030.

The national plans should be updated once during the ten-year period covered to allow Member States the opportunity to adapt to significantly changing circumstances. For the plans covering the period 2021 to 2030, Member States should update their plans by 30 June 2024. Objectives, targets, and contributions should only be modified to reflect an increased overall ambition in particular as regards the 2030 targets for energy and climate.

The planned schedule for the integrated National Energy and Climate Plans[1] in short:

- NECPs drafts by 31.12.2018
- Final NECPs by 31.12.2019
- Progress reports every 2 years
- Draft update NECPs by 30.6.2023
- Update NECPs by 30.6.2024

The integrated national energy and climate progress reports among others shall cover e.g., information on the progress accomplished towards reaching the objectives; targets and contributions set out in the integrated national energy and climate plan; finance planning and implementing policies and measures necessary for their execution, including a review of the actual level of investments measured against initial investment assumptions.

The EC published individual assessments and summaries of the NECPs (staff working documents) in October 2020.[2]

However, as the EU climate framework is changing rapidly with more stringent targets, the national plans should be updated in a shorter interval. In fact, the European Green Deal, with its ambitious goal of making Europe the first climate-neutral continent by 2050 by increasing the climate targets for 2030 (to 55% GHG emission cut instead of 40% compared to the 1990 levels), should be reflected in the updated NECPs. In addition, many strategic policies and strategies were released in March 2020, e.g., European Climate Law, the European Climate Pack Launch, the Circular Economy Action Plan, and the EU Industrial Strategy, all of them influencing the climate plans of the Member States. Finally, the NECPs will play an important

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[1] The final integrated National Energy and Climate Plans for the period from 2021 to 2030, as submitted by Member States can be found in the EC web site: https://ec.europa.eu/energy/en/topics/energy-strategy/national-energy-climate-plans#final-necps.

[2] The European Commission's assessments of the final NECP Plans can be found at this link: https://ec.europa.eu/energy/topics/energy-strategy/national-energy-climate-plans/individual-assessments-and-summaries.

role in the EU recovery package since the Member States' recovery plans should support the energy measures contained therein.

1.2 The national Long-Term Strategies (LTS)

All the EU countries were required also to develop their national long-term strategies (LTS) and submit them to the EC by 2020. The LTSs should be consistent with the 10-year NECPs.The strategies should be updated every ten years, next time due 01/01/2029, or every five years when necessary. The long-term strategies include total greenhouse gas emission reductions; emission reductions of individual sectors such as electricity, industry and, transport; expected progress on the transition to a low greenhouse gas emission economy, socio-economic influence of the decarbonisation measures; and links to other national objectives, policies and investment. The national long-term strategies are published on the EC website.[3]

Analysis of the LTS is part of this Task, but the analysis will be included in the next deliverable (D2.5 Update of consolidated common and regional pathways in NECPs and stakeholders mapping).

1.3 Method of analysis

The focus in the analysis of the planned energy measures in the NECPs to formulate the common pathways was to identify the most promising areas for cooperation with industry and the cross-thematic activities. In the SUPEERA context, the *'common pathway'* means a selected thematic area based on the analysis of the NECPs, presenting either technological approach (e.g., wind energy and solar power) or systemic aspects of the transition (e.g., energy systems integration), and the analysis of them include the best practices and examples of e.g., regional cooperation, financial programmes, or cross-cutting and sectoral issues. The pathways will serve as a starting point to define a facilitating framework in dialogue with the EERA Joint Programmes (JPs) and industrial platforms and to select key cases to be piloted during the SUPEERA project. These pathways will provide the basis for making recommendations pertaining to these areas as well as giving input to the improvement of the operationalisation of the cooperation model for future implementation.

The cross-cutting themes described in the SUPEERA project include general topics such as infrastructure needs, research-industry cooperation, societal awareness, acceptance, and engagement, improving energy culture, and enabling policies and regulatory measures. More technical or economic topics include data analytics, artificial intelligence, smart and innovative materials, enhancing grid integration and security, development of business models and innovation and co-creation frameworks to develop attractive services. Additional relevant activities may include e.g., social desirability; materials for extreme conditions; and novel materials integrated with the perspectives of Industry 4.0.

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[3] The national long-term strategies are accessible at this link: https://ec.europa.eu/info/energy-climate-change-environment/implementation-eu-countries/energy-and-climate-governance-and-reporting/national-long-term-strategies_en#strategies.

The NECPs were shared by countries between the project partners and the following analysis methodology was applied. After the publication of the EC assessments of the NECPs, also those were taken into the analysis as well. The national Long-Term Strategies will be included in the analysis later in the project.

The target in this SUPEERA work package is acceleration innovation and uptake by industry, and therefore the analysis of the NECPs was based on the selected topics and issues for key point analysis. The topics were concerning cooperation with industry and cross-sectoral issues.

The analysis included general observations of the NECPs in each country, especially on the *cooperation with industry* (if that was described), i.e. how the academia–industry collaboration was planned, such as joint projects and demonstrations, technology development with universities and research organisations, demonstrations and promoting business investments in research. *Knowledge transfer* between research and industry was also studied, e.g., developing skills of universities and research institutions to enhance the commercial viability and market importance. Other analysed topics were innovation policies and planned activities on technology transfer and deployment of innovation. *Infrastructure needs* relevant to the research community were analysed as well.

As the SET Plan Implementation Plans follow strongly on technological silos, the *cross-sectoral issues* were analysed to find possible linkages between different topics that could be applied and exploited over the technological areas. These included *cross-cutting technologies* such as storage, hydrogen, smart grids, renewable heating, and circular economy. The position of *digitalisation* with data-analytics and artificial intelligence was one of the key points in the NECP analysis. *Smart and innovative materials* could be applied for several technologies, and they were taken into the analysis to see if NECPs were mentioning them. *Enhancing grid integration and security* was also seen as a cross-sectoral issue that was analysed from the Plans. Other non-technological issues that were analysed in the NECPs were *social acceptance, societal awareness, and engagement*, *enabling policies and regulatory measures*, and *financing* plans that support the cooperation with industry and foster research and innovation. *Regional cooperation* and *international cooperation* were analysed to find best practices of the countries to support the research for energy transition in collaboration with neighbouring countries or globally.

The cross-sectoral issues will be complemented with the comparison on the SET Plan Implementation Plans, which are analysed in the other SUPEERA Task Cross-cutting and interdisciplinary activities (T1.3), also with the Task Systemic and cross-sectoral solutions pertaining to the Clean Energy Transition objectives (T2.2). The gap analysis and comparison between the NECPs and IPs will take place in the coming months of the project.

After the analysis, six “common pathways” were selected for a more thorough analysis. These six pathways will be used in the coming workshops to define recommendations pertaining to these areas as well as giving input to the improvement of the operationalisation of the cooperation model for future implementation. Due to the Covid-19 pandemic, physical workshops had not been able to organize, and therefore three introductory webinars were arranged to present the first findings on the pathways and to start the dialogue with the EERA Joint Programmes and industrial platforms. The webinars are used to identify the means to obtain information on how to strengthen collaboration between the different stakeholders and hence transfer knowledge to overcome barriers in the implementation plans. The target audience for the webinars was EERA JPs members, ETIP members, industrial platform representatives (e.g., KICs, EMIRI, Umicore, EASE), SET Plan IWG members and EC representatives.

When the Covid-19 pandemic allows, the physical so-called knowledge generating workshops will be arranged to continue the dialogue with the stakeholders and receive feedback from the selected pathways and their analysis to start defining a facilitating framework matching common pathways with correspondent industrial R&I and policy stakeholders, such as regional clusters, ETIPs and global actors. The common pathways will be mapped with the industrial stakeholders, energy expertise capacities such as EERA Joint Programmes, Key Enabling Technologies centres, KIC InnoEnergy and compared with the SET Plan implementation Plans. Then the pathways will be prioritized for piloting. “Piloting” in the SUPEERA context means dialogue/exchange of best practices, challenges, and gaps between key stakeholders (academia, industry, decision makers) to define recommendations on the selected pathways, with the final objective to bring technologies closer to the market.

1.4 Summary on the NECP analysis

Best examples and practices from all the Member States were studied based on the topics covering the academia–industry cooperation and cross-sectoral issues. The NECPs, even though having the same structure, described the national plans in different ways, and the plans had diverse levels on putting the planned activities into practice. Also, the starting points from different Member States varied drastically from advanced countries in the energy transition to less advanced, e.g., Poland, which plans very much focused on coal, gas, and oil supplies.

Some countries presented very targeted plans with existing funding schemes, like Austria with its ongoing Flagship projects, Bulgaria with its national scientific programmes, Estonia with ESDP 2030 research and development program and the Netherlands with Multi-annual Mission-oriented Innovation Programmes. However, in some areas, only incentives without clear funding towards the actions were described, like in Bulgaria, which planned to create a technological park by introducing incentives to encourage the private sector to invest in research and development and in innovation in extensively used production methods aimed at optimum resource efficiency, in Czech, where National Initiative Industry 4.0 aims to mobilise key sectors and industry representatives to develop detailed action plans in areas of political, economic and social life, or in Portugal, where a set of 15 Thematic Agendas for Research and Innovation are being developed.

From the industrial point of view, Luxembourg foresees to become a "hub" for climate-friendly start-ups and companies. According to the NECP, by adapting the national legal framework to support companies in the fields of research, innovation, energy, and the environment with the European directives on State aid, Luxembourg has already created the tools necessary to encourage the private sector as much as possible in the implementation of forward-looking innovations.

Some of the cross-cutting technologies, e.g., circular economy, bioeconomy heating and cooling, development of storage capabilities, power-to-X, biofuels, energy efficiency, and hydrogen synthesis and integration were mentioned in many countries, such as Austria, Finland, Italy Latvia and Lithuania.

Many countries acknowledged the importance of digitalisation, but only a few countries mentioned it with clear plans, like Austria with Breakthrough technologies for industry (BTI.12

Digitalisation and regulation), Czech with DataHUB plans and Germany with Smart Energy Showcases – Digital Agenda for the Energy Transition' programme (SINTEG). Smart and innovative materials were hardly at all mentioned in the NECPs.

Social aspects and consumer engagement were often dealt with energy poverty or affordable energy to all citizens. Belgium provided information on supporting consumer engagement and active role through e.g., different technologies and investments, supporting local energy communities and supporting social innovation.

Some regions were very active in cooperation. Nordic Energy Research (NER) (e.g., Denmark, Finland, Norway, Sweden), North Seas Energy Cooperation (NSEC) for offshore wind development and usage (e.g., Belgium, the Netherlands, Luxembourg, France, Germany, UK, Ireland, Norway, Sweden and Denmark), Pentalateral Forum (e.g., Belgium, France, Germany, Luxembourg, the Netherlands and, since 2011, Austria), Visegrad Group (e.g., Czech Republic, Hungary, Poland and Slovakia) and Central and South-Eastern Europe Energy Connectivity (CESEC) (e.g., Austria, Bulgaria, Croatia, Greece, Hungary, Italy, Romania, Slovakia and Slovenia and the EU) were good examples of ongoing joint incentives and concrete actions.

In international cooperation, Mission Innovation (e.g., Austria, Denmark, Finland, France, Netherlands, Sweden), International Energy Agency IEA (e.g., Czech, Denmark, Ireland, Netherlands, Sweden) and Clean Energy Ministerial (CEM) (e.g., Finland, Netherlands) were mentioned as tools to support the energy transition. Some countries did not list any international cooperation (e.g., Bulgaria, Croatia, Cyprus, Hungary, Malta).

The main findings of the pathways are described in the chapter 'Consolidated common and regional pathways in the NECPs', and the exhaustive analyses of the pathways are presented in Annexes 1-6.

1.5 Summary on the analysis of the EC assessment of the NECPs

The individual EC assessments of the NECPs were analysed and compared to the NECP analyses made by SUPEERA project to detect if there were issues that should be taken into account when selecting the pathways. The SUPEERA analysis consisted of a brief explanation of the structure of the Final Assessment, a table summarising different sections of the Final Assessment:

- Relevant Areas (as within the Commission document)
- Targets, measures and policies of the final NECP
- Related recommendations (given by the Commission in 2019) and evaluation on their implementation within the final NECP (partially/largely/fully or not addressed)
- Final commission assessment together with a comment on the implementation of the 2019 recommendations

The analysis also contains a summary with the main points of the guidance on the implementation of the NECP and the link to the recovery from the Covid-19 crisis, including the key areas indicated by the Commission to be considered in the development of the national Recovery and Resilience Plans.

In conclusion, the EC assessments did not influence the pathway selection as such, because the main recommendations focused especially on buildings (mentioned 34 times), energy efficiency (mentioned 25 times), electromobility (22 times), renewable energy (17), renovation (16), sustainable mobility (10), which were not very relevant towards the focus of SUPEERA project on the industry – research cooperation and technological uptake. Hydrogen was mentioned 7 times, which supported our selection.

The analyses of the EC assessment of individual NECPs are presented in Annex 7.

1.6 Consolidated common and regional pathways in the NECPs

Several factors were considered for the selection of pathways in the NECPs, and they are described in the following.

The factors included *regional coverage*, i.e. how many countries idenfitied a specific technology and how the geographic areas differed between those technologies and if some technologies that are widely used in some regions could be applied to other areas as well. The *regions with best practices* with clear measures and targets were also analysed. In order to match regions, identification of those regions with best practices is needed and excellent examples were looked for. The regions prioritising specific technologies or non-technological issues ("a common pathway") but with gaps in the implementation measures were also studied. This means that some regions described plans but did not provide any concrete actions towards the implementation of these plans. *Transnational collaboration and knowledge transfer* were studied in the NECPs, and countries, which have strong transnational collaboration, were listed along with the technologies or non-technological issues under cooperation.

The criteria on the selection of the pathways took into account also the areas that were seen as *strong European competitive areas* and important to be further developed and supported by both of the research and industry. One area of interest was the *maturity of the technology*. Some of the more mature technologies could be used as an example of less matured technologies. Therefore also *best practices* on R&I, cooperation with industry, social aspects, etc. were analysed, if these could be applied as models for the pathways and future piloting of the pathways. *Policy gaps* with no clear implementation, hence hindering or preventing the uptake of the technologies or non-technological issues, were also tried to identify. *Research and funding opportunities* that were mentioned in the NECPs relevant to the research–industry cooperation and technology development were also studied. The NECP analysis to select the pathways also consider reasons for the gaps, e.g. identify the technologies that are not appropriate for certain countries are not sufficiently mature in their development to take into implementation. *Emerging transition issues*, e.g. system integration, market integration and social acceptance were also analysed in the NECPs.

The *position of EERA* in regard to the potential pathways was also taken into account. Technologies and non-technological issues that EERA Joint Programmes could bring strong and significant impact were regarded with high importance. Also, *links to the EU plans* such as technological strategies and national strategies were considered when selecting the pathways. *Related platforms*, especially the industrial platforms such as ETIPs, had weight on selecting the pathways.

In the analysis of the NECPs based on the criteria presented above, the following technology and non-technology related areas were identified as possible pathways, representing a balanced mix of above mentioned factors, i.e. different levels of maturity of technologies, different geographical areas, excellent regional cooperation or the existance of cross-cutting aspects that could be applied for several technologies to ensure the energy transition.

- Renewable heating and cooling; several technologies to implement with many active countries (e.g. Cyprus, Belgium, Croatia, Finland, Greece, Hungary, Italy)
- Hydrogen; cross-cutting in several areas related to fuels (e.g. Portugal, Germany, France, Netherlands, Belgium, Croatia, Denmark, Estonia, Greece, Hungary, Italy, Latvia)
- Storage (e.g. Belgium, Croatia, Denmark, Greece, Italy, Latvia)
- Solar and wind energy development (including infrastructures) (e.g. Ireland, Croatia, Denmark, Greece, Latvia)
- Smart grids / examples of common electricity markets (e.g. Denmark, Finland, France, Italy, Latvia)
- Transport sector; biofuels, hydrogen, batteries, distribution infrastructure, etc. (e.g. Latvia)
- Circular economy (e.g. Croatia, Estonia)

Additional topics that were also identified to be applied in the pathway piloting included:

- Regional cooperation, e.g. Baltic countries, Eastern Europe, Nordic countries, Pentaforum
- Funding programs in different countries (e.g. Denmark, Estonia, Finland, France, Italy, Latvia)
- Regulation

Based on the analyses, the following **six pathways** were selected, as they represent important technologies in the energy transition, present several examples of best practices and offer opportunities for cooperation with industry and knowledge transfer. They cover strong R&I within European RTO and university forum, being also represented by EERA Joint Programmes.

- Energy systems integration
- Bioenergy
- Energy storage
- Hydrogen
- Solar power
- Wind energy.

1.7 SUPEERA webinars

In order to mitigate the adverse cirumstances of the pandemic which prevented the organisation of the physical workshops, three webinars on “Bringing research and industry closer - accelerating innovation & uptake by industry” were organised. The objective of the webinars was to introduce the selected pathways, two at a time, to discuss objectives and their piloting with relevant stakeholders and to assure their involvment in the workshops that will be organised as soon as the circumstances will allow. For the webinars, both R&I and industrial points of view were included besides the presentations of the SUPEERA pathways. The EC intervention on EU policies and strategies in the respective fields were also covered. Based on the discussion and feedback, SUPEERA project will draw recommendations to be disseminated later, e.g. towards the European Commission and Member States and Associated Countries. The webinars are shortly presented in the following.

Webinar #1 on Hydrogen and Offshore Wind Energy 8.10.2020

On the 8th of October, SUPEERA hosted the first webinar of the series “Bringing research and industry closer: Accelerating innovation and uptake of new technologies”, which aims at exploring different technology pathways to reach the Clean Energy Transition (CET). The event was particularly focused on pathways Hydrogen and Offshore Wind. These two energy sources have been chosen due to the strong focus they have, both at European and national level, their relevance for EU strategy on clean energy, and the existing examples of cross-sector collaboration. The findings of the analysis developed by SUPEERA triggered the discussion amongst the panellists.

Wind energy currently represents one of the main and most advanced renewable energy sources in Europe. However, a key area, offshore wind, has not yet been fully exploited while it holds great potential. The Commission has published its Strategy for Offshore Renewable Energy, but the road ahead is still long. *“The technology we have today cannot support the goals of the EU*” stated Peter Eecen, Coordinator of the Joint Programme on Wind Energy at EERA. In addition, many barriers remain, hampering the adoption of the technology. Eecen underlined that these barriers, ranging from safety issues to environmental factors, need to be addressed together, otherwise they may halt or reverse the progress achieved so far. According to Peter Eecen, *“technology alone will not make it”,* as it will need a strong push from citizens as well.

Alexander Vandenberghe, from the ETIP Wind platform, supported this view and reinforced that industry and research need to *“find areas where everybody agrees there is a need for collaboration”.* While many projects focus on collaboration where public spending is involved, Vandenberghe highlighted that a significant part of collaborative initiatives happens outside of this scope. *“40% of the revenues of research institutes come from bilateral partnerships with industries*”, claimed Vandenberghe.

For its part, Hydrogen will be crucial for the energy transition, as it has the potential to act as a potential substitute for fossil fuels, while also attracting investments and creating jobs that will sustain its implementation. European focus on hydrogen has led to a new strategy published in July 2020 and to the launch of a European Alliance on Clean Hydrogen. Amidst all these initiatives, *“the EERA Joint Programme on Fuel Cells and Hydrogen is trying to clarify the state of play for hydrogen”* said Stephen McPhail, Coordinator of the EERA Joint Programme. This Joint Programme has drafted an implementation plan to prioritise the next steps for research. One of the main objectives is to make research facilities accessible.

Laurent Antoni, President of Hydrogen Europe Research, highlighted that *“Hydrogen is not a silver bullet, [but] is one of* the *energy vectors to be considered”.* While Europe is currently a global leader in hydrogen, efforts in R&D must be supported further not to *“lose competitiveness like [what happened with] batteries”*. According to Antoni, the main challenges are commercial maturity and ensuring a safe deployment of clean hydrogen. To this end, research is called to play a major role in providing a low Technology Readiness Level (TRLs) solution, by addressing critical technical barriers and training engineers, technicians, and operators.

The discussion was be based on the webinar presentations, in the context of good examples of research-industry collaboration to support energy transition (and what makes them good examples), how could they be replicated in other regions/countries with similar priorities but with different contexts, what are the main obstacles to research-industry collaboration in the technology areas, what kind of support is needed to overcome the obstacles and at what level (funding, policies…) and how can EERA give support.[4]

Webinar #2 on Bioenergy and Energy storage 17.3.2021

On March 17th, SUPEERA hosted its second webinar focused on Bioenergy and Energy Storage.

During the webinar apart from the insights of SUPEERA project partners on NECPs analysis insights from EERA partner organizations were presented and discussed. Insights related to the first pathway on Bioenergy were presented by Andrea Monti, Professor at UNIBO and EERA JP Bioenergy Coordinator, Raquel Iglesias Esteban, Head of Biofuels and Biochemicals Unit at CIEMAT and EERA JP Bioenergy member, and René Venendaal, Vice-Chair of ETIP Bioenergy and SET IWG-8 and CEO of Biomass Technology Group (BTG).

The Bioenergy panel started by underscoring that, with about 60% of renewables being produced by biomass, bioenergy represents the largest renewable energy source worldwide. According to Andrea Monti, the deployment of bioenergy is crucial to reach the EU's energy and climate targets. Monti also pointed out recommendations on how to get research closer to industry, such as short-term exploitation of results, a clear understanding of return on investment, as well as effective communication across the value chain and reduction of bureaucracy to facilitate cooperation. For her part, Raquel Iglesias Esteban outlined some of the best collaboration practices in the field of biofuels. As an example, "PERSEO Biotechnology", a project developed by CIEMAT and IMECAL, was brought forward. *"Demonstration projects are necessary to implement new biotechnology processes and they represent a type of collaboration providing competitiveness in the marketplace"* Iglesias Esteban concluded. Closing the topic, René Venendaal presented the perspective of industrial-led organizations concerning the production and deployment of biomass and biofuels.

Consecutively, insights regarding the second pathway, Energy Storage, were introduced by Stefano Passerini, Director and Professor at Helmholtz Institute Ulm and EERA JP Energy Storage Coordinator, followed by Alexey Koposov, Senior Scientist at IFE and EERA JP Energy Storage SP1 Deputy Coordinator, and Alessandro Romanello, ETIP Batteries Coordinator.

During his intervention, Stefano Passerini described the EERA Joint Programme on Energy Storage (JP ES) and outlined the key priorities of the field such as the hybridization of energy. In relation to this topic priority, "StoRIES" (Storage Research Infrastructure Eco-System), a proposal recently submitted by the Joint Programme, focuses on improving materials for devices and optimizing hybrid energy systems with the aim of making energy technologies more competitive and reducing costs. For his part, Alexey Koposov outlined some of the best

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[4] The webinar was recorded and the link to the webinar can be found at the SUPEERA website: https://www.supeera.eu/news-and-resources/511-news/2132-research-and-industry-must-find-a-common-ground-to-achieve-the-eu-goals-on-energy-and-climate.html.

practices of the Joint Programme by thoroughly presenting the SIMBA (Sodium-Ion and Sodium Metal Batteries) project and its objectives.

To close the Energy Storage pathway, Alessandro Romanello provided an overview of the experience of Batteries Europe in bridging the gap between research and industry, highlighting the contribution of the industrial-led alliance in affirming the role of EU batteries in the global market. More specifically, Batteries Europe has done so by providing input and recommendations on R&I priorities in the field of batteries, which were subsequently converted by the Battery Partnership, the partnership representing the industrial sector, into concrete actions to be negotiated with the European Commission within Horizon Europe R&I framework programme. Furthermore, Romanello outlined some of the priorities identified by Batteries Europe to transform new developments from concept to market readiness, such as a focus on short- and long-term research efforts ensuring consistent growth of the industry, as well as a focus on digitalization as a booster to accelerate technological development.

In summary, the webinar showed how, despite its crucial importance, the relationship between industry and research still needs further input and development to effectively produce results. However, the additional effort will be outweighed by the benefits: such cooperation would create a mutually beneficial partnership, producing ground-breaking innovation and accelerating the uptake of new technologies, strengthening the EU’s long-term recovery capacity.[5]

Webinar #3 on Solar power and Energy systems integration 28.4.2021

On 28 April, SUPEERA hosted the third webinar focused on the pathways on Solar Power and Energy System Integration.

The key findings from the NECPs analysis on the two selected pathways, Solar Power and Energy System Integration, were presented respectively by EERA, VTT, and DTU, SUPEERA project partners. In addition to the partner presentation insights related to the pathway on Solar Power and energy system integration were presented by Francesco Roca, Research Manager at ENEA and EERA JP Photovoltaics member, Ricardo Sanchez, Project Coordinator at CIEMAT and EERA JP Concentrated Solar Power (CSP) member, and Roch Drozdowski-Strehl, Vice-Chair of ETIP PV and CEO at IPVF.

During his presentation, Francesco Roca outlined some examples of national initiatives that aim at fostering collaboration between the PV R&I sector and the industry. Roca highlighted the role of IAPI, the Italian network for Photovoltaic R&I pathways, in translating the priorities of the PV Implementation Plan of the SET Plan into a comprehensive Action Plan to make the green transition a reality. For his part, Ricardo Sanchez gave an overview of the main barriers hindering the cooperation between research and industry in the solar energy field. Among the latter, he mentioned a lack of trust of companies, different work paces, and a lack of commercial power plant projects.

Closing the Solar Power topic, Roch Drozdowski-Strehl presented the perspective of industrial-led organisations and outlined key recommendations for Member States to boost the cooperation between R&I and industry. As an example, Drozdowski-Strehl mentioned the

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[5] The recording of the webinar is on the SUPEERA website: https://www.supeera.eu/news-and-resources/2605-bridging-the-gap-between-research-and-industry-supeera-s-pathways-on-bioenergy-and-energy-storage.html.

implementation of sectorial flagship initiatives that could help the industry to benefit from greater incentives.

Insights regarding the pathway on Energy System Integration were introduced by Laurens de Vries, Associate Professor at TU Delft and EERA JP Energy System Integration Coordinator, and Maria Laura Trafiletti, ETIP SNET Coordinator.

During his intervention, Laurens de Vries provided valuable insights on the importance of Energy System Integration, as well as on the challenges faced in the field, bringing forward PROMOTioN, an H2020 project that developed a complete and feasible vision for the regulation, organization, and financing of a North Sea wind infrastructure. Diving deeper into the needs and challenges of the sector, Maria Laura Trafiletti provided an overview of the experience of ETIP SNET in bridging the gap between research and industry, by outlining identified obstacles and mitigation measures. Trafiletti emphasized the need to foster a much stronger collaboration between private industry and public R&D centres. Such cooperation is essential to enhance synergies between policy-related goals and investment capacities necessary to transform R&D results into industrial deployment.

In light of all interventions, the webinar showed how the relationship between academia and industry still needs further input and development to effectively deliver results.

During the webinar, the presenters also suggested and discussed different barriers for the energy system integration and some recommendations for the PV sector improvement.[6]

1.8 Stakeholders mapping

The stakeholders mapping was performed with all the project partners, listing relevant organisations and public bodies. These included *EERA Joint Programmes, ETIPs, industrial platforms, SET Plan Steering Group and Implementation Working Groups, EC and non-profit organisations and consumer organisations*.

EERA Joint Programmes include: Advanced Materials and Processes for Energy Applications (AMPEA), Bioenergy, Carbon Capture and Storage (CCS), Concentrated Solar Power (CSP), Digitalisation for Energy, Economic, Environmental and Social Impacts of the Energy Transition (e3s), Energy Efficiency in Industrial Processes, Energy Storage, Energy Systems Integration (ESI), Fuel Cells and Hydrogen (FCH), Geothermal, Hydropower, Nuclear Materials, Ocean Energy, Photovoltaic Solar Energy, Smart Cities, Smart Grids and Wind Energy.

ETIPs include: ETIP SNET, BATTERIES Europe, ETIP Bioenergy, ETIP Deep Geothermal, ETIP Ocean, ETIP Photovoltaics, ETIP Wind, RHC-ETIP (Renewable Heating and Cooling), SNETP (Sustainable Nuclear Energy Technology Platform) and ZEP (Zero Emission Platform).

Other identified relevant industrial platforms include KIC InnoEnergy, KIC Climate, KIC Urban Mobility, EMIRI, Umicore, EASE (European Association for Storage of Energy), Hydrogen Europe Secretariat, Fuel Cells & Hydrogen JU – Secretariat, Clean Hydrogen Alliance, EUREC, Solar Power Europe, Solar Heat Europe, Wind Europe, CEFIC (European Chemical

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[6] Link to the recorded webinar can be found in the SUPEERA website: https://zoom.us/rec/play/minyL2MEZpDG6IIuxuTIWdxTuVmpXnADgQluc1IwcNM6VY2CxCIYYD674qk3bAGzN7BhIt241ExkukYZ.8xqEeQTNxne-5S-9.

Industry Council), A.SPIRE, European Green Vehicle Initiative, European Batteries Alliance, Big Data Value Association/Big Data PPP, European AI Alliance, ETP for HPC, ECTP/EE Buildings PPP and Bio-based Industries JU.

Other organisations listed as stakeholders include BEUC, Friends of the Earth Europe, European Environmental Bureau, WWF, and EuroCities. For some JPs and industrial platforms, the pathways represent relevant technologies, but the pathways with their findings can be applied for several JPs, ETIPs, and other industrial platforms, especially in cross-sectoral issues.

II ANALYSIS OF THE SIX IDENTIFIED PATHWAYS

2.1 The pathway analysis on ‘Energy Systems Integration’

Terminology

To meet the globally recognized imperative to cut carbon emissions through the deployment of large renewable energy capacities, while maintaining reliability and competitiveness, flexible energy systems are vital. This flexibility can be achieved through integrating various systems, not only energy carriers and technologies, but also infrastructures across geographical scales, the governing institutional mechanisms and also other infrastructures; water, data, and transport.[7]

Energy system integration refers to the coordinated planning and operation of the energy system ‘as a whole’, across multiple energy carriers, infrastructures, and consumption sectors.[8]

Sector coupling involves the increased integration of energy end-use and supply sectors with one another.[9] Sector coupling can either be interpreted as end-use sector coupling, which mainly addresses the electrification of the end-use sectors and providing balancing services to the power sector, or as supply-side integration through coupling electricity and gas. This is referred to as cross-vector integration.[10]

Variable renewable energy refers to electricity generation from dispatchable sources that have a fluctuating availability, e.g. wind and solar.

Controllable renewable energy refers to electricity generation whose output can be dispatched on demand, e.g. biomass and hydropower.

Flexibility of a power system refers to the extent to which a power system can modify electricity production or consumption in response to variability, expected or otherwise.

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[7] O’Malley et al (2016).Energy Systems Integration: Defining and Describing the Value Proposition. International Institute of Energy system integration. https://doi.org/10.2172/1257674.

[8] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0299&from=EN.

[9] https://www.europarl.europa.eu/RegData/etudes/STUD/2018/626091/IPOL_STU(2018)626091_EN.pdf.

[10] https://energia.fi/files/4385/Greenlink_-_Sector_Coupling_-_the_final_report.pdf.

Demand-side management (**DSM**) or **demand-side response** (**DSR**) refers to actions to modify consumer-level energy demand toward reducing energy consumption during peak hours, or shifting the time of energy consumption to off-peak times.

Background information

The European Commission presented EU strategy for Energy System Integration in July 2020 as part of European Green Deal. The strategy defines energy system integration as “the coordinated planning and operation of the energy system ‘as a whole’, across multiple energy carriers, infrastructures, and consumption sectors.”

The strategy proposes concrete policy and legislative measures at EU level to shape a new, integrated energy system. The strategy indicates the following main policies, directives and regulations:

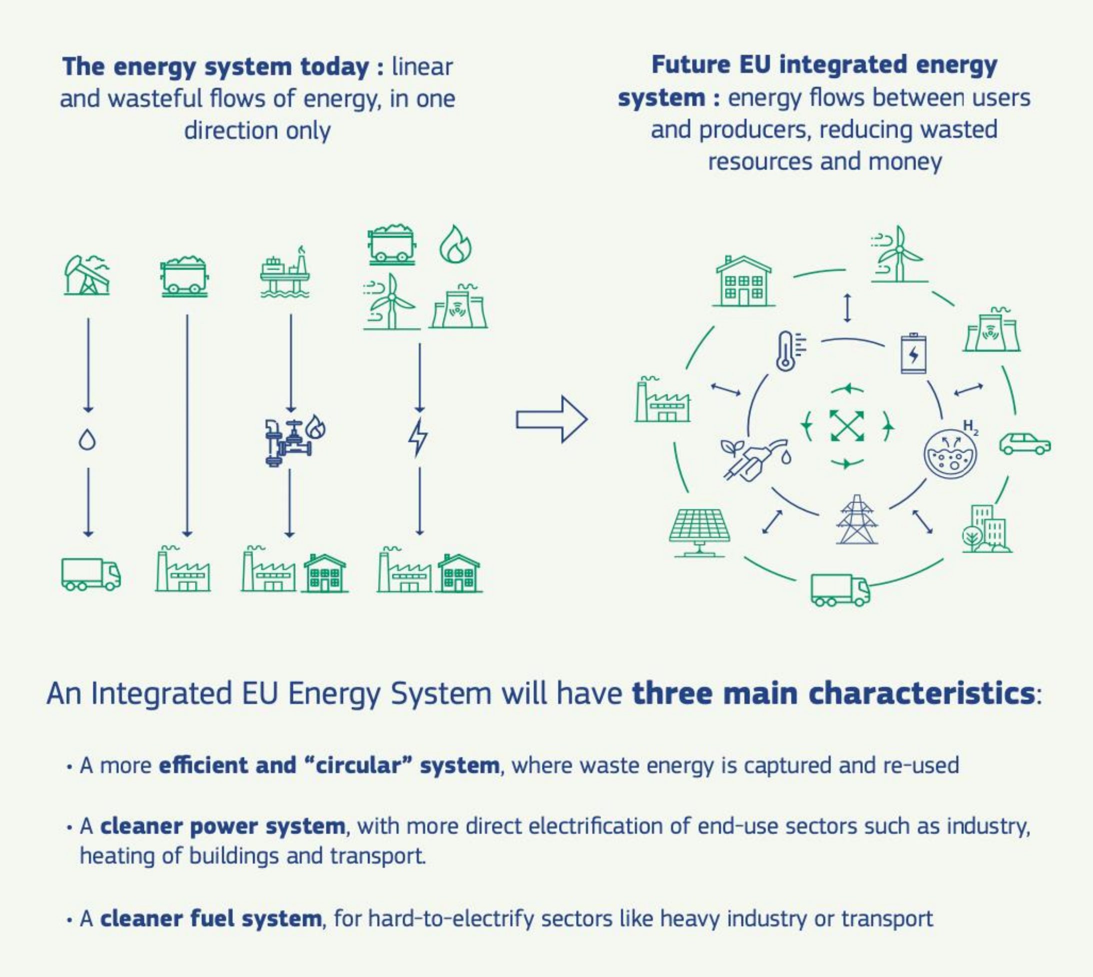
- Clean energy package
- Energy efficiency directive
- Renewable energy directive
- Energy performance in buildings directive
- Industrial emissions directive
- Alternative fuels infrastructure directive
- TEN-E regulation (grid infrastructure)
- Network code in demand side flexibility

The strategy defines three principles for system integration:

- More ‘circular’ energy system, prioritising energy efficiency and the least energy intensive choices
- Greater direct electrification of end-use sectors, largely RE-based power system and removing barriers
- Use of renewable and low-carbon fuels, incl. Hydrogen, if direct heating or electrification are not feasible

In addition, consumers will play an active role in energy supply in a more integrated system. Energy infrastructures, energy markets and digitalisation are identified as critical enablers for successful system integration.

The EU Energy System Integration Strategy



The energy system today : linear and wasteful flows of energy, in one direction only

Future EU integrated energy system : energy flows between users and producers, reducing wasted resources and money

An Integrated EU Energy System will have **three main characteristics**:

- A more **efficient and "circular" system**, where waste energy is captured and re-used
- A **cleaner power system**, with more direct electrification of end-use sectors such as industry, heating of buildings and transport.
- A **cleaner fuel system**, for hard-to-electrify sectors like heavy industry or transport

Figure 1. The EU Energy System Integration Strategy. [11]

Energy system integration has multiple facets. This analysis focuses on the first and second principles of the Energy Sector Integration Strategy: improving energy efficiency and applying circular economy principles, and increasing electrification in end-use sectors. Regarding the first principle, district heating and cooling has been used as an indicator for opportunities to system integration, in terms of taking advantage of RES electricity and heat generation, via e.g. heat storage tanks, heat pumps integration to various RES sources, and biogas. However, district heating and cooling are to be seen as a particular type of integration potential that exists within specified conditions. Where potential does not exist, e.g. due to dispersed settlement patterns, other sustainable technologies, e.g. individual heat pumps, may supply the same energy services more efficiently.

Smart metering was chosen as indicator for the second principle of the ESI strategy, increasing end-use electrification. Smart metering, or advanced metering, is as a critical

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[11] Source: European Commission, The EU Energy System Integration Strategy.

enabler for smart grids and implementing flexibility in electricity system. Network operators (DSOs and TSOs), in particular are the key actors for the deployment of smart grids.

Their task is to implement the network infrastructure that allows the flow of both energy and information between consumers, generators, suppliers and other service providers in the new smart grid framework. The progress in smart metering therefore also indicates to the capacities of smart grid participants, including TSOs and DSOs, grid users such as generators, consumers, storage owners as well as other actors.[12] Therefore, the status of electricity metering serves as in important indicator of the existing possibilities in energy system integration in the electricity sector at a given time.

The third principle addresses largely the sector coupling of electricity and gas sectors and solutions for sectors that are difficult to decarbonise via the two preceding principles. This principle remains beyond the scope of this analysis. More specifically, Power-to-X, apart from hydrogen, has not been included in the pathways chosen for SUPEERA project. Furthermore, combustion engine-based mobility and transport sector are largely beyond of the scope the pathways analysed.

Assessment of Energy System Integration per Member State

Austria

For Austria, sector coupling is a vital part of developing a decarbonised energy system. Sector coupling allows the flexibility of electricity demand to be increased significantly. Austria has two ESI-specific development plans, Mission Plus-Energy Neighbourhoods and Mission Integrated Regional Energy Systems, which e.g. address topics like flexibility and resilience of neighbourhoods, seasonal transferability of energy, flexible energy storage for local use, local waste heat sources, digital sector coupling and low-temperature heating networks.

The following coupling is currently in use or being tested: power-to- gas, power-to-heat, power-to-chemicals and cogeneration. Renewable hydrogen may become a key technology for sector integration and linking.

In Austria, key to integrated urban development is a central heating and cooling supply to conurbations which uses waste heat from existing high-efficiency CHP plants, waste incineration, industrial waste heat and the efficient use of heat from biomass plants. Significant use is already being made of high-efficiency cogeneration and efficient district heating and cooling. Grid densification is ongoing.

Austria’s main objectives and measures affecting the security of energy supply dimension includes accelerating demand response. By the end of 2020, 80% of meter points are to be converted to new digital meters and at least 95 per cent of households should be equipped with smart meters by the end of 2022 where technically feasible.

Due to its central geographic location, Austria is particularly affected by north-south connections and energy flows, and must therefore increasingly balance out volatility in renewable energy generation.

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[12] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52011SC0463&from=EN.

In 2018, public spending on energy research in Austria amounted to EUR 144 million. The priorities for state-funded energy research in Austria are energy efficiency, transmission / storage technology (smart grids) and renewables.

In large test areas, innovative energy technology from Austria will be used to develop and demonstrate model solutions for smart, safe and affordable energy and transport systems. One of model regions already up and running is GreenEnergyLab, whose focus is to demonstrate smart grids, demand side management and demand response.

Belgium

In terms of energy system integration, the NECP does not directly address system integration or sector coupling.

In the past, district heating has not been commonly used in Flanders. However, since financial support was introduced in 2013, involving regular calls for tenders for green heat, waste heat, district heating systems and geothermal energy, a large number of new projects have been implemented and are still planned. Renewable energy accounted for 39% of the heat supplied to these systems in 2017, with this figure expected to rise to 52% by 2020.

District heating in Wallonia is not reported, either. Wallonia will support the development of various forms of renewable heat, based on their respective advantages, through one or more appropriate mechanisms. In order to achieve Wallonia’s renewable targets while protecting air quality, measures will be introduced to encourage the replacement of poor-performing individual biomass heating systems with stoves to reduce the emission of particulate matter.

Considering the smart grids and flexibility in Flanders, since mid-2019 smart meters enable real-time consumption information, targeted communication and budget meters that can be set to even prevent the accumulation of debt. This approach is used to protecting energy consumers against disconnection and alleviating energy poverty.

In Walloon region, the phased roll-out of smart meters must be systematically installed and activated (communication function) by 1 January 2023 at the latest, unless this is technically impossible or not cost-effective.

From 2020, between 5% and 10% of the Federal R&I budget will be spent on climate- and energy-related projects. At federal level, the Energy Transition Fund will be used to promote innovative projects.

Bulgaria

Bulgaria NECP does not directly address system integration or sector coupling.

Reflecting the heating and cooling, the Bulgarian district has predominantly developed in the capital city Sofia as well as in other large Bulgarian cities, serving 18% of Bulgarians in 2015.[13] In 2030, the final consumption of energy for heating and cooling in Bulgaria is projected to decrease by 2% as compared to 2020 owing to the additional measures improving energy efficiency. Energy efficiency potential of central heating and cooling will be achieved by

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[13] https://www.euroheat.org/knowledge-hub/country-profiles/district-energy-bulgaria/.

rehabilitating heat transmission networks and replacing obsolete DH stations with highly efficient units. The average power density of district heating systems will allow to reduce average heat losses to 10% (against current 23.7%).

Priority will also be given to the introduction of high-efficiency cooling and heating systems and innovative technologies using geothermal, hydrothermal and solar energy, and waste heat and cold. Bulgaria projects 42.60% RES in heating and cooling in 2030.

The following, related measures from the Third National Climate Change Action Plan 2013-2020 are extended until 2030:

1. Reconstruction of district heating cogeneration systems and boilers with natural gas turbines;
2. Reducing losses in heat transmission networks;
3. Transition from coal to natural gas;
4. Increasing high efficiency cogeneration;
5. Increasing the share of heating and cooling from renewable sources;

Bulgaria indicates introducing smart metering devices as the first measure to increase flexibility in energy system. During the period 2021-2030 Bulgaria envisages to introduce interim measures to enable the reform in creating appropriate conditions and increased participation of demand response for individual and aggregated participants, both in the wholesale and balancing market.

The Bulgaria government's policy on research, innovation and competitiveness aims to promote the deployment of smart grids and energy storage technologies and research into the possibilities to deploy electrochemical power sources, such as rechargeable batteries, hydrogen and fuel cell technologies.

Bulgaria has identified possibilities for co-operation with Romania and Greece in the development of smart grids and smart metering, smart medium-voltage and low-voltage electricity distribution systems and efficient use of local energy sources.

Croatia

The NECP does not directly address system integration or sector coupling.

Connsidering heating and cooling district heat served 6% of residential clients in Croatia in 2017[14]. As the estimated share of cogeneration in Croatian district heating and cooling systems is 79%, Croatia fulfills the requirement on the promotion of the use of energy from renewable sources. Also the increase in energy efficiency in district heating and cooling systems is already being implemented in the period until 2020 as part of the State Aid Programme for increasing the efficiency of district heating systems.

District heating systems have been identified as one of the priorities of the energy policy in Croatia. The measure for the maintenance and upgrading of existing DHS systems, envisages also stopping the trend of disconnecting customers, introducing heat storage tanks to integrate RES electricity, using RES for DHS and replacing existing heat production with RES and heat pumps. To integrate more RES into DHS and later district cooling, it is necessary to create the

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[14] https://www.euroheat.org/knowledge-hub/district-energy-croatia/?hilite=%22croatia%22.

conditions for connection and operation of the respective production units, in particular geothermal power plants, which operate mainly as baseload supply.

The introduction of advanced metering systems by 2025 has been identified as priority for investment in the distribution system. Pilot projects for advanced grids are envisaged, to explore the characteristics of grid users and possibilities of their active participation in the power system.

Existing measure for reduction of losses in the distribution power grid involves introduction of advanced meters for end customers by Croatian Electrical Utility's HEP-DSO. For the pilot project "Introduction of smart grids in pilot areas", EUR 20 million has been provided to HEP-DSO.

Following measures are planned:

- Reduction of losses in the distribution network and introduction of smart grids
- Elaboration of the regulatory framework for active participation of customers in the electricity market
- Introduction of advanced metering and data management systems

The funds of the Modernisation Fund will be used for investments in: modernization of industrial production, production and use of electricity from renewable sources, improvement of energy efficiency, energy storage and modernization of energy grids, energy efficiency in transport, buildings, agriculture and waste management.

Cyprus

Cyprus NECP does not directly address system integration or sector coupling. Investments in renewable energy technologies in buildings, as well as in heat pumps lead to an increase in the renewable energy share in the heating and cooling sector. The renewable energy share will increase toward 2030, driven by solar thermal technologies (water heaters) and heat pumps in buildings. An increase in district heating network is projected during the end of the period, due to some technical and economic potential for district heating systems in the two tourism areas.

The total estimated investments for the period 2021-2030 will need to increase to 910 million euros, as annual investment cost, cumulative up to 2030. The RES share foreseen in the heating and cooling sector increases and reaches 39% in 2030.

The objective to deploy an Advanced Metering Infrastructure, including the roll-out of 400,000 smart meters by January 2027, will enable various flexibility measures and increase direct final customer participation in electricity markets. The timeline for installing 400,000 smart meters will be equally divided in seven installation rounds, each round consisting of the installation of 57,143 smart meters. The completion date for the first round is January 2021 and for the seventh round in January 2027.

Dynamic pricing retail contracts will be introduced gradually as the installation of smart meters is roll out and the competitive electricity market becomes operational. Cyprus shall provide the necessary regulatory framework. The final customers who have a smart meter installed can request a dynamic electricity contract from a supplier that has more than 200,000 final customers. Estimated timeframe for meeting this objective is 8-12 months after the installation of 200,000 smart meters i.e. September 2025- December 2025.

During the period 2015-2020, the Smart Specialization Strategy for Cyprus (S3CY) prioritized domains and activities where the country has a competitive advantage or the potential to generate knowledge-driven growth through R&I. Energy was identified as the main priority along with tourism. S3CY identified the following energy sector priorities in the development or improvement of RES technologies and storage, in particular solar energy.

Czechia

The Czech NECP also does not directly address system integration or sector coupling.

The Czech Republic has a developed heating sector that will be transformed for the use of low-carbon energy sources, including energy from secondary sources and waste heat. Development of the use of RES in existing heat supply systems will be crucial in achieving the Czech Republic’s 2030 target. The Czech Republic therefore plans to support mainly the modernisation of existing heat supply systems in order to meet the requirements for efficient energy supply systems under the Energy Efficiency Directive. There is also room for the creation of new, especially smaller, renewable heat supply systems, e.g. biogas stations.

In connection with the decarbonisation targets, one of the gas sector’s goals is to prepare the gas transmission and distribution system for a higher share of new gas types and sector coupling.

The conditions for the implementation of smart metering in the Czech Republic are being prepared within the framework of the National Action Plan for Smart Grids.

National Priorities of Oriented Research, Experimental Development and Innovation originate from 2012 and are valid for the period up to 2030. The key documents containing measures to increase the flexibility of the energy system is the National Action Plan for Smart Grids and its’ Update. NAP SG 2019–2030 involves 20 projects divided into three main groups: support, implementation and pilot. Four pilot projects testing flexibility technologies are included:

- Flexibility of battery systems (0.5 MW and above) to provide balance and other support services
- DECE flexibility (0.5 MW and above) to provide balance and other support services
- Flexibility of large consumers (connected to 110 KV) to provide balance and other support services
- Aggregation of supply-side flexibility providers (including prosumers) connected to HV and LV to provide balance and other support services.

Denmark

System integration is a growing and very important area. In addition to smart grids, system integration covers aspects relating to energy storage and smart energy. Smart energy covers several energy grids, energy types and sectors in the energy infrastructure (electricity, heating, cooling, gas, transport).

Denmark sees the developments within system integration, to a great extent, a question of creating dynamic incentive structures which can incorporate different technologies and different parts of the energy system in an integrated interplay, and in a technologies and concepts that can store the energy from periods with high production and low demand and save it for peak demand periods, or, alternatively, to convert the energy to other, high-value energy products (e.g. fuels).

According to the Comprehensive Assessment of the Potential for High-Efficient Cogeneration and Efficient District Heating and Cooling and in Denmark, the total cooling potential is around 5,000 MW, of which approximately 40% could be covered by district cooling networks.

As part of the green transition, the roles in the energy system of the heating and district heating sectors are expected to change. Electrification and a higher degree of distributed generation will support the incorporation of fluctuating RE-sources in the electricity system, as an example. Moreover, the use of geothermal energy in the heating sector is expected to increase and the use of surplus heat as well. The renewable share in the heating and cooling sector and the district heating sector is expected to be achieved mainly through the use of biomass and heat pumps.

Denmark is particularly interested in smart grids because of the need to integrating large amounts of intermittent wind power into the existing system, and to regulate electricity consumption efficiently and intelligently. One element in this context is activation of consumers through hourly meter pricing and smart meters. Denmark has an overall objective of rolling out smart meters to all consumers by 2020.

Denmark established Energy Technology Development and Demonstration Program (EUDP) in 2007 to support national energy targets regarding a stable and secure energy supply. EUDP supports actions under the SET Plan, IEA and Nordic Energy Research and funds projects in many different energy sectors. In 2018 the EUDP allocated 86% (approximately DKK 362 million) of its funds to four different sectors: Wind, hydrogen and fuel cells, system integration and energy efficiency.

Denmark has committed to spend DKK 580 million in 2020 and 1 billion DKK in 2024 on research, development and demonstration (R&D) of new technologies related to energy and climate. A large share will go to the EUDP programme, which funds projects in line with SET Plan objectives.

Estonia

As most of the NECPs Estonia NECP does not directly address system integration or sector coupling.

Building energy and district heating are important in Estonia, where the energy consumption of the households forms 42.7% of the total energy balance, whereby heating accounts for the greatest share of consumption. New residential areas are mainly connected to district heating regions. State-applied energy efficiency policies focus increasingly on renovating buildings to make them more energy-efficient. National energy development plan (NDPES 2030) comprehensively addresses energy consumption in transport and district heating sector, including cogeneration. An analysis of district heating systems showed that it is more profitable to reconstruct the existing district heating infrastructure than to replace it with a new system. The potential regions for the district cooling in Estonia are downtown Tallinn and Tartu.

All Estonian electricity consumers have been supplied with remotely readable meters as of 1 January 2017. The Electricity Market Act prohibits discrimination of market participants. The network operator is obliged to connect any electrical installation which conforms to requirements and is located in its service area. As from 2018, aggregators are able to enter into a contract with the TSO (Elering AS) to provide a balancing service, on the same principles as other market participants. The regulation will be updated to cover independent aggregators and energy storage in accordance with Directive (EU) 2019/944 on the internal market for electricity.

As regards the Baltic States, it should be taken into account that the electricity system of the Baltic States is not synchronised with the synchronous areas subject to EU law. Therefore, the liberalisation of the balancing market is more complicated than for other EU Member States. E.g. the price of the balancing service is considerably influenced by balancing deliveries from Russia.

Research and development activities relating to the energy sector contribute to the achievement of the overall national research and development targets. In the ‘State budget strategy 2019-2022’, energy-related research and development would be funded from 2019 in the four subsequent years to a total of EUR 1.6 million, i.e. EUR 400,000 a year.

The NDPES RD program focuses on:

- development of the environment for dissemination of energy-related information
- participation in international cooperation in energy technology and in energy-related projects,
- integration of RES into the power grid and security of supply,
- introduction of biofuels and adoption of electric vehicles,
- availability of bioenergy resources in the future,
- development of a long-term strategy for the renovation of buildings (by March 2020), and
- more efficient use of oil shale.

Finland

The NECP contains a comment that there are not yet concrete political measures aimed at sector coupling and thus not in NECP either, but it is a topic is already discussed in e.g. the Nordic cooperation.

Finland efficiently utilises the Cogeneration Heat and Power (CHP) and district heating potential. District heating is used to heat around 90% of all Finnish residential apartment buildings, 30% of industrial buildings and more than 60% of other buildings. In Finland, district heating networks have been built at almost all sites where it is economically viable to do so. Almost 70% of district heat production is based on CHP.

Finland aims to implement CHP and related district heating and cooling with smart demand response mechanisms to improve energy efficiency, help to increase the share of renewables and link heating with electricity to provide flexibility. Finland will adopt an energy subsidy scheme designed especially for housing companies to support energy efficiency improvements and smart, flexible energy consumption.

The role of flexibility and demand response is emphasised in the National Energy and Climate Strategy. The Ministry of Economic Affairs and Employment’s Smart Grid Working Group proposed an extensive operational programme to increase the demand-side response in 2018. The implementation of these proposals is well under way in Finland. Many elements of the flexibility requirements, such as fully deregulated retail markets, balancing responsibility, customers' ability to choose dynamic tariffs and 100% roll-out of smart meters, already exist in the Finnish electricity market and legislation. The initiatives to promote demand response and storage include the definition of the improved functionalities of next-generation smart meters and the discontinuation of the flexibility implemented by distribution network operators to encourage market-based initiatives.

Finland has invested heavily to the introduction of clean and smart energy systems and associated products and services, in addition to resource-wise solutions based on user needs. For example, the innovation funding agency Business Finland invested approximately EUR 150 million in energy-related projects. The NECPS describes no notable descriptions of demonstration projects cases or plans. Demonstrations can receive supporting funding (e.g. Energy Aid Scheme).

France

France's NECP also does not directly address system integration or sector coupling.

France aims at achieving carbon neutrality by 2050 in French territory. The National Low-Carbon Strategy (SNBC) describes the roadmap to 2050 for France for the implementation of its climate change mitigation policy, and the measures that make it possible to achieve carbon neutrality, including in innovation.

Targets relating to renewable energies are set under the Energy Code. The Energy Code sets a target of 38% for the share of renewable energies in final heat consumption by 2030. The Energy Code also sets the target of a five-fold increase in the amount of renewable and recovered heating and cooling supplied by district heating and cooling networks by 2030 (compared to 2012).

France is introducing smart meters, Linky for electricity and Gazpar for gas. The deployment of Linky smart meters began on 1 December 2015 and will continue until 2021. The NECP reports that more than 23 million meters have already been installed. New metering for electricity and gas are being introduced with the aim of gaining more detailed information on energy consumption and improving the quality of service. Investment into the Linky scheme will total around EUR 5 billion, and respectively for the Gazpar scheme, around EUR 1 billion. Further developments smart meters will enable include optimised management and development of the distribution network and the large-scale integration of renewable energies and electric vehicles.

The National Industry Council is currently made up of 16 Strategic Sectoral Committees. The Strategic Sectoral Committee for New Energy Systems was set up in 2018. The industry-wide contract contains details of four large-scale thematic projects: energy efficiency, renewable energies (focus on biogas and offshore wind), storage (batteries and hydrogen) and micro-grids (scaling up of solutions). A strong focus is placed on innovation, particularly with regard to hydrogen, anaerobic digestion and digital technologies.

Germany

Germany's NECP outlines the principles and enablers that are central to the Commission's ESI strategy. The focus of the current phase of the Renewable Energy Sources Act is the network and system integration of renewable energies. Joint examination of energy infrastructures and sectoral coupling for electricity, heating and transport are Germany’s central goals for 2030. The first prerequisite for properly functioning sectoral coupling is the supra-regional and local energy infrastructure. Fair conditions of competition will also be established, with the view that efficient sectoral coupling, and therefore decarbonisation, should be driven primarily by the market. Increasing integration and flexibility of European electricity markets is a further focus area that is relevant to system integration.

The building sector must significantly reduce the demand for heating and cooling energy through efficiency measures, and the share of renewable energies must increase significantly. Biomass (incl. biogenic waste) will remain the most important RES for the heat generation. Waste heat, geothermal energy and ambient heat via high-capacity heat pumps will be increasingly used in district heating. The majority of district heating from coal CHP plants will be phased-out by 2030. The share of renewables for decentralised space heating and hot water will increase primarily due to heat pumps used in buildings.

The Federal Government is supporting the expansion of low-temperature networks, and in the near term, the transformation of existing heating networks, progressively preparing and converting them for a high share of renewable energies and waste heat. The funding arrangements of Heating Network Systems 4.0 for low-temperature networks represented Germany’s first system-based funding (i.e. funding whole systems rather than individual technologies) in the heating sector. The systems developed within this project showcase a very low temperature, a very high share of renewable energies and waste heat, and often feature large seasonal heat reservoirs as a key component.

The Smart Meters Operation Act has formed the legislative basis for the installation and operation of smart meters in Germany since 2016. It stipulates the roll-out of certified devices with a certificate issued by the Federal Office for Information Security, guaranteeing IT security and privacy by design. Steps have been taken to ensure the efficiency of the roll-out. As of writing the NECP, two manufacturers were certified and further certificates were expected. Installation schedule is not described.

Germany has dedicated research funding to system integration at least since 2007. The 7th Energy Research Programme of the Federal Government, adopted in 2018, covers five main topics, including system integration. Research in the area of system integration focuses is on networks, storage reservoirs and sectoral coupling. Efficient and affordable storage of renewable energies is a crucial research objective. The planned national hydrogen strategy will also focus on energy research.

‘Smart Energy Showcases – Digital Agenda for the Energy Transition’ programme (SINTEG) is aimed at the development and demonstration of solutions to the technical, economic and regulatory challenges of the energy transition. Digitalisation of the energy sector will be the main focus of attention. The Smart Border Initiative (SBI) is a smart grid project between Germany and France that optimises the use of resources and at the same time addresses the needs of regions separated by national borders.[15]

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[15] https://ec.europa.eu/energy/sites/ener/files/documents/pci_factsheet_smart_border_initiative_2017.pdf.

Greece

The NECP does not directly address system integration or sector coupling.

Greece has set an objective for a minimum share of 35% RES in gross final energy consumption and emphasises that the energy transformation takes place in power generation. The RES in electricity consumption should exceed 60% by 2030. High levels of RES electricity generation, as set out in Greece’s NECP, require energy storage to help ensure flexibility and adequate system capacity.

Key energy efficiency actions include e.g. improvement in energy efficiency of public buildings, renovation of the building stock in the residential and tertiary sector; promoting energy efficiency contracts by energy service companies, improving energy efficiency and competitiveness of the industrial sector, as well as in electricity and gas infrastructures.

Energy efficiency of buildings is emphasised, as buildings are currently responsible for 40% of energy consumption. Energy efficiency of buildings requires improving through renovation and modernisation, adopting measures for renewing end-of-lifecycle buildings, and applying the principles of circular economy to using construction and demolition waste.

RES-based district heating and cooling infrastructure is relevant mainly on Northern Greece and/or semi-mountainous/mountainous areas, as well as on certain North Aegean islands where there is both local RES potential for district heating and inter-seasonal thermal needs at a local level.

there is a need to completely digitise networks and meters management to reorganise the electricity and gas markets, in particular, to install digital, ‘smart’ meters and to install centralised systems for the control and management of the operators’ property.

In the context of innovative smart city models, the planning and implementation of policy measures in the building, transport and network sectors is taking place. Smart meters and smart networks will form a key part of these plans. When completed, smart metering will contribute significantly towards the rational use of energy by final consumers. Combined with the new regulatory framework for the demand response mechanism, better electricity balancing and peak load management are to be achieved.

Greece enlists ‘Completion of a programme for the installation of individual smart meters’ and ‘Development of the regulatory framework for demand response’ in policy measures envisaged to improve energy efficiency. However, more information about smart meter installation is not given.

Greece’s NECP enlists two particularly ESI related research and innovation challenges and targeted solutions:

I. Use of new RES technologies to meet the needs for generation, transmission, distribution and storage of electricity:

- ‘Increasing the overall needs for electricity system flexibility and energy storage’
- ‘Optimally integrating RES technologies in distribution networks in direct connection with consumption, as well as integrating ICT’.

II. Use of new RES technologies to meet heating and cooling needs:

- ‘Optimally integrating RES technologies for heating and cooling purposes in the building sector, in particular to new buildings that are to be nearly zero-energy buildings’.

Hungary

Hungary aims to promote the interconnection of the production processes of various forms of energy (electricity, heat and fuels). The coordination of the gas and electricity markets’ operating cycles and regulatory framework is a priority. The convergence of energy systems is also supported by the development of energy storage technologies (e.g. battery, heat storage, power-to-gas technologies). Sector coupling may also extend to the replacement of gas-based heating and cooling with electricity based on RES and heat pumps in regions without the gas network or with a low utilisation rate. Use of the gas network for energy storage purposes can facilitate the integration of RES electricity.

The share of renewable energy in the heating and cooling sector may approximate 30% in 2030 with additional measures. The efficient use of biomass in both individual heating equipment and district heating, and options for using ambient heat through heat pumps have great potential. Hungary plans to reduce gas consumption for heating by improving building energy efficiency, programmes that support RES heating/cooling solutions, and implementation of the Green District Heating Programme that encourages use of RES in DH generation.

Hungary is installing 1 million smart consumption meters in the electricity sector. The smart metering equipment must fulfil of specific specifications, and free of charge to consumers. In parallel, universal service providers and authorised traders shall offer flexible tariff packages to consumers with smart meters, encouraging more effective use of the network. Timeline of this plan is not given.

Hungary is planning a pilot project to support innovative seasonal energy storage. The plans involve:

- Power-to-gas technology based on the operating domestic prototype;
- RES electricity into heat storage in district heating systems;
- Hydrogen storage and consumption;
- Small-scale testing of commercial cold energy and heat storage solutions under operating conditions.

As regards innovative system balance (flexibility energy storage and demand management), the following pilot projects are planned:

- Pilot projects on energy storage systems is recommended for DSOs and TSOs;
- Establishment of a complex, pilot-scaled R&D centre is desirable to coordinate research to test the systemic interconnection of various RES and storage technologies;
- Testing of complex DSR solutions for individual prosumers within a pilot programme, giving the DSO a direct option for intervention to optimise the network load of individual consumers.

Ireland

The NECP recognises that as Ireland moves towards fully decarbonising the energy system, there will be a move towards stronger sector coupling across the electricity, heating/cooling and transport sectors. Offshore wind power and green hydrogen are expected to have a key role in Ireland's transition to a low carbon economy and society.

District heating and cooling in Ireland is at a very low level and is estimated at most at about 0.8% of heat consumption. Due to Ireland's dispersed settlement structure with low population density, the heat demand in Ireland is generally low density. Around 90% of the heat demand is at densities too low to make district heating a viable proposition. Ireland plans to use the two district heating pilot schemes to develop experience and knowledge that can promote and inform further schemes nationwide to facilitate greater uptake of district heating through self-financed heat networks.

Ireland's NECP recognises smart meters as one of the most significant energy infrastructure projects for the coming decades. Smart meters will help decarbonise the society as they facilitate reduced energy consumption, additional energy efficiency and microgeneration. The Smart Metering Programme is set out to implement the plan to install smart-ready electricity meters in every house by 2019-2024.

From the market regulation perspective, one of the main elements of the objective is maintaining and developing the successful all island wholesale Single Electricity Market. The new market and its associated capacity mechanism were launched in October 2018. The new market design addresses aspects related e.g. to smart grids, demand response, storage and distributed generation.

Sustainable Energy Authority of Ireland (SEAI) oversees the National Energy Research Development & Demonstration (RD&D) Funding Programme. SEAI's scope of activity in RD&D activities is to coordinate Irish energy research, including demonstration & innovation activities, and to promote its application in policy and practice. The SEAI National Energy RD&D Funding Programme seeks to grow national capacity in energy research. The prioritisation in energy RD&D areas to be funded is decided through on consultative processes within all sectors of the economy. In addition, the Sustainable Energy Authority of Ireland (SEAI) organises annually a Cross-Government consultation. Smart grid research is included in prioritised research areas.

Italy

Italy's NECP does not directly address system integration or sector coupling.

The final gross consumption on a national level intended for heating and cooling is around 56 Mtoe, equivalent to slightly less than 50% of final overall energy consumption. The principal instruments used to promote the use of thermal renewable energy sources are often integrated with those for energy efficiency and are already operational. In absolute terms, consumption from renewables is expected to surpass 15 Mtoe in the heating and cooling sector, an increase which is primarily linked to the increase in renewable energy provided by heat pumps.

The development of the heating RES sector is influenced by the impacts of emissions from pre-existing solid biomass-fired heating systems. The installation of new biomass-fired heating systems must be targeted towards promoting high-efficiency systems meeting high environmental quality standards, with consideration to impact on areas characterised by critical air quality conditions. More stringent performance requirements on accessing incentives for biomass-fired heat generators will be introduced in the short term. The replacement of domestic wood-fired systems with more efficient, lower-emission systems that meet the highest environmental classification standards will be also encouraged.

In 2017, district heating supplied 3% of Italian residential sector.[16] The economic potential for expanding district heating and cooling networks on a national level is currently estimated at around 900 km, in addition to the existing around 4 100 km.

Italy is moving toward the installation of second generation smart meters. Four million 2G meters have already been put into service for low-voltage users. In 2019 with Resolution No 306/2019/R/eel the regulations in this area were updated for 2020-2022, including a plan for the time frames envisaged for the putting into service of 2G meters for all distribution companies with more than 100,000 customers (corresponding to 98% of extraction points in Italy). The large-scale replacement of existing meters must be finished by 2026 for 95% of meters, the same percentage used for the first-generation meters.

Italy has undertaken to double the value of the resources portfolio for public research in the field of clean energy, from around EUR 222 million in 2013 (the year taken as the baseline) to around EUR 444 million from 2021.

Latvia

Latvia's NECP does not directly address system integration or sector coupling.

The overall share of cogeneration in DH in Latvia is high – 72.6%. Some regional DH systems in Latvia have reached nearly 100% share of cogeneration in heat production and a high share of renewable energy in the overall fuel structure. There is no potential for increasing the share of RES at national level in DH, while in certain cities have potential to introduce high-efficiency cogeneration in DH.

During the period 2021-2030 covered by the Plan, the following infrastructure modernisation projects will be carried out:

- modernisation of the electricity infrastructure and improvement of energy efficiency for the provision of a smart, digital-technology-based and efficiently managed distribution network meeting the needs of customers;
- complete replacement of electricity meters with smart meters, which in turn will allow new entrants – aggregators, who will provide energy optimisation services, to operate on the market.

The latter objective sets Latvia's timeline to complete smart metering by 2030. In addition, an important target for Latvia and the other two Baltic countries is that the electricity networks of the Baltic States are synchronised with the European networks ensuring secure and sustainable electricity supply through a total of at least 5 European interconnections by 2030.

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[16] https://www.euroheat.org/knowledge-hub/district-energy-italy/?hilite=%22italy%22.

R&I is being developed in Latvia in accordance with the Smart Specialisation Strategy (RIS3) in five specialisation areas, smart energy listed on the top. The RIS3 specialisation area “Smart energy” includes the development of clean technologies or new materials, research and development of engineering and digital solutions for acquisition, storage and integration of RE into the energy system, improvement of energy efficiency in construction and automation and optimisation of production processes, as well as the development of alternative fuels for transport.

EAAI is a sub-programme of the national budget, with funding eligible for climate change mitigation and adaptation, including energy, industry, transport, agriculture and waste management. EAAI granted funds to assist 36 innovative energy efficiency and RES smart technology demonstration projects by the end of 2018, covering both direct and indirect reduction of GHG emissions.

Lithuania

Lithuania’s The NECP does not does not directly address system integration or sector coupling.

In Lithuania, the district heating system is an integral part of the energy sector, closely linked to the electricity system, fuel supply and other systems. All Lithuanian cities have well-developed district heating systems, which supply heat to about 53% of all buildings in the country and 76% in the cities. The primary goal for Lithuania in the heat sector is a consistent and balanced upgrading (optimisation) of district heating systems to ensure efficient heat consumption, reliable and competitive supply and production. Lithuania also seeks to integrate solar power plants into the district heating networks and promote the use of surplus and waste heat for heating buildings. By 2030, a 45% share of renewable energy in final energy consumption is expected (one of the biggest ambitions for the development of RES in the EU), of which 45% in electricity and 90% in district heating will come from RES.

The power system of the three Baltic States is still currently synchronised with the Russian IPS/UPS synchronous area. Lithuania, together with Latvia and Estonia, will synchronise through Poland with a reliable and unified power system of continental Europe by 2025.

The Lithuanian energy sector will undergo major changes up to 2030. In the electricity sector, a growing share of decentralized generation will require major structural changes. The share of local power generation increases each year, and creates challenges such as system balancing. A legal framework is being developed for the aggregator mechanism, which would create preconditions for demand-side response and avoid a part of the peaks in the electricity demand market. The 10-year investment plan of AB Energijos skirstymo operatorius (‘ESO’) for the period 2019-2028 focuses on the modernisation of the electricity and natural gas networks. By the end of 2023, ESO plans to install smart meters for its customers who consume about 90% of the electricity distributed. Smart meters will be installed in stages, starting with largest electricity consumers. For natural gas customers, smart meters will be introduced if the cost-benefit analysis yields a positive result.

Two strategic documents currently set out the guidelines for national policies to promote research and innovation: the National Energy Independence Strategy and the Smart Specialisation Strategy.

Litgrid is conducting a pilot battery project to test the potential of battery storage systems under realistic operating conditions of the Lithuanian power system. The project's objective is to increase frequency management and to ensure system stability and security.

Luxembourg

Luxembourg includes sector coupling of the electricity, heat and transport sectors as one of the central objectives on the energy market dimension. Hydrogen is seen potentially in a crucial role in energy supply and in sector coupling for the electricity, heat and transport sectors, in particular if efficiencies of production and conversion as well as the effectiveness of fuel cells for transport use is increased.

The economic potential of cogeneration in the building sector is currently being realised at about 50% through existing local heating concepts. Therefore, in Luxembourg, there is currently an economic cogeneration potential of around 1,170 GWh of useful energy in the building sector alone. The Luxembourg government expects a high number of potential heating and cooling uses for low-temperature heating networks. These low-temperature networks will in future be supplied predominantly from environmentally friendly sources (deep geothermal energy, heat pumps, waste heat from industry and data centres, solar thermal installations), insofar as this is economically viable. Since gas, like other fossil fuels in Luxembourg, is also used extensively for heating and cooling, Luxembourg is pushing for an increase in energy efficiency as well as the increased use of renewable energy for heating and cooling.

Electricity and gas system operators were required by law to replace current metering systems with smart meters and to manage the relevant data through a national central system by 2020 and 2021, respectively. In addition, DSOs have also been required by law to set up a common national infrastructure of public recharging points for electric vehicles.

Luxembourg intends to continuously increase the volume of investment in research and development in the energy sector and to focus e.g. on the following thematic priorities:

- Integration of renewable energies and e-mobility in digital power networks, energy-internet and sector coupling
- Sustainable buildings and building materials – energy efficiency and circular economy, decentralised renewable energy, 'indoor pollution'
- Éco-quartiers made in Luxembourg – plus energy systems, car-free mobility, socially inclusive urban planning; Social transition processes and social innovation aimed at 'climate positive lifestyles'

Malta

The NECP does not directly address system integration or sector coupling.

Malta does not have any district heating and cooling networks as past studies have confirmed that district heating networks would not be cost-effective. Local climatic conditions impose a much higher summer cooling demand than the winter heating requirements. The residential and services sectors make up 87% of the total estimated heating and cooling demand. Renewable energy share in the heating and cooling sector is primarily driven by heat pumps and solar water heaters.

In line with its programme to ensure an efficient distribution system, Enemalta has equipped 99.6% of its consumers with smart meters and has adopted a tariff system that favours the prudent use of energy. Additionally, a second generation of smart meters is being installed. This will be done through the consumer energy management system where in-house display systems, smart phones and other devices will provide the consumer with real-time information on their consumption.

No planned measures are envisaged for the establishment of real-time price signals and dynamic prices due to the absence of a liquid wholesale electricity market in Malta, limited demand, and relatively flat on-island production costs. The expected increased share of renewable self-consumption by consumers with an installed PV system would reduce the stress on the electricity grid, in particular during peak hours in the summer months.

In 2017, three projects were allocated ERDF funding of over EUR 5 million in total under the category of Energy Efficiency renovation of public infrastructure, demonstration projects and supporting measures. These projects focused primarily on the retrofitting of street lighting and upgrading and retrofitting of public buildings.

Under the Smart Specialisation Strategy of Malta’s National Strategy for R&I, energy and low-carbon technologies featured under the theme of resource-efficient buildings. As a result, access to European Structural and Investment Funds for R&I in low-carbon technologies was limited to projects focused on buildings. This sector was identified with the goal of exploring innovative solutions for improved resource efficiency in new and existing buildings, including through demonstration projects and optimisation.

Netherlands

The NECP does not directly address system integration or sector coupling.

Netherlands in making a transition toward district heating systems and natural gas-free alternatives such as heat pumps, residual heat or geothermal energy. The NECP indicates there will be a shift from fossil heat sources, such as the traditional gas-fired central heating boiler. Homes and other buildings in the Netherlands will be made more energy-efficient and more comfortable in a gradual, sustainable transformation of the built-up environment.

The greatest challenge in the built-up environment lies in insulating existing buildings and making them natural gas-free, with over 1.5 million homes and other buildings by 2030. These include privately owned homes, rented homes and non-residential buildings. There will also be a district-oriented approach. Some alternative heat sources - such as a heat grid - can best be applied at the district level. Municipalities assume the directive role in the transition to gas-free districts. In a diligent process that involves district residents they will have to weigh up the best solution per district, if houses are no longer heated using natural gas.

The Netherlands will organise market regulation in the coming years via the legislative agenda, so that demand response can be increased even further and small consumers get better access to the market and are rewarded in accordance with the market. To this end, small consumers could be supplied with an aggregator. The Netherlands will continue rolling out smart meters, to allow consumers to respond more effectively to real-time prices. The target is for 80% of Dutch small consumers of electricity and gas to be supplied with a smart meter by 2020.

The growth in the share of intermittent sources will result in an increase in the demand for flexibility on the market. Flexibility in the form of demand response, storage or adjustable capacity is interwoven in the electricity market and is traded across the various markets without flexibility being a clearly identifiable factor.

Specific innovation policy focuses on nine top sectors. The nine top sectors will work more closely with the mission-oriented top sectors and innovation policy. With regard to climate and energy, the collaboration primarily concerns the top sectors of Energy, the Chemical Industry, Agriculture & Food, High Tech Systems & Materials, Logistics, Water and Creative Industries.

Poland

In terms of energy sytem integration the NECP does not directly address system integration or sector coupling.

In heating buildings, a significant question for Poland is to reduce inefficient small-scale combustion of solid fuels, typically household combustion of coal and wood, which practise has a significant negative impact in air quality. The aim is to satisfy the demand for heat primarily through district heat, to ensure that fuels are utilised efficiently, to improve the quality of life for citizens, and to mitigate ‘low-stack’ emissions.

The changing business environment and technological development constitute major challenges for the heating sector. Important issues to be regulated in the near future include: changing the heat market model and tariff policy, developing smart network infrastructure, regulating the rules on the purchase of RES heat, and fostering the use of district cooling. The draft Energy Policy of Poland until 2040 envisages the development of district heating as one of the strategic directions. The target will be pursued by the following activities:

- development of cogeneration;
- converting power plants into CHP plants;
- increasing the use of RES and waste in district heating;
- modernisation and expansion of the heating and cooling distribution systems;
- promoting heat storage facilities and smart networks;

New regulations will introduce a legal framework for the operation of the smart metering system, which will have an impact on the flexibility of the power system. As regards the smart metering system, remote reading meters for at least 80% of end consumers connected to the distribution network with the rated voltage of no more than 1 kV are planned to be installed by the end of 2028.

The low flexibility of the Polish energy market (on the demand and supply sides) is primarily due to the fact that in practice it has no regulating reserve sources (except for pumped-storage power plants) that would be capable of adjusting the production level dynamically depending on demand.

In 2017, the Ministry of Energy developed the Directions for Energy Innovation Development (DEID). Pursuant to the objectives of DEID, projects in the following areas will be carried out: an integrated and interconnected power system giving the central role to the energy user; effective and flexible energy generation and use of raw materials combining the reduction of the impact on the environment with energy security; diversification of energy generation and use technologies; as well as a green and energy-efficient city.

Portugal

Portugal recognises that “the interdependence of the electricity system and gas system must also be considered at a national and trans-border level, using a logic of ‘sector coupling’”. “The current network planning instruments, must consider the goals and targets set out in NECP and RCN 2050, as well as the need to adapt network investments to prepare for the energy transition (greater integration of renewables, decentralised production, storage, electric vehicles, flexibility, among others).”

In 2016 Portugal conducted an assessment of the potential of high-efficiency cogeneration and efficient district heating and cooling. There is insufficient demand to justify district heating networks for the residential sector. Consumption in the residential sector in Portugal is very low when compared to consumption in other European countries, particularly for heating and even for cooling. This is due to Portugal’s mild climate. Fuel consumption in the heating and cooling sector is expected to reduce as energy efficiency measures and the electrification of consumption are reinforced. In the residential and services buildings sector, along with other efficient solutions, heat pumps are one of the most efficient forms of heating and cooling, contributing toward increased comfort and reinforcing the electrification of consumption.

Portugal’s NECP describes policies and measures for developing smart electricity grids and smart metering coherently in the plan’s dimension Energy security. Promoting the expansion of smart meters involves “a drive to install smart meters, from an economically viable perspective, promoting the roll-out for all consumers, ensuring better information and the involvement of consumers in the coming years”

Promoting the development of smart grids involves the planning for transmission and distribution networks. The necessary rules and orientations will be defined in legislation and regulations, to implement the development of smart grids. Access to more accurate information through smart grids will also be improved. It is also important to manage cybersecurity of grids and information. Measures on both metering and grids are to be implemented between 2020-2030.

The Portuguese government recently committed to an overall investment of 3% of GDP by 2030 in research and development (R&D). The targets proposed by Portugal for 2030 with regard to energy and climate for carbon neutrality by 2050 require continued growth in investment in low-carbon technologies.

In addition to Portugal’s participation and cooperation in the SET Plan, NECP, national programmes are planned to promote RD&I, which initially, will include as a minimum, the following topics: (i) Energy management smart systems and new infrastructures; (ii) Energy Storage; (iii) Low-carbon technologies; (iv) Energy Efficiency; (v) Hydrogen as an energy source.

Romania

Considering the energy system integration the NECP does not directly address system integration or sector coupling.

District heating supplied 23% of residential heating in 2015.[17] The development of new electricity production capacities by 2030 is important, considering that 80% of the existing heat units are outdated. Romania plans to replace a significant high-carbon capacity with new gas, nuclear and RES efficient low-carbon plants. This will be achieved also for district heating systems through national energy system, the use of heat pumps, and through electricity market mechanisms. “District Heating” Programme is a multiannual programme targeted to district heating systems for localities to fund investments for the upgrading, rehabilitation and extension or deployment of centralised heat supply systems for localities. The programme is implemented in the period 2019-2027 by updating the 2006-2020 ‘Heat and Comfort’ DH Programme. Investments in the modernisation of energy grids, including urban district heating pipelines, will be financed though Modernisation Fund.

In the context of the “Smart City” strategies under preparation (e.g. Bucharest, Cluj-Napoca), local authorities have planned a series of projects focused on the production of electricity and heat from renewable sources by using photovoltaic panels, heat solar panels or biomass.

The digitisation of the Romanian energy system, including transmission and distribution grids (smart grids), is important in turning the Romanian energy market “fit-for-RES”. The introduction of smart measurement systems in the energy sector is a national priority as a first step in the digitisation of the infrastructure. The National Energy Regulatory Authority (ANRE) approved in 2019 the “Calendar of implementation of electricity smart measurement systems (SMS) at national level for the period 2019-2028”. The distribution system operator must offer dynamic distribution tariffs from 2020 onward. Similarly, from 2020 onward, the day-ahead and intra-day markets are to ensure that all market participants can have access to the market individually or by aggregation.

Under theme of fostering energy symbioses between district heating systems and the adjacent industry, a pilot demonstration project in Cluj-Napoca City, will be recover residual heat from ovens of a local factory (producing floor and wall tiles) into the district heating system of the city to heat households.

Pilot and demonstration projects promoting use of hydrogen in electricity production and in the industrial sector will be facilitated. The main strategic areas are energy system flexibility and power transmission infrastructure. Romania plans to carry out an assessment in the period 2021-2022 of injecting hydrogen in the form of synthesis gas from RES (methane by reaction with CO_2) in the gas transmission/distribution systems.

Slovakia

Slovakia will address linking sectors by 1) energy storage technologies from local battery storage, storage facilities, electric vehicles and gas grid, 2) local power consumption management, and 3) maintaining and supporting the existing capacity and operation of pumped-storage power plants.

District heating systems already use cogeneration of electricity, heat and cold, RES, emission-reducing technologies, and energy storage facilities. Heating sector will have support for efficient district heating systems with heat supplied from RES, waste heat from industrial

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[17] https://www.euroheat.org/knowledge-hub/district-energy-romania/?hilite=%22romania%22.

processes making cost-intensive use of RES, especially locally available biomass/biomethane and waste, including support for multi-fuel systems as well as heat pumps.

Slovakia will use heat plant infrastructure to integrate RES into district heating systems, by electricity and heat generation from biomethane. Biomethane will be produced from various biodegradable waste streams. In addition, Slovakia plans to make use of energy recovery from municipal waste as part of the circular economy, and energy efficient equipment using RES that meet sustainability criteria. Slovakia envisions efficient district heating systems, innovative DH technologies and modernisation as well as new technologies toward 2050.[18]

The main measures in the development of smart metering systems (SMS) and smart networks (SN) are summarized in the Energy Policy of the Slovak Republic, 2014. The SR is in the initial construction phase of basic SN infrastructure. Slovakia's measures in the development of smart metering systems and smart grids involve ensuring that the technological compliance and interoperability of SMS components and communication capabilities support SN development. Measures also aim to support local or broad testing of the SN and, in the time horizon to 2035, the development of intelligent cities, municipalities and regions, to support electromobility, to increase the number of households equipped with smart appliances and SMS and to develop the conditions for electricity storage near to consumption.

The SR is currently focusing primarily on the selective implementation of SMS pursuant to the relevant Decree of the Ministry of Economy No 358/2013 with a schedule to 2020 (offtake points with annual consumption over 4 MWh with anticipated penetration of about 23% low voltage OP by the target year 2020).

Draft State R&D programmes for 2020-2024 with outlook to 2029 assumes funding for R&D in key areas of the Slovak economy, which include the following areas: Improving the transmission capabilities and security of the Slovak electricity grid; Smart grids and renewable energy sources and nuclear energy.

There are two large cross-border smart grid projects in Slovakia. ACON smart grid project is implemented between the Slovak Republic and the Czech Republic. The first project in Slovakia to feature massive deployment of state-of-the-art smart technologies, this project will both modernize existing infrastructure and build new infrastructure. Danube InGrid smart grid project is implemented in cooperation with Hungarian partners. The main goal of the Danube InGrid project is to increase the integration of RES into the grid through the use of intelligent technologies at transmission and distribution level, including their smart management.

There is interest in setting up a laboratory for smart grid research. The role of the laboratory would be testing new network, consumption, production and interoperability technologies. The laboratory should also be a representative centre for public awareness.

Slovenia

The increased volume of renewable electricity in the energy markets will necessitate efficient market-based instruments to develop flexibility and new energy services. Slovenia will link the gas, heat and electricity sectors by converting and storing surplus electricity to gas fuels and heat. A national approach to integrating thermal infrastructure and other sectors at the local

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[18] LTS https://ec.europa.eu/clima/sites/lts/lts_sk_en.pdf.

and national level will need to be shaped. Slovenia aims to ensure appropriate technical capacity power-to-gas and power-to-heat to allow the seasonal storage of renewable methane as well as to offset intraday variation.

Slovenia has district heating mainly in cities. Only 8% of energy use is from district heating systems, Various fossil fuels are used as the energy source for the most part. Slovakia has set the goals of 1% annual increase in the share of RES and surplus heat and cold in district heating and cooling systems, and at least 41% share of RES in heating and cooling by 2030.

Accelerated development of district heating and cooling systems is enlisted as one the key challenges for Slovenia in the area of energy and climate policy. In future, the district energy sector will serve as a connecting factor between the power and heat sectors, in order to manage increasingly complex dynamics of electricity demand and generation.

At the end of 2018, 61% of users on the distribution system were equipped with advanced measuring devices. Slovenia is expected to move closer to the European Directive target stipulating that 80% of users should be equipped with advanced measuring devices by 2020. By 2025, system meters should be installed which will enable operation and control of the distribution system using advanced systems.

The NECP confirms as a target increasing investment in R&D by at least 3% of GDP by 2030 (of which 1% of GDP is public funding), with funds earmarked for climate-neutral goals and projected to be directed towards targeted research projects, multidisciplinary programmes and demonstration projects.

The main areas of energy research will include RES, efficient energy use in buildings, nuclear energy, electric power and electricity systems, heat and heating systems and the circular economy. Slovenia will encourage the development of technologies in these areas, such as upgrading gasification and waste recovery for energy purposes, power to X, digitisation of energy, cybersecurity, and energy storage.

The SINCRO.GRID is a smart grid interconnection project between Slovenia and Croatia. Trial operation and optimisation of all systems developed under the SINCRO.GRID project is scheduled for 2021.[19]

Spain

The NECP recognises sector coupling as the alignment of renewable electricity with energy uses. Sector coupling makes it possible to introduce manageability in the electricity demand while also responding to other uses of the energy.

In Spain, the share of heating and cooling networks out of the total consumption in the heating and cooling sector is low: the share was 0.15% in 2015. District heating and cooling maybe feasible in concentrated urban areas. Solar heating and heat pumps are feasible in households in general.

In the building sector, energy efficiency improvements in the thermal envelope will help facilitate the deployment of renewable energy:

- Heating and cooling systems;

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[19] https://www.sincrogrid.eu/en

- The use of renewable energy in urban heating and cooling networks;
- The use of renewable energy in buildings;
- Renewable energy produced by cities, energy communities and self-consumers;

In heating and cooling sector, Spain's NECP National Plan focuses on renewable energy communities and proposes regulatory development that allows them to exercise their right to generate, consume and sell renewable energy. It also focuses on the promotion of a set of administrative and economic measures. An increase in electricity use for heat generation is also proposed.

The deployment of smart meters launched in 2008 and completed at the end of 2018. Thereby the consumers have a basic tool for understanding their hourly consumption, becoming active consumers, and adjusting adjust their demand to times when the market prices are lower, contributing thus to shifting the demand curve.

The Spanish Science, Technology and Innovation Strategy for 2021-2028 will incorporate a Strategic Action on Energy and Climate Change, and assign funding for Research, Innovation and Competitiveness (RIC) in energy and climate. The Strategic Action on Energy and Climate Change has the objectives of promoting RIC for the energy transition and of accelerating the full decarbonisation of the economy by 2050, the implementation of a model of sustainable development and resilience to climate change.

Sweden

The NECP nods at "system integration" once in the context of wind power and its grid integration.

The Swedish district heating system is well developed and district heating competes with other forms of heating. The respective system owners assess whether new infrastructure for district heating and district cooling is necessary and will be profitable.

The share of renewable energy in the heating and cooling sector was 114 TWh of renewable energy in the sector in 2017, which is an increase from 89 TWh in 2005. The renewable energy is mainly biofuels, which account for 86%, followed by heat pumps at 14%. The energy generation in district heating system is expected to fall by 2030 due to energy efficiency measures, despite new connections to existing and new buildings are expected.

The Smartgrid Forum, a joint enterprise to promote smarter energy use set up in spring 2016 by a government decision, has developed a strategy for increasing the flexibility in the electricity system with smart grids. The Forum has identified four areas to be developed and produced 20 recommendations for activities in the following four areas:

- establishing the conditions for new business models for flexible services
- developing the markets for system services;
- carrying out IT-security and integrity measures; and
- carrying out information and awareness-raising measures.

However, the NECP states that in a future electricity market with a higher share of renewable and variable electricity generation, it will be important to use all of the electricity system's flexibility resources, i.e. flexible production and demand response.

Sweden participates in many ERA-NET cooperative programmes. Smart grids is one of the key areas for Sweden. Around SEK 45 million was paid for the cooperative programmes and initiatives in which Sweden participates in 2018.

There are a number of national centres and research and innovation programmes relating to smart electricity networks, namely SamspEL, the Swedish Centre for Future Electricity Grids and Energy Storage (SweGRIDS) and KTH ACCESS Linnaeus Centre.

2.2 The pathway analysis on 'Bioenergy'

Terminology

Bioenergy refers to all types of energy derived from the conversion of natural, biological sources (referred to as *biomass*) available on a renewable basis. Within our immediate environment lies an abundant source of organic materials (also known as *feedstocks*) such as plants, trees, algae, or organic wastes. All can be valuable fuels as soon as a technology makes it possible to efficiently extract all of its energy potential. Biomass currently used in Europe includes wood from forests, agricultural crops and residues, by-products from the wood and agricultural industry, herbaceous and woody energy crops, municipal organic wastes and manure, and could potentially integrate algae and marine biomass in the future. Bioenergy is the only renewable energy source capable of providing heating and cooling, electricity and transport fuel.[20]

The most common types of bioenergy are:

1. **Combustion**: Combined heat and power (CHP) plants use solid biomass to produce electricity and heat.
2. **Biogas**: Biogas is produced by biochemical processes by anaerobic digestion of organic material such as manure, sewage sludge, and organic waste. It consists primarily of methane, and it can replace natural gas.
3. **Gasification**: Thermal gasification is a thermochemical process consisting of heating of biomass with limited oxygen available. The biomass is turned into inflammable gases that can be combusted or upgraded.
4. **Liquid biofuels**: Biomass crops and crop residuals can be processed by either biochemical or thermochemical means to produce liquid biofuels. Bioethanol is produced by fermentation and distillation of biomass, and biodiesel is produced by processing plant-based oils.

The EU Renewable Energy Directive of 2018 (RED II) dictates a raise in the overall EU renewable energy source consumption to 32% in 2030. The previous RED stated a target of 20%. Biomass accounted for 7.5% of final energy consumption in Europe in 2016, and 44% of renewable energy consumption. A significant feature of RED II is that biomass overall is considered a RES (with the logic that burning biomass is carbon neutral as the loss of carbon to the atmosphere is counterbalanced through photosynthesis when new biomass is grown afterwards). This has been strongly criticised due to fears of deforestation as well as arguments about limited efficiency in burning firewood and pellets as opposed to wastes and residues (who would decompose anyway, even if not burned), and indeed suggestions have been made to consider only appropriately defined residues and wastes as sustainable. However, at present the RED II allows burning of solid, not-waste biomass to count as an RES.

The analysis relies on the following major bioenergy aspects:

- Biomass type, origin, sustainability and production)

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[20] Bioenergy Europe.

- Biofuels (i.e. biogas or liquid biofuels, produced by biochemical and/or thermochemical processes)

Most NECP's discuss biomass, biogas and liquid biofuels, but do not distinguish on whether the production is of biochemical or thermochemical origin.

Biomass can have different origins: there are areas where biomass production starts from forests rather than spontaneous weeds or crops, and this depends on the characteristics of the territory. Also, as indicated above, the question of using deforestation to meet increased needs for biomass vs burning wastes and residues is pertinent. The evaluation of best practices and their dissemination will have to consider these aspects, so the relationship with the territory will have to be highlighted.

Background information

Presentation of relevant EU initiatives in the sector and its main targets/objectives

- The European Industrial Bioenergy Initiative
- The 2006 IPCC Guidelines for National Greenhouse Gas Inventories and its 2019 Refinement[21].
- Mission Innovation Challenge n°4 Sustainable Biofuels[22]
- EU Renewable Energy Directive of 2018 (RED II)

When analysing the final NECPs concerning bioenergy, the first concern is to check the overall target for GHG reductions and secondly the RES shares in energy consumption overall as well as for the sectors: electricity, heating and cooling, and transport. An important measure is the biomass and bioenergy contribution to the RES in each sector.

According to the ETS the use of biomass is carbon neutral, and therefore countries have an incentive to switch from fossil to biomass in the various sectors, but this is important to do in a sustainable manner. To this end, the recast Renewable Energy Directive (RED II) sets an overall RES target, and measure towards the sustainable use of biomass in the sectors.

That notwithstanding, the use of biomass (especially firewood and pellets in the heating and electricity sectors) has been largely criticised for its potential delay or even lack of contribution to meeting the GHG emission targets, and an additional measure is therefore to note the non-ETS targets.

Biomass

Direct use of biomass occurs mainly in the heating sector, and occasionally also in the electricity sector. Several countries have a substantial use of biomass in the heating sector, e.g. Denmark and the Baltic states, and even if the import/export from precisely the Baltic states is governed by a trading portal called Baltpool, there is a lack of data in the NECPs concerning the sustainability of this biomass. It is also a question of avoiding counting the

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[21] https://www.ipcc-nggip.iges.or.jp/public/2019rf/vol4.html

[22] http://mission-innovation.net/our-work/innovation-challenges/sustainable-biofuels/

carbon reductions twice, as the biomass is also a carbon sink in terms of land use. France, Sweden and Luxembourg have detailed descriptions in the NECPs concerning the sustainability issue and R&D in terms of the carbon cycle.

Concerning biomass use in the heating sector, some countries are efficiently using the biomass in centralized or decentralized boilers, e.g. in combined heating and power plants, and heating is supplied either as district heating or with heat pumps running on the electricity generated. This certainly is among the most effective uses of the biomass, and also has significant cross-cutting potential. In fact, if the biomass is sustainable and carbon-capture and storage (CCS) is in place at the power plant, then this has potentially negative-emission prospects (i.e., gives net carbon removal in the atmosphere). This will be critical for a future zero emission scenario for offsetting industries that cannot become carbon neutral. Other countries, e.g., Italy, Czech Republic, Bulgaria, have significant use of residential wood burning. This is not only less efficient, but also problematic for the air quality, and has currently no possibility for CCS. Such countries should promote use of wood pellets ovens as a minimum and consider district heating and heat pump solutions. There are also new pilot plants in e.g., Denmark for carbon neutral district heating, where the biomass used is local and comprises of agricultural waste.

Biomass remains a somewhat hidden opportunity in terms of phasing out coal. Denmark has successfully converted CHP plants from coal to biomass, and thereby avoids the pitfall of lock-in effects when e.g., expanding the gas infrastructure to compensate the loss in coal (like Romania is planning).

Finally, it should be noted that each country’s energy history and potential is important to know when assessing the use of biomass. A country with large amounts of non-fossil sources (nuclear, hydro, geothermal) will obviously be less aggressive on the “newer” technologies (wind, solar, district heating, heat pumps) and have less use for biomass combustion in the heating and electricity sector. E.g., France does not have a high-RES target, but a vast part of the non-RES is actually a continued use of nuclear power, which despite all its flaws does have the advantage of a low CO_2 footprint (at least once it is constructed).

Biofuels and biogases

Transport

RED II sets a 14% 2030 target for RES in transport, and there are two main paths: adding biofuels to the petrol for use in combustion engines, or switching towards electricity or other means (e.g. hydrogen, fuel cells). Unlike RES in the two other sectors, most NECPs do try to meet at least 14%. That being said, in many NECPs it is not clear how this is achieved, and how big a part electricity vs. biofuel additions is playing, respectively. Digging into the biofuels, most use today 1st generation (originating from food crops) and ideally these should be replaced by more sustainable 2nd generation biofuels. This transition is specified in some NECPs, but clear plans and targets are lacking in most. Additionally, even the most ambitious countries, like Denmark, do not have a clear plan for electrifying the personal transport fleet.

Production

Some NECPs (e.g., France, Denmark, Sweden, Austria) have clear plans and ambitions in producing biogases and biofuels, and switching towards 2nd generation. Other countries mention that what they lack they have to import and make an assessment of the overall

EU/world market in order to do that, while finally some countries do not specify how their need towards 2030 and beyond should be met.

Use in other sectors

Biogases and biofuels can also be used in other sectors than transport, e.g. in the gas distribution net (either for industry or domestic use), or directly at the heat and power plants. Some countries have clear plans for this, and set out plans for the R&D needed to meet this goal (e.g. upgrading the biogas to biomethane).

Research funding and industry possibilities

Some NECPs are quite detailed and specific about the R&D funding schemes, and the various innovation actions taken to make sure the industry uptake is effectuated. Occasionally the detail level is quite overwhelming, and it makes it difficult to assess the overall direction of the funding elements. Also concerning is that many NECPs mention non-energy (let alone bioenergy) specific funding schemes that are expired or will expire soon.

Some of the leading countries have specific industry-targeting R&D initiatives, like innovation incubators and foundations for the green transition (e.g. France, Denmark, Poland), where the funding mechanisms are quite novel. Some of the countries lagging behind the EU target of 3% GDP in R&D spending are picking up the pace and additionally devote significant spending into climate and energy (e.g., Baltic states, Poland).

Collaborations

The NECPs outline existing fora to address common issues affecting energy transition priorities, especially for the regional aspects. Examples of this happening already are the four existing groups: the Pentalateral and Central and South Eastern Europe energy connectivity, the Northern Seas initiative, the Nordic Energy forum, the Benelux partners, and the tight collaboration in the Baltic countries.

Other collaborations mentioned are Concerted Action on the RES Directive (CA-RES), the IEA Bioenergy, Clean Energy for EU Islands, Mission Innovation.

Assessment of Bioenergy per Member State

Austria

Targets:

- Renewable energies share in 2030 of total final energy consumption 46-50%
    - Share of RES-E 100% (hydro and wind dominates, biomass 7%)
    - Share of RES thermal: not indicated, plan expected in 2020
    - Share of RES transport 14% (increased e-mobility, biofuels)

The biomass and bioenergy contribution to RES is quite limited in Austria. It should be noted that the heating market still depends heavily on imported fossil fuels. In order to mitigate that dependency, the use of biomass, solar heat and ambient heat will be developed by 2030, both as direct heating and as district heating. In addition, the existing contribution of heat from waste management and industrial waste heat will be maintained or boosted. The details will be set out in a National Heating Strategy in 2020.

The **Climate and Energy Strategy**, from 2018 aims to meet the Sustainable Development Goals in greenhouse gas reduction, renewable energy, and energy efficiency by 2030, in line with the objectives of the European Union. In this strategy, 12 flagship projects are set up, and of these two are related to bioenergy, (Renewable hydrogen and biomethane and Bio-economy Strategy). The 2020 **Renewable Energy Expansion Act** aims to at a 100% renewable electricity target.

In terms of bioenergy, the Renewable Energy Expansion Act aims for natural gas to be replaced by renewable gas. The *Greening the gas* initiative, using biomethane from biogenic residues and waste, hydrogen and synthetic methane from renewable power sources, is a key factor in the future sustainable energy system. This will be encouraged by feed-in quotas of renewable gas into the natural gas distribution system. In order to meet the 100% renewable electricity target, the plan is to use high-efficiency cogeneration technology (CHP plants) based on solid biomass.

For both solid biomass-based and biogas-based energy generation technology, the revised approach to raw materials must be adopted, which aims to replace fossil fuel resources with sustainable raw materials in as many areas and applications as possible.

As far as research and funding schemes are concerned, a plan for implementing the energy research initiative was drawn up in 2019 for the 2020-2030 period. This plan includes the formulation of three missions for the future energy systems, including *Breakthrough technologies for industry* (decarbonising industrial processes and products). A focus activity here is *Biogenic raw materials and fuels in industrial processes*.

Austria is part of the Pentalateral Energy Forum (Belgium, Netherlands, Luxembourg, Germany, France, Austria, and Switzerland), focusing on electricity market integration, incl. renewables, but with no specific bioenergy goals.

As regards gaps and challenges, the heating sector must develop towards 2030 in terms of increased use of renewables (including biomass), and this plan is yet to be defined. Biofuels is a significant part of the current RES share in transport and will be expanded slightly (and shifted towards advanced biofuels) for 2030, but no plans are set out for where the biofuel is coming from.

Belgium

Targets:

- Renewable energies share in 2030 of total final energy consumption 17%
    - Share of RES transport 14% (biofuels)

The Belgian NECP is mostly divided into 4 parts, covering plans for the Federal, Walloon, Flemish and occasionally Brussels regions. This makes it very complex to summarize. As an example, some federal Technological Innovations are highlighted in the Policy Ch. 3.5, including the use of “more sustainable biofuels (algae- or waste-based), sustainable biogas- or biofuel-based maritime and air transport, third-generation biofuels”, but also states that these priorities “may or may not be shared with the Regions”. In the present assessment, only the federal aspects are considered.

Responsibility for energy R&I policy is shared between the Federal Government, the three Regions and the Communities. The Federal State is responsible for R&I in the field of nuclear energy (nuclear fission and fusion) and in other areas under federal jurisdiction – such as biofuels. All other aspects relating to renewable energy are under regional jurisdiction. Nuclear power and fossil fuel-based power plants are dominating the energy market.

In terms of research and funding, from 2020, 5% to 10% of the R&D budget will be earmarked for climate and energy projects. An Energy Transition Fund was established in 2016 (20 MEUR/year), which aims to finance measures designed to support and encourage research and development in federal innovative energy projects, including biofuels.

Under transport, the aim is to promote and regulate alternative fuels such as biofuels and limit the use of problematic alternatives and gradually exclude them. The use of biofuels goes from 5.5% in 2017 to a goal of 10.5% by 2030, compared to 14% in draft NECP. This would be divided into 7% coming from food commodities and the other 3.5% being advanced biofuels.

Coordination on research/industry/government/public sector (and other stakeholders, when relevant) within EU and alignment of EU-national R&I priorities through EU SET Plan. Participation in different activities/platforms including the Pentalateral Energy Forum (see Austria).

There is a lack of coordination between regions and the federal and regional government. The NECP presents a compilation of individual measures. There is no prioritisation aiming at reducing emissions and a clear definition is missing of the benefits such measures would have in the long-term on jobs, reduction of fossil fuel consumption etc. The final NECP provides for an unprecedented return to the use of destructive biofuels in part coming from food commodities.

Bulgaria

Targets:

- Renewable energies share in 2030 of total final energy consumption 27%
    - Share of RES-E 30% (biomass 10% of RES)
    - Share of RES thermal 43% (biomass 37% of RES)
    - Share of RES transport 14% (primarily biofuels)

Bulgaria has adopted the core energy policy objectives of the European Union of security of supply, competitiveness and sustainability. The National Action Plan for Energy from Forest Biomass 2018-2027 sets out estimates of biomass potential after 2020 at national level.

To reach the share of renewables in transport of 14.2% in 2030, the penetration of second-generation biofuels (renewable liquid and gaseous fuels of non-biological origin) will be encouraged by use of quotas. There will be focus on applied research and support schemes for large-scale demonstration activities for making advanced biofuels in a sustainable manner.

Solid biomass is the renewable energy source most widely used in Bulgaria, mainly in the heating and cooling sector. Consumption of other types of biomass, including waste, is still insignificant. Firewood is the main type of biomass used in the country and the use of wood waste and plant waste has been growing.

The consumption of energy from biomass is expected to increase both in final energy consumption and electricity generation. The additional consumption of energy from biomass will require an increase in (sustainably produced) biomass quantities in Bulgaria (projected increase of 37% in the period 2020-2030). Biomass plants will eventually be constructed in line with market principles, without any investment or operational financial aid being granted to investors. Biomass for energy purposes has wide potential for development, and the NECP actually sets funding aside for new biomass power plants with carbon capture and storage.

Biogas production from anaerobic fermentation of biomass and from sewage sludge is still negligible and is primarily used for electricity and heat generation.

As far as gaps and challenges are concerned, most of the action plans in the NECP are either outdated or lack detail. The only energy-related strategic document aiming for 2030 is the National Action Plan for Energy from Biomass.

The main concerns with the increased use of biomass in Bulgaria are: the low efficiency of the current heating system especially in households; plans for combined burning of biomass and fossil fuels; and increased logging plans in high-biodiversity value forests. The low efficiency of household heating is related to the low efficiency of household wood stoves and to the high energy poverty in Bulgaria. Additionally, since the biomass use for energy purposes is quite rudimentary, the NECP acknowledges there is a larger potential for development to more advanced and efficient use. However, these aspects are not targeted in the plan and there are no R&D plans for advanced use of biomass for energy purposes. Improvement of the efficiency of could increase the share of RES in heating, while decreasing consumption and improving comfort, instead of switching to another fossil fuel. Household renewable energy production is almost non-existent in Bulgaria due to lack of appropriate legislation and subsidy schemes.

Croatia

Targets:

- Renewable energies share in 2030 of total final energy consumption 36%
    - Share of RES-E 64% (dominated by hydro and wind, biomass 10% of RES)
    - Share of RES thermal 37% (biomass 90% of RES)
    - Share of RES transport 13% (primarily biofuels)

The Ministry of Agriculture, through the **Rural Development Programme 2014-2020**, ensures the financing of investment grants for biomass and other RES projects. One of the objectives is the development of bioeconomy and reduction in greenhouse gases. Furthermore, the importance of using wood biomass, biomass from agriculture and solar energy in agriculture and the food processing industry is emphasized.

The energy market in Croatia is dominated by hydro and natural gas. Biomass energy is largely dominated by thermal energy (>90%), e.g. from burning of firewood.

Biomass is around 3-4% of the power plant capacity (around the same level as coal and nuclear) and is projected to remain constant in absolute terms. The estimated trajectory of demand for biomass energy broken down into heat and electricity and transport is shown in Figure 2-7, page 59 of the NECP. The origin and type of biomass used will become clear in an upcoming report.

The NECP proposes the following measures within biomass and biofuels: Establishing a platform for bioeconomy; Collection and treatment of agricultural plantings and residues for energy use**;** Use of biogas for biomethane production and electricity and heat generation, including biomethane injection into the gas network; Anaerobic decomposition of manure and biogas production; Development of alternative fuels infrastructure; Advanced biofuels market development plan.

The introduction of specific low-carbon technologies is primarily market driven. The state will increase investment in R&I, and investment in the transfer of knowledge and technologies and the development of knowledge and innovation-based technologies through various programmes. Among the focus areas are sustainable conversion of biomass into energy and biogas technologies for electricity and heat generation.

In terms of regional cooperation, Croatia has engaged in a joint development of a soil map (relevant for e.g. the energy-use of biomass); cooperation in the context of the "Clean Energy Initiative for EU Islands"; and regional planning for an alternative fuel infrastructure and efficient public transport.

Domestic production of biofuels is lagging behind, with announced projects in that have yet to start, and declining production of biodiesel, linked probably to lack of incentives. Notwithstanding declared interest in the transport sector in the deployment of advanced biofuels technologies and the steep upswing of blending targets, the actual penetration of biofuels seems yet to come, with emphasis shifting towards electro-mobility. The NECP does not include how the measures will be implemented, and it does not include the sources and amount of financing needed, relying instead on market-driven forces. Almost half of the planned measures will be funded from the European Structural and Investment Fund.

Cyprus

Targets:

- Renewable energies share in 2030 of total final energy consumption 23%
    - Share of RES-E 30% (through investments in mainly PV, Wind and Biomass)
    - Share of RES thermal 39%
    - Share of RES transport 14%

Cyprus has very little use of biomass and does not plan for using much more in the transition. Electricity will switch from oil and diesel to natural gas as main fuel over the next decade. Solar will expand and be the dominating RES-E source.

The heating and cooling sector is dominated by fossil fuel and electricity (mainly for cooling). RES will be mainly driven by solar thermal technologies and heat pumps in buildings, as well as an increase in district heating networks. Wood biomass is a key RES in this sector, as biomass CHP plants provides part of the heating demand refer to existing and future agricultural facilities making use of biogas, both for heating and electricity generation.

Transport will use biofuels to meet the RES target in the short term. This is mostly 2nd generation. EVs are ideal in Cyprus due to the small distances on the island, and in 2030 most cars sold are likely EVs.

A Working Group for Research, Innovation and Competitiveness was formed consisting of stakeholders from the public sector, the private sector and academia and is operating as a consultation forum to identify priority areas of research and innovation that correspond to the national targets for decarbonisation. Among the areas suggested, which are related to biomass are

- Agricultural sector: Incentives for agricultural industries to move to circular economy – (waste treatment plants anaerobic digesters for biomass utilization to produce energy, compost or other useful products that can lead to revenue increase).
- Cyprus Energy Regulatory Authority: Research in biomass and energy is needed, addressed by tailor-made calls for research that are applicable to Cyprus specific problems.
- Transportation: Production and distribution of Biomethane in a cost-effective manner, funding, policy framework and infrastructure for distribution are not in place.

Cypriot Universities and research institutions participate in the Temporary Working Group of ten SET Implementation Plans of Renewable Fuels and Bioenergy. As part of the National Operational Programme "Competitiveness and Sustainable Development 2014-2020", the Directorate General for European Programmes Coordination and Development, has dedicated resources to the implementation of an Energy Fund of Funds (EnergyFoF) managed by European Investment Bank.

Czech Republic

Targets:

- Renewable energies share in 2030 of total final energy consumption 22%
    - Share of RES-E 17% (The major energy electricity share comes from nuclear and coal, also in 2030)
    - Share of RES thermal 31%
    - Share of RES transport 14% (mainly biofuels, mix of 1st and 2nd generation)

The NECP is based on two main national documents: **State Energy Policy**, 2015, and **Climate Protection Policy**, 2017. Other relevant strategy documents and policies worth mentioning are: **Action Plan for Biomass,** 2012–2020. The NECP includes references to existing and planned measures, timing, actors and in some cases the financial provisions.

The Czech Republic has a heating sector that needs to be gradually transformed for the use of low-carbon energy sources, including energy from secondary sources and waste heat, and their transport to consumers, especially in urban agglomerations. Biomass is a major source of heating, especially with small and inefficient furnaces. In fact, of the current 15% RES one third comes from production of heating in households (i.e. burning of firewood in fireplaces). The transformation in the household sector will be done by grants and subsidies. The RES target of 22% is proposed to be handled by addressing smaller power plants (1 MW) by modifying or constructing new, larger ones (>1 MW), under a "pro-market" principle. Biomass consumption until 2030 will be covered mainly by domestic sources.

Advanced biofuels will gradually contribute with half of the projected 14% RES in 2030, achieved by introducing new support, which will initiate the production of advanced biomethane and its supply to the transport sector. Liquid biofuels, especially biodiesel, will in the future be associated with higher imports.

As far as research funding is concerned, one of the priority areas identified in the State Energy Policy is "Renewable (alternative) energy sources", which aims at a "more efficient use of biomass, development of advanced biofuels made from non-food biomass and waste". The subject of R&D must be a suitable transformation processes of biomass showing the most effective solutions in the future. Topics for biogas plants are the expansion of the fuel base and the efficient use of heat.

In terms of regional and international cooperation, the following should be mentioned:

- Cooperation (including on bioenergy) within Visegrad Group consisting of the Czech Republic, Hungary, Poland and Slovakia.
- Cross-border cooperation project RESINDUSTRY (exchange best practices in setting up subsidy programmes for the promotion of energy from renewable sources; Czech Republic, Spain, Malta, Austria, Poland, Estonia and Finland).
- Research cooperation programmes in IEA.

With reference to challenges, it should be stressed that, Generally, the Czech Republic has not set any specific quantifiable targets in public R&I specifically related to the Energy Union. The difficulty of setting energy and climate targets is due, inter alia, to the structure of public funding for R&I, which is not sector focused.

Denmark

Targets:

- Renewable energies share in 2030 of total final energy consumption 55%
    - Share of RES-E 110% (enabling export, wind dominates, bioenergy 10%)
    - Share of RES thermal 60% (bioenergy dominates, 45% of total)
    - Share of RES transport 19% (first-generation biogas and biofuel 6.5% of total, electricity rest)

The **Climate Act**, 2019, included a legally binding target to reduce greenhouse gases by 70% by 2030 (relative to 1990 level), to reach net-zero emissions by 2050 at the latest, and to set milestone targets based on a five-year cycle. It is a very ambitious goal, and how it will be reached will be outlined in the upcoming Climate Action Plans.

Bioenergy is the most widely used renewable energy source in Denmark for heating. Currently several large-scale power plants are converting from fossil fuels to solid biomass, and the production of biogas is increasing. Bioenergy plays an important part in the green transition. Denmark is one of EU's largest consumers of biomass for energy per capita, and currently has no specific measures that promote the production of electricity from new biomass installations after 2020. Imported biomass accounts for 45% of the total biomass use. Denmark has established a solid platform for bioenergy and a large number of local and decentralized biomass-fired CHP plants were built and large-scale and centralized CHP plants were converted from coal to biomass.

Unique knowledge and technology exist within biofuels and biogas production. Biogas production will increase 2-3 times. The use of biogas will become independent of local CHP plants, with distribution through the existing gas infrastructure, so that gas can be used in the CHP sector, in industry, in natural gas boilers in households, and in the transport sector. There is an increasing risk of indirect effects linked to demand for biomass when global and regional demands rise. The use of 1st and 2nd generation biofuels for transport is projected to remain constant from 2020-2030, with the increase in RES for transport coming from electrification.

Denmark has over the past decade set up an elaborate R&D funding portfolio targeting the green transition, covering everything from research on the lower-intermediate TRL, to bringing the research closer to the market, and finally major capital investments in start-ups and SMEs. Billion-EUR level investments will be made every year in the next decade in “green” R&D. Investments in biofuels have declined over the past five years, while investments in bioenergy and waste-to-energy have increased. Biomass will probably increasingly have to be used to make high-value products, e.g., in parts of the transport sector that are not so easily electrified.

Denmark cooperates regionally in order to contribute to common reduction of carbon emissions and to assist in the energy transition to a low-carbon economy. The cooperation is primarily focusing on policy improvements in long-term energy planning and modelling, renewable energy integration and deployment, energy efficiency interventions and in climate change mitigation. The main relevant cooperation initiatives are:

- The Nordic Council of Ministers. The official body for intergovernmental cooperation in the Nordic Region covers both climate and energy, including the Nordic Energy Research programme (where carbon capture and storage R&I&D is a key topic).
- European policy fora: CA-RES (RES in EU), BEMIP (RES and other topics in countries around the Baltic Sea), IEA Renewable Energy Working Party.
- Cooperation on stability of electricity supply with neighbouring European countries.
- North Seas Energy Cooperation and the Baltic Energy Market Interconnection Plan.

Estonia

Targets:

- Renewable energies share in 2030 of total final energy consumption 42%
    - Share of RES-E 40% (biomass 28%)
    - Share of RES thermal 63% (district heating w. biomass plays major role)
    - Share of RES transport 14% (2nd generation biofuels 35%)

Estonia’s climate targets were set out in 2017 in the vision paper “**General principles of climate policy for 2050**”, which formed the basis for the NECP. The current national development documents have not set independent R&D targets related to the energy sector, and the energy sector instead contributes to the achievement of the overall national research and development targets (3% GDP funding).

Biomass plays an important role for the renewable energy targets, and solutions are sought that are in line with the sustainability criteria under the RED II. Wood is used for energy in Estonia to an extent in line with the sustainable allowable cut of the forestry development plan.

One of the key objectives of the NECP is ensuring energy security by keeping the rate of dependency on imported energy as low as possible: Use of local fuels is kept as high as possible (including increasing the use of fuel-free energy sources), developing biomethane production and potential uses. 2nd generation biofuels are set to replace 1st generation biofuels. Estonia must ramp up domestic biomethane production to meet these goals, but except for being a target in the R&D activities how this is done is not clear.

The 2030 R&D energy programme was approved in 2019 and includes R&D support for biomass and biofuel in the energy sector and transport. This area covers activities relating to ‘Developing electricity production’; ‘Efficient production of heat’ and ‘Increasing the availability of alternative fuels in transport’ (e.g., biomethane production). Baltic and Nordic scientists can apply for R&D funding under the Baltic-Nordic countries research cooperation programme funded by Nordic Energy Research and the Baltic States. Legislation will be used to motivate industry to employ predominantly low-carbon fuels and production inputs. The 'Green technology investment programme' aims to use state equity capital to boost start-up and scale-up companies whose activities are directed towards developing and bringing to market new low-carbon products, services, and technologies.

In connection with the climate and energy policy, Estonia participates in different regional cooperation, including the Baltic Assembly; Summits of the prime ministers of the Baltic States; Baltic Council of Ministers and broader regional cooperation (Finland, Sweden, Poland, Denmark, and Germany); European Union Strategy for the Baltic Sea Region; Baltic Nordic Energy Research Program; Baltpool International Biomass Exchange. The Baltic states have agreed to cooperate on among others biomethane production and market development; and coordination of biofuel mixing requirements. Estonia is also part of the Baltic Energy Market Interconnection Plan.

Finland

Targets:

- Renewable energies share in 2030 of total final energy consumption 54%
    - Share of RES-E 53% (biomass 32% of RES-E)
    - Share of RES thermal 61% (almost exclusively biomass)
    - Share of RES transport 30% (almost exclusively liquid biofuels)

Finland will target carbon neutrality by 2035 and aims to be the world's first fossil-free welfare society. The main basis for the NECP, the **National Energy and Climate Strategy** from 2016 outlines concrete actions and objectives that will enable Finland to achieve the national energy and climate targets and targets adopted by the EU for 2030, and for reaching the 2050 targets. The **Act on Promoting the use of Biofuels in Transport** (2008) regulates biofuels in transport.

Bioenergy has a key role in the renewable energy production, which is largely integrated into forestry and forest industries. In recent years, energy derived from woody biomass was 25% of Finland's total energy consumption. Towards 2030 coal will be phased out of energy production, and biomass boilers, heat pumps and district heating will be phased in. There is a subsidy on wood chips for CHP to compensate for the price difference towards fossil fuels. The biomasses sustainability is regulated in RED II, regulated by legislation and monitoring.

The majority of biofuels and bioliquids are estimated to be domestic and their raw materials are estimated to include biodegradable waste, side streams of the forest and other industries, and logging residues.

Overall, Finland is one of the leading countries in funding R&D, going well beyond the suggested 3% GDP. Energy technologies are currently a strong focus, e.g., through the innovation funding agency Business Finland. Finland also joined the Mission Innovation project in 2016, with the aim to strengthen a clean energy ecosystem.

The Government has prepared a national biogas programme to improve Finland's vitality and to achieve Finland's climate targets. The majority of the biogas potential is associated with farming.

Renewable energy is also promoted through the Energy Aid Scheme (investment subsidy). Aid is primarily targeted at the commercialisation of new technologies and to the non-ETS sector, including plants producing advanced biofuels for transport, and non-ETS electricity and heat production of companies.

Finland cooperates mainly in the Nordic region, e.g. The Nordic Council of Ministers; Nordic cooperation on renewable energy; Nordic Energy Research (a platform for cooperative energy research and analysis, where carbon capture and storage R&I is a key topic). Finland is also part of the Baltic Energy Market Interconnection Plan, and the Clean Energy Ministerial CEM cooperation.

France

Targets:

- Renewable energies share in 2030 of total final energy consumption 32% (France has a vast nuclear energy production)
    - Share of RES-E 40% (hydro, wind, geothermal and PV main, biomass minor)
    - Share of RES thermal 38% (solid biomass 70% of RES)
    - Share of RES transport 15%

The NECP builds on the Multiannual Energy Planning (MEP) and the National Low-Carbon Strategy; both documents were government proposals still to be adopted by the parliament at the time of submission. The guiding objectives of the draft plan are to decarbonise the energy system and to achieve carbon neutrality by 2050.

In the domain of research funding, the Strategic Sectoral Committee for New Energy Systems covers four large-scale thematic projects, including renewable energies (where biogas is one of the focus areas). A strong focus is placed on innovation, including in anaerobic digestion. Other funding opportunities (more general and not per se bio-related) are the EUR 10b French Innovation Fund, which aims to support the development of breakthrough innovations and their mass production in France.

In terms of biomass, four incentives have been identified in the forestry sector: use of bio-based products as substitutes for energy-intensive materials; recovery of energy from bio-based products or from their waste; storage of carbon in wood and waste wood products; carbon sequestration in the forestry ecosystem. The NECP reflects the fact that the energy transition and the green economy require control of the use of fossil resources in all areas and better use of nationally available renewable resources, especially biomass. France prioritises the use of biomass for heat and not electricity, and therefore support is reserved to heat generation technologies. Carbon capture and storage technologies are also mobilised, and when coupled with bioenergy (BECCS) negative emissions in 2050 are projected (10 Mt/year scale).

The NECP raises the issue of the balance between production and consumption of biomass for energy and mentions the impact of increased use of biomass on the carbon sink. France has a National Biomass Mobilisation Strategy.

The share of renewable energies is set to 10% of gas consumption in 2030, achieved by anaerobic digestion, gasification and Power-to-gas. The need for large-scale power-to-gas is unlikely to arise before 2035. All energy system stakeholders therefore still need an industrial scale experimentation framework. At the same time, R&D efforts are also needed in less mature electrolysis technologies. Feedback is planned on the demonstrators for gasification for injection into the gas networks in order to analyse the role that could potentially be played by this sector. The development of producing biomethane requires substantial public support. Support to efforts will be made by the various sectors to decrease production costs.

Although biogas today is a small part of France's energy mix, there is a systematic analysis on costs, potentials and trade-offs in enhancing use of biogas towards the 2030 targets.

To achieve the target of 15% RES in transport, increased biofuels are foreseen along with development of alternative fuels, especially on the basis of waste and residues. Also, a study of the feasibility of implementing a production and distribution pathway for sustainable aeronautical biofuels will be taken.

In terms of gaps and challenges, it is worth mentioning that most of the analyses focus on 2028 (to some extent also 2030) and then the long-term 2050 goal. It is difficult to find e.g., the energy mix in 2030-2050 (e.g. in terms of use of nuclear power, RES etc).

France is part of the Pentalateral Energy Forum.

Germany

Targets:

- Renewable energies share in 2030 of total final energy consumption 30%
    - Share of RES-E 53% (dominated by PV and wind, biomass 7% of total)
    - Share of RES thermal 19% (biomass 14% of total)
    - Share of RES transport 15% (mix of biofuels and electricity)

The **Climate Action Programme 2030** from 2019 will shape the energy and climate policy up to 2030 and beyond. The **Seventh Energy Research Programme** from 2018 focuses on accelerated transfer and aligns energy research with the needs of the energy transition.

Towards 2040, biomass will continue to represent the most important source of renewable energy for the generation of piped heat, even though the baseline shows a slight drop in district heat generated using biomass. There are no plans to expand the cultivation areas for bioenergy and no expansions are being considered because of land surface area restrictions. The sustainability criteria of RED II will also be used for imports (from the internal market and from third countries).

The share of first-generation biofuels will be limited to 5.3% in 2030, while advanced biofuels are already contributing to GHG reduction in the transport sector. Existing gaps in research and development on innovative advanced biofuels (for instance, fuels made from straw) will be filled through projects and demonstration projects, to enable large-scale production in the medium term. The increased use of farm manure in biogas plants and the gas-tight storage of digestate will be promoted using current and new instruments.

The Seventh Energy Research Programme reflects the core and special priorities of the European SET Plan and the energy union which are most relevant to Germany. The federal research funding is striving to ramp up energy research and is based on a technology-neutral approach and covers a broad range of sustainable energy technologies. Regulatory measures are made to bring innovative energy technologies to the market successfully, and support transfer of research and market preparation through targeted funding measures. This includes a “New Bioeconomy Strategy”, focusing on cutting-edge technologies for the industrial bioeconomy, funding of high-carbon waste streams as a material for the production of functional biomass.

The funding programme ‘Use of Biomass for the Generation of Energy’ from 2015 prioritises demonstration or pilot projects which increase the flexibility of biomass-based systems for the generation of electricity and heat. Sustainable energy use in the heat and electricity sector is sought through using the potential of biomass residues and waste.

The development of liquid and gaseous renewable fuels from biomass and their large-scale production in biogas and synthesis plants will be supported, to enable their use in some segments of the transport sector in the medium and long term. The projected bioenergy use will be more heavily based on waste and residues in the future.

Germany participates in several regional and international cooperation arenas but none of them have bioenergy specifically as a topic.

In terms of gaps and challenges, the climate target in the NECP of 65% renewable electricity and 30% renewable energy in 2030 is not established legally. Additionally, even if the biomass part of the electricity mix remains quite steady over the next decade in absolute terms, in relative terms it will go from over 30% in 2010 to under 10% in 2040.

Greece

Targets:

- Renewable energies share in 2030 of total final energy consumption 35%
    - Share of RES-E 60%
    - Share of RES thermal 43%
    - Share of RES transport 19%

Bioenergy is only a small fraction of power generation, which is dominated by natural gas, wind and solar.

A “new strategic agenda” (2019-2024) was adopted in 2019 outlining the initial steps towards the green transition. The plan is not specifically named in the NECP.

Greece has committed to phase-out in using brown coal (lignite) in power generation in 2030. Unfortunately, it seems to be replaced by natural gas. That notwithstanding, this decision does create space for the installation of additional RES plants, while strengthening the role of the gas-fired plants will provide the necessary system flexibility. The NECP is also mentioning that biogas can be fed into the natural gas network.

There are specific policy measures aimed at feeding biogas into the natural gas network, for development of supply chains for residual biomass/biodegradable matter and support for the development and implementation of optimal environmental and energy-efficient bioenergy applications.

The high-RES transport goal (19%) is achieved in part by focusing on electrification of the car fleet. Using 2nd generation biofuels is also included in the 2030 targets, with the overall biofuel consumption (1st and 2nd generation) set to almost double in 2030 compared to 2020. The main objective is promoting the use of Greek raw materials and to support domestic biodiesel producers. However, the current regulatory framework needs to be revised to render the further exploitation of biodiesel compatible with the policy on the promotion of advanced biofuels and the reduction of conventional biofuels in line with the requirements of the new Directive.

In terms of regional cooperation, Greece participates actively in the new EU initiative 'Clean Energy for EU Islands'. Greece also cooperates with non-EU countries and is actively engaged with neighbouring countries in Africa and the Middle East (Israel, Jordan, Egypt, and EU countries like Germany, Italy and Cyprus). This is within areas like RES R&D, energy efficiency in buildings (40% of Greece's energy consumption), alternative fuels etc.

Research and innovation actions are taken in bioenergy, specifically for development of solid, liquid, and gaseous bio-energy intermediates using sustainable (and local) biomass.

Hungary

Targets:

- Renewable energies share in 2030 of total final energy consumption 21%
    - Share of RES-E 21% (achieved by PV expansion)
    - Share of RES thermal 29% (almost exclusively biomass and biogas)
    - Share of RES transport 17% (half from 2nd gen. biofuels and half from 1st gen. biofuels and electrification)

Hungary is very dependent on fossil fuels as a primary energy source, with renewables and nuclear only accounting for 25% today. Two new nuclear power plants are projected for 2030, which gives emissions-free energy sources.

The new National Energy Strategy was drawn up concurrently with the NECP and adopted together with the NECP. The plan is aligned with policy measures set out in the Second National Climate Change Strategy from 2018, and in the First Climate Change Action Plan.

The RES in the thermal sector is almost exclusively biomass and biofuels today, and this will remain unchanged towards 2030. Use of heat pumps and the burning of biomass in efficient individual heating equipment are encouraged for heating and cooling in new buildings. The NECP includes detailed information on the supply and use of biomass and sustainable forest management.

Advanced 2nd generation biofuels will play a major role (>50% of the RES-T) in the transport sector in 2030.

Establishment of biogas plants processing agricultural waste is encouraged to both satisfy local heat demand and to feed in purified biomethane to the natural gas network

Regarding research funding, a planned Transport Greening Programme would aim to support the use of 2nd generation biofuels; the related pilot project would serve the testing of production technologies (and empirical determination of the national production cost and competitiveness).

Ireland

Targets:

- Renewable energies share in 2030 of total final energy consumption 34% (non-RES is oil and gas)
    - Share of RES-E 70% (mainly wind, some solar, biomass very little)
    - Share of RES thermal 24% (biomass, biogas, geothermal and heat pumps)
    - Share of RES transport 13% (without multipliers used, mix of biodiesel and electrification)

Building on the policy framework of the National Mitigation Plan (NMP) and Project Ireland 2040, the Government published its Climate Action Plan in 2019. Ireland's Support Scheme for Renewable Heat (SSRH) is a government funded initiative designed to increase the energy generated from renewable sources in the heat sector.

17% of the biomass is imported by 2030, with the assumption that domestic forestry, agricultural residues, and waste resources are harnessed for growing demands in heat and transport. Transition from co-fired peat and biomass boilers to 100% biomass is planned.

A biofuels Obligation Scheme is set in place to reduce the concentration of high-emitting fuels, and it aims to increase the renewable, 2nd generation biofuel content.

The Climate Action Plan outlines the need to set a 2030 target for the level of energy to be supplied by indigenous biomethane injected into the gas grid and consider how necessary supports would be funded.

No specific bio-energy related cooperation is indicated in the NECP.

Ireland takes a technology agnostic approach when funding energy R&I. General prioritisation of areas to be funded is decided on the basis of an exercise run by the Department of Business, Enterprise & Innovation. Under the SSRH, R&D support can be found for biomass boiler/biomass HE CHP heating systems and biogas production (anaerobic digestion).

Italy

Targets:

- Renewable energies share in 2030 of total final energy consumption 30%
    - Share of RES-E 55% (dominated by PV, hydro and wind, biomass 10% of RES)
    - Share of RES thermal 34% (biomass over half)
    - Share of RES transport 22% (mainly biofuels)

Italy will follow in the tracks of the Energy Union strategy, and is planning instruments to identify objectives, policies, and measures coherent with the European framework. The 2017 **National Energy Strategy** served as a starting point for drafting the NECP.

Approximately 80% of biomass is domestic in origin. An increased penetration of more highly efficient technologies is planned, with the possibility of increasing the share of pre-processed fuels, such as pellets. Biomass will provide over 50% of the thermal RES contribution, especially from burning solid biomass, primarily in the household sector in the form of firewood and pellets. This value is projected to remain constant until 2040. Another aim is to encourage a circular bioeconomy using agricultural waste, not least to prevent it from being burnt in the fields and promote the use of local biomass.

Contributions to the 2030 target of thermal RES from bioliquids, biogas, geothermal power and PV are limited. For transport, the 22% RES target is up from the current 14% (where largely biodiesel is contributing), and the main growth for this to happen is in biomethane (which currently is very limited in use). Incentives to use biomethane and advanced biofuels will occur through a certificate incentivisation system. This system is expected to cover the predicted demand for methane in road transport with biomethane. Building and operation of biomethane production plants will be promoted, encouraging investment in this area.

The **Fund for Energy and Environmental Services** aims to support actions and measures for technological and industrial development in the field of renewable sources and energy efficiency, as well as support for demonstration projects. Notably only a few of the funding schemes are specifically targeting bioenergy. The funds available from CO_2 auctions will cover experimental development and support of demonstration projects, with the results being passed on to the production system. Among the topics are use of biofuels in the aviation sector, and alternative fuels derived from microcellular algae. There are also incentives set out to support R&D projects for converting production processes towards the circular economy, which consist of granting of financial incentives for making a commitment to invest in projects, in particular to achieve the energy transition.

A **National Technology Cluster** for energy has been launched, based on a public interest call for mixed public-private groups, with the aim to generate technological and innovative development opportunities for the industrial system between public and private research.

In terms of International and regional cooperation, Italy is involved in all 8 Mission Innovation Challenges and has in 2021 committed to doubling (since 2013) its public research spending into clean energy. While preparing the NECP, Italy held a joint meeting with the four countries of the eastern cross-border quadrant – Slovenia, Hungary, Croatia, and Austria. Among the shared topics of interest is the development of best practices for biomethane production. In addition, a Memorandum of Understanding was signed between Italy and Greece with the aim of fostering energy cooperation.

As far as gaps and challenges are concerned, currently Italy does not seem to have an overall, cross-cutting plan for the 2030 energy transition, but instead it seems to be work in progress building on a period of fragmented initiatives. The NECP puts forward that the projected need for Italy will be around 5% of the 2030 biomethane availability in EU. While it also aims to promote Italian biomethane production, it is not clear what policies or funding instruments should enable this to happen.

Latvia

Targets:

- Renewable energies share in 2030 of total final energy consumption 50%
    - Share of RES-E 72% (biomass 10%, dominated by solar and wind)
    - Share of RES thermal 60% (biomass dominates)
    - Share of RES transport 7% (biofuels 3.5% of total)

Overall biomass plays a little role in the road towards 2030, since a) the RES expansion in the electricity sector is covered by PV and wind; b) the use of biomass in RES thermal is large but rather constant, and the increased share will be achieved by making the sector more efficient;

c) while biofuels for transport is an important measure to achieve the target, in the overall energy consumption transport does not play a big role.

The Sustainable Development Strategy of Latvia 2030, National Development Plan of Latvia 2014–2020 and National Development Plan of Latvia 2021–2027 (under development), and Long-Term Energy Strategy of Latvia 2030 (which includes optional and non-binding targets for the use of RES, energy and energy sources, and the share of imports for 2030) are the key policy documents for the energy sector and climate targets.

R&D spending increases from 0.7% to >2% GDP in 2030. From 2021-2027, there are plans for a targeted support for the development and implementation of R&D in climate technologies (aiming at 25% of total investments in this area), in particular within the scope of implementation of the Smart Specialisation Strategy. One focus area is innovative RES solutions, including production and use of biomethane, modern biofuels, and smart use of biomass before combustion. Several new initiatives have been started and implemented for fostering the innovation and business discovery process: promotion of development of the start-up system; state capital companies innovation platform; establishment of the Latvian Innovation and Technology Support Fund.

A key factor for reducing GHG emissions is replacement of fossil fuel with biomass in district heating, as well as the implementation of energy efficiency measures (mainly renovation of residential and public buildings) in households and the services sector.

Like Lithuania, Latvia is drafting the **Alternative Fuels Law** that will promote the use of alternative fuels with focus on advanced liquid and gaseous 2nd generation biofuels and the electrification of the vehicle fleet and rail system. In order to ensure that the share of RES increases through local energy sources and in the light of available resources in the agricultural and waste sector, and existing biogas plants and investments in them, it is necessary to encourage the installation of biogas purification plants, to improve the infrastructure for biomethane use and to promote its consumption in transport.

For regional collaboration, see the analysis of Estonia.

As far as gaps and challenges are concerned, the type and origin of the solid biomass for the thermal and electricity sectors are not clear. However, it is indicated in various passages that production and origin is local: e.g., “RES used in the transformation sector are local energy sources: wood fuel, biogas and other types of biomass”. Latvia is not planning to increase biomass and biogas capacities for production of electricity.

Lithuania

Targets:

- Renewable energies share in 2030 of total final energy consumption 45%
    - Share of RES-E 45% (biomass 9% of RES, dominated by 70% wind)
    - Share of RES thermal 67% (local biofuels used, district heating integral)
    - Share of RES transport 15% (biogas and electricity dominate)

Lithuanian yey policies ar: National Energy Independence Strategy (2018); the National Strategy for the Climate Change Management Policy (2012, updated in 2019); the National Air Pollution Reduction Plan (2019). The 2021-2030 National Progress Plan is aiming to identify the main developments needed and sets a target of R&D funding from all sources in Lithuania at a minimum 2% of GDP by 2030.

In terms of biomass, the expected increase in demand for wood and fuel wood waste would easily be satisfied from local resources merely by starting to use the forests reserved for the restoration of property rights, also through more extensive and efficient use of the wood resources currently cut (logging waste, etc.). No significant impact on the LULUCF sector is foreseen. The heat sector is becoming increasingly dependent on the national biomass market as it moves towards renewable energy. Currently, indigenous biofuels are used, which are purchased by DH companies via the biofuel exchange Baltpool (see Cooperation below). DH will take 60% of the biomass used for heat, while 40% is decentralised heat production with biomass.

As far as biogas and biofuels are concerned, like Latvia, Lithuania is drafting the **Alternative Fuels Law** that will promote the use of alternative fuels with focus on advanced liquid and gaseous 2nd generation biofuels and the electrification of the vehicle fleet and rail system. Since biogas (biomethane) use expected to be transport-oriented, it is estimated that the development of biogas power plants in the electricity sector will not be carried out in the 2020-2030 period.

Re-orientation of biogas use for electricity and heat production towards biogas treatment and supply to natural gas networks will be proposed. Such a measure would allow the fastest possible deployment of existing infrastructure and the expected future emergence of biomethane gas on the Lithuanian market. The measure would consist of investment support for the construction and installation of biogas treatment plants in the already existing plants.

Biomethane gas production facilities, including biogas treatment facilities, would be financed in the planned policy measures for RES in the transport sector. In order to meet the domestic demand, new production capacities are necessary by 2030 to ensure production of the expected use of biomethane gas per year.

For the energy R&I ecosystem the objectives are: 1) To create a legal environment for testing innovative energy products and business solutions in a new regulatory sandbox for energy innovation. 2) Establishment of a facility providing low-value grants or start-up loans in the field of energy technology innovation (product manufacturing). 3) To encourage innovation by regulated energy undertakings, by identifying sources of innovation funding. Under the Smart Specialisation Strategy 2014–2020, 20% will go to energy and environmental sustainability. The goal for Lithuania is to become a centre of information technology and cybersecurity solutions for energy, biomass and biofuel technologies, as well as system management approaches and implementation of energy projects.

As to regional cooperation, Baltpool International Biomass Exchange is operating in Lithuania, Latvia, Estonia, Poland, Denmark, as well as in Finland and Sweden. Baltpool is part of Lithuania‘s state owned EPSO-G energy transmission and exchange group. For other cooperation activities see Estonia. Lithuania is also part of the Baltic Energy Market Interconnection Plan.

Luxembourg

Targets:

- Renewable energies share in 2030 of total final energy consumption 25%
  - Share of RES-E 34% (dominated by PV and wind, biomass 13% of RES)
  - Share of RES thermal 31% (biomass dominates)
  - Share of RES transport 16% (mainly 2nd generation biofuels, some e-mobility)

Under the **National Energy Efficiency Action Plan 2017-2030**, the climate and energy policies are mainly based on improving energy efficiency, promoting renewable energy (including biomass) and promoting more sustainable public and individual mobility. In those policies: 1) biomass is mentioned under “Renewable energy” in the context of sustainable wood availability in the wider region; 2) biogas is mentioned under “Internal energy market”, where it is indicated as a measure that it will be provided “active support for gas distribution companies in setting up green gas infrastructure (collection of biogases from decentralised biogas plants, biogas and sewage sludge washing plants)”.

In its current legislative programme aims to transforming Luxembourg’s financial centre (where EIB is located) into a ‘green finance’ centre. Research priorities currently include the creation of a research team for ‘green finance’ and ‘impact finance’. A research priority on ‘Financing the Energy Transition’ will be developed, where new financial instruments such as ‘de-risking instruments’ for energy efficiency, renewable energy and energy infrastructure will be explored, all aiming to exploit the proximity with the EIB.

In terms of research funding, the "**Let´s make it happen**” strategy will be developed in 2021 and will involve the financial sectors, tech companies mainly in the field of energy transition, smart cities, smart mobility and also circular economy, universities and research centres. Public-private partnerships are encouraged in order to innovate and develop the private sector landscape. Luxembourg aims to become a pioneer in key energy technologies and innovation.

The use of biomass has predominantly been promoted in cogeneration plants. A new directive provides sustainability criteria for the use of biomass in large plants (> 20MW). Plants with a rated electrical output over 10 MW which use biomass or used and residual wood as an energy source must comply with these sustainability criteria in order to receive a feed-in tariff/market premium. Luxembourg is considering creating its own sustainability label, and a draft forestry code law also sets out better sustainability criteria for national forestry.

Biogas continues to be a pioneering energy source (electricity, heat, supply). The framework conditions need to be revised in order to better promote biogas and to better take into account environmental issues. Biogas produced will be fed into the gas network as a priority. To this end, a technical and economic analysis was commissioned to determine the potential of biogas and the implementation of all the above factors. In view of the scarcity of land in Luxembourg, the 2030 renewable energy targets and the results of the study, the energy, environment, and agriculture ministries will work closely together to define the future role of agriculture in energy production and specifically in relation to biogas and PV.

The use of 1st-generation biofuels will be limited to 5%, and 2nd-generation biofuels will be promoted using a blending obligation and through cooperation with the Benelux partners.

At an international level, Luxembourg participates in the UN GCF ("Green Climate Fund") and in the "Network of Financial Centers for Sustainability". Luxembourg is a member of the

International Renewable Energy Agency (IRENA), collaborates with the Benelux partners and is part of the Pentalateral Energy Forum (see Austria).

The NECP is based on the **Climate Agreement** (2019). Relevant policies are: **The Climate act** (2019), establishing the national climate targets; The state-wide programme for a **Circular Economy by 2050** and the **Raw Materials Agreement** focusing on reusing raw materials, including biomass; The **Integrated Knowledge and Innovation Agenda for climate and energy**, identifying in connection to the Climate Agreement thirteen Multi-annual Mission-oriented Innovation Programmes (MMIPs). Relevant MMIPs are: MMIP 6 Closing industrial chains, aiming at achieving among others Bio-based raw materials for products and transport fuels; CCS and CCU. MMIP 12 Land and water, applies knowledge and innovation to design land and water for the purpose of increasing biomass production.

Malta

Targets:

- Renewable energies share in 2030 of total final energy consumption 11%
    - Share of RES-E 11% (dominated by PV and waste, biomass not present)
    - Share of RES thermal 26% (heat pumps dominate, biomass imported)
    - Share of RES transport 15% (imported biofuels dominate)

Malta has no sources of indigenous biomass, no natural gas system, no district heating, and needs to import all biofuels that should be used for meeting targets.

On transport, Malta relies on road transportation, and electrification of the fleet is only projected to be a minor part of RES transport. Biofuels for transport (imported) is therefore the main source of bioenergy, and bioethanol cannot be used due to the hot climate. 25% of the imported biofuels is projected to be 2nd generation.

Imported biomass like wood pellets and firewood is used for the small heating need there is in the residential sector.

The Netherlands

Targets:

- Share of RES in 2030 of total final energy consumption 27% (biomass 25%)
    - Share of RES in electricity 73% in 2030
    - Share of RES in thermal 13% in 2030 (6% in 2018)

The use of biomass leading up to 2030 and 2050 is seen as necessary for a sustainable economy. Currently, almost 60% of renewable energy consumption comes from biomass. Consumption of biomass energy will continue to grow, for example as a result of co-firing in coal-fired power plants. A framework for the sustainable use of renewable biomass is being developed. In order to establish a framework, the Netherlands Environmental Assessment Agency together with an external agency will work on concrete sustainability criteria for the different types of biomass, originating from both national and international sources.

The production of renewable gas, which is fed into the gas network, and used exclusively in the transport sector, is expected to more than triple from 2018 to 2030.

The Netherlands is committed to the use of sustainable biofuels reducing in this way the energy imports from developing countries to be achieved. The government also intends to increase the production of so-called more advanced sustainable biofuels. In 2030, all new cars sold will be zero-emission vehicles.

Concerning research funding, The Netherlands medium to long-term objective is to invest 2.5% of GDP in R&D, in which the share of private funding will be increased. In order to generate additional private R&D the government is focusing, among other things, on further strengthening public-private partnerships. Schemes like Public-Private Partnership Allowance, Research & Development Tax Credit, have been introduced. Their main objectives are to address the needs of the market, increase and support public-private partnerships and strengthen SMEs in innovation.

With respect to regional and international cooperation, the MMIPs are connected to several international initiatives like Biomass Sustaining the Future BESTFII and BESTFIII ERA-Net Co-Funds; Electric Mobility Europe ERA-Net Co-Fund Electromobility + ERA-Net. In addition, there is ad hoc cooperation with relevant countries, in particular the Pentalateral Energy Forum (see Austria). Concerning international cooperation, the Netherlands participates in several Technology Collaboration Programmes of the IEA, and in the Innovation Challenges within Mission Innovation.

As to gaps and challenges, generally, the NECP is not very concrete. It is very difficult to assess in terms of getting an overview of the overall energy mix today and in 2030 and there is no forecast for 2030 for the biofuel contribution to RES in transport.

Poland

Targets:

- Renewable energies share in 2030 of total final energy consumption 23%
    - Share of RES-E 32% (fossil coal is dominating with 77% today, and will be reduced to below 60%, biomass 26% of RES, RES dominated by wind)
    - Share of RES thermal 28% (biomass 85% of RES)
    - Share of RES transport 14% (biofuels dominate, mostly 1st generation)

Energy Policy of Poland, currently being updated, and the **Responsible Development Strategy** 2020 – with an outlook for 2030 (adopted in 2017). The **Directions for Energy Innovation Development** (2017), which aims to target public expenditures at the most attractive and urgent challenges, and to activate business involvement in and financial commitment to R&I&D activities.

Poland aims to increase its expenditure on R&I&D activities to 2.5% of GDP in 2030, and the national objectives are pursued within the framework of the state science, technology and innovation policy as defined in the **National Research Programme** (NRP) updated in 2020. NRP chooses strategic directions for research and development, including “New energy technologies”. A central focus will be on supporting investments in infrastructure (including technologies) for the production, storage and use of syngas and methanol.

The GreenEvo initiative (Green Technology Accelerator) supports entrepreneurs subject to the de minimis principle applicable to State Aid. Support for RES in electricity and heat and for the production of biofuels is given within the seven Regional Operational Programmes. The financial support level in the periods 2021-2027 and 2028-2034 is yet to be determined.

Biomass will be used for heating in households and for cogeneration purposes, exploiting the large potential for achieving the RES heating target. Owing to its local nature, RES in heat generation will require funds to be invested at the local government level, which implies the need for the financing of the development of RES mainly by municipal utility companies using grants, repayable instruments, guarantee funds.

For new biomass mobilisation, Polish agriculture has considerable resources of biomass and agriculture and agri-food processing by-products, which should be used for biogas production, especially considering that the Polish agricultural sector is currently growing. Energy products of biogas plants will be increasingly used in the energy sector, especially in combined electricity and heat generation.

Although not a biogas per se, Poland has through its considerable mining activities a significant leakage of methane (an aggressive GHG) and will support R&D in prevention by capturing the methane and usage of the it.

The **Low-Emission Transport Fund** will support the expansion of alternative fuels (CNG, LNG, but also biofuels) infrastructure and build up a market for those fuels. Alternative fuels are at an early stage of development or at the pilot or even experimental stage and therefore this area needs special financial support. The transition away from 1st generation biofuels will be supported in terms of grants, subsidies, repayable instruments for the development and application of new production technologies.

Cooperation on the following issues is planned in the period 2021-2030 among the Visegrad Group states: joint position within the European Union on the directions of development for the energy sector; scientific R&D cooperation; experience sharing in the area of development of the energy sector, including cooperation with the particular technology suppliers. Poland is also part of the Baltic Energy Market Interconnection Plan.

As to gaps and challenges, there is focus on “alternative fuels” for low-emission transport, but these mainly focus on fossil fuel alternatives like CNG and LNG, and not so much the biofuels (2nd generation). At the same time electricity and biofuels are needed for reaching the 14% RES in transport and is for road transport mostly based on 1st generation biofuels. There is support for R&D in 2nd generation biofuels, but no clear targets are being set for the share of RES.

Portugal

Targets:

- Renewable energies share in 2030 of total final energy consumption 47%
    - Share of RES-E 80% (driven by PV expansion, biomass only 2-3%)
    - Share of RES thermal 38% (biomass, district heating and heat pumps)
    - Share of RES transport 20% (electricity half, biofuels half)

The NECP was developed in cooperation with the tasks of Roadmap for Carbon Neutrality 2050, 2019, long-term development strategy for low greenhouse gas emissions, submitted to the Conference of the Parties to the United Nations Framework Convention on Climate

Changes, identifying the main vectors for decarbonisation and action lines to achieve a carbon neutral society by 2050.

In relation to renewable energy and energy efficiency, with a view to integration, Portugal currently has a National Action Plan for Renewable Energy (2020), and a National Action Plan for Energy Efficiency (2020), to promote renewable energy and make energy efficiency a priority for energy policies.

The use of forestry biomass will contribute toward creating more value in the forestry sector. The strategy includes decarbonising existing thermal consumption and promoting energy efficiency, namely by promoting the installation of small, decentralised biomass thermal power plants (e.g., cogeneration). The role of fuel consumption in this sector is expected to reduce as energy efficiency measures and the electrification of consumption is reinforced. In this regard, it will be possible to increase the percentage of renewable energy through the greater use of biomass and renewable gases. The aim is establishment of a network of small power plants to make use of biomass.

In terms of biogases, regulation and R&D are foreseen to fulfil the potential of renewable gases as an efficient fuel to produce heating/cooling and electricity or for transport. Mainly hydrogen and biomethane are targeted, with a view to creating a real market for renewable gases in Portugal.

National production of advanced biofuels is planned by using residual biomass or biomass with negligible economic value, the use of waste such as used cooking oils and other alternative endogenous resources.

The Portuguese government recently committed to an overall investment of 3% of GDP by 2030 in research and development (R&D). The targets proposed by Portugal for 2030 with regard to energy and climate for carbon neutrality by 2050 require continued growth in investment in low-carbon technologies. It is thus clear that investments in R&D in the areas of energy and climate will grow in the national panorama until 2030.

Romania

Targets:

- RES share in 2030 of total final energy consumption 31%
    - Share of RES-E 49% (almost exclusively hydro, wind, and solar; 3 nuclear power plants – 2 current and 1 planned – give 1.9 GW of capacity)
    - Share of RES thermal 33% (primarily from the use of biomass in boilers and a strong increase in the use of heat pumps)
    - Share of RES transport 14% (rollout of electric vehicles and further uptake of advanced biofuels)

The **National Smart Specialisation Strategy 2021-2027** (2020) intends to define the national objectives and targets of funding in the fields of research, innovation, and competitiveness.

Romania relies heavily on biomass for the heating and cooling sector, with the use of biomass generally found in rural areas. The true potential of biomass is not clear at national level (due to lack of data and an unclear legal framework). Biomass, in the form of firewood, is a widely used heating fuel. A growing number of households, in particular new residences, will adopt efficient biomass heating installations with full combustion and zero pollutants, and heat pumps will be further rolled out to couple the thermal sector to the electricity grid. On the other hand, the air quality problems connected with residential use of biomass are not assessed. The NECP also includes specific measures on the promotion of the use of bioenergy from new biomass mobilisation from agricultural waste and crops.

A small increase in 2nd generation biofuels is projected for 2030. Policies are planned for national production by fostering investments in co-processing installations in refineries (production of regenerable and sustainable Diesel) and fostering investments in advanced ethanol production. LNG/CNG mixed with biomethane is mentioned under possible EU support for “alternative fuels” sustainable infrastructures but is not a priority in the NECP.

R&I&D in Romania is mainly fundamental research with priority for a given field under a relevant ministry. For the energy sector the decarbonisation objectives will be strengthened by adopting advanced technologies through specific domestic initiatives for the RES components developing R&I for production of biofuels (e.g., production of advanced biofuels and coprocessing of oils) and biogas.

Slovakia

Targets:

- Renewable energies share in 2030 of total final energy consumption 19%
    - Share of RES-E 27% (nuclear power dominates until 2050)
    - Share of RES thermal 34% (biomass 65%, biogas 10% of RES)
    - Share of RES transport 14% (mainly 1st gen. bioethanol and biodiesel)

The objectives of energy research and development are in line with the “**Research and Innovation Strategy for Smart Specialisation of the Slovak Republic**” (2013).

It is expected that bioenergy accounts for 75% of renewable heat in 2030, 65% point from biomass and 10% point from biogas. The main sources of fuel wood biomass are forest land, long-term non-managed agricultural land with forest growth and residues from industry. Slovakia considers heating and cooling to be a key sector for meeting the RES target for 2030 and has all the prerequisites for building and developing 4th generation CHP systems. There will be a focus on optimisation of district heating systems, i.e., transition from fossil fuels to biomass and natural gas or biogas.

The role of advanced biofuels will increase in 2030, and there are measures to support 2nd generation biofuels (targeting 3.5% in 2030), and an alternative fuel infrastructure.

Nothing specific is mentioned in the NECP with respect to research funding.

In terms of regional and international cooperation, Slovakia is involved in international R&I&D through bilateral agreements on scientific and technological cooperation within EU and outside EU. Slovakia is a member of the IEA.

Slovenia

Targets:

- Renewable energies share in 2030 of total final energy consumption 27%
    - Share of RES-E 43% (solar and hydro dominates)

- Share of RES thermal 41% (biomass 66%)
- Share of RES transport 21% (mainly biofuels)

Slovenia in 2030 has a substantial hydro and nuclear energy production, of the order of twice the overall RES share.

The **Slovenian Development Strategy 2030** (2017) is a framework document on national development that incorporates globally agreed sustainable development goals as well as five strategic orientations and twelve interrelated development goals that lay down new long-term development foundations for Slovenia.

There is focus on sustainable use of national woody biomass that does not affect carbon sinks. The use of biomass in electricity is doubled in 2030 while the use for heating drops 20% (replaced by heat pumps). Competition calls for new CHP plants will be able to use woody biomass, and new micro-system district heating systems will be encouraged to use woody biomass.

Concerning biogas, the aim is to support the implementation of pilot and demonstration projects for the production of synthetic methane and hydrogen (with an indicative target 10% share of renewable methane or hydrogen in the transmission and distribution network by 2030), and to prepare a regulatory and support environment for renewable gas alternatives in the natural gas network.

Biofuels for transport is 80% of RES, and half of the biofuels used will be 2nd generation. The development, production and use of advanced sustainable biofuels will be prioritised, and there will be incentives for their production.

In 2030, the aim is to have 3% GDP in R&D spending (1% public investments), focusing on among others the transition to a low-carbon circular economy. There will be accelerated cooperation between R&D institutions and the economy and joint involvement in international projects. The main bioenergy R&D focus will be 2nd generation fuels.

Nothing specific is mentioned with respect to regional cooperation.

Spain

Targets:

- Renewable energies share in 2030 of total final energy consumption 42%
  - Share of RES-E 74% (biomass use tripled in 2030 but still less than 3%)
  - Share of RES thermal 31%
  - Share of RES transport 28% (electrification and advanced biofuels)

The **2021-2028 Spanish Science, Technology and Innovation Strategy** will incorporate a **Strategic Action on Energy and Climate Change**, as well as including this in its development plans, and assign R&D funding in energy and climate, including bioenergy and biofuels.

The **Spanish Strategy for the Development of Energy Use from Forest Biomass** is aimed at promoting residual forest biomass for energy purposes, as it considers that the implementation of a sustainable energy model, based on savings, efficiency, and diversification of sources, requires a decisive boost to the development of residual forest biomass as renewable energy.

The use of biomass in the energy mix is very limited (mainly biogases and biofuels).

Biomass is seen as a key technology with potential for decarbonising the industrial sector. Promotion of energy from biomass with sustainability criteria, and economic aid measures linked to use of biomass in state-owned facilities are foreseen. Biomass (and biogas) will be promoted to increase RES in heating and cooling, but the 2030 target is mainly achieved by combining solar with heat pumps and allowing energy communities to generate, consume and sell renewable energy.

Biofuels in transport is set to decrease in the next decade, but in that transition the goal is to switch to advanced biofuels. The development of renewable advanced fuels for the transport sector is considered a priority because of their broad applications.

Renewable gases (biogas, biomethane, hydrogen) are considered a key RES since it can be used both to generate electricity and to cover energy demand in high-temperature industrial processes and in transport. Penetration of renewable gases will be encouraged through the approval of specific plans, including RDI actions both for biogas and hydrogen and for less mature technologies such as power to gas.

Spain has no specific bioenergy cooperation, but participates in many European, national and regional policies and instruments to promote innovation and inter-regional cooperation on energy and climate.

Sweden

Targets:

- Renewable energies share in 2030 of total final energy consumption 67% (biomass 30% of total)
    - Share of RES-E 83% (hydro and wind dominates, biomass 10% of RES)
    - Share of RES thermal 72% (biomass over half, and mainly in industry or district heating)
    - Share of RES transport 48% (dominated by biofuels)

The NECP is based primarily on the **Climate Policy Framework** (2017) energy policy and the targets drawn from the **Energy Policy Framework Agreement**. Energy research policies are set out in a 2016 Government bill and implemented under the **National Energy Research and Innovation Programme**.

Beside national agencies, the municipalities and regions are important for Sweden's climate work, they promote energy efficiency and renewable energy sources locally and regionally. These agencies are not allowed to compete with private companies, they operate not-for-profit energy organisations.

The availability of sustainable biomass and the possibility to grow trees in Swedish forests or use land formerly devoted to annual crops can contribute to the transition to a fossil-free society. A great deal of research is being carried out in Sweden in relation to the use of forests as carbon sinks and the efficient use of bioenergy stocks.

Sweden imports a relatively large amount of biofuel feedstocks for heating and cooling, transport, and electricity sectors. There is significant national potential for most types of feedstock. There is no state policy for controlling the balance between domestic production and imports; it is controlled by market forces.

Sweden is a global leader in the field of biofuels and waste-based cogeneration. Research has played an important role in the development of efficient and environmentally friendly biofuel- and waste-based cogeneration plants.

In 2018, temporary governmental support was introduced for production of biogas upgraded to vehicle gas (biofuel) that was not produced from sewage sludge or landfill gas.

The annual budget of the National energy research and innovation programme is approximately SEK 1.6 billion. Institutions within the private sector are expected to contribute private funding equivalent to at least half of the public funding they receive. The programme runs research and innovation initiatives in nine areas, including bioenergy, general energy system studies, and business development and commercialisation.

Support measures for improving energy efficiency include e.g., the *Energisteg* programme, the *Klimatkliv* and *Industrikliv* initiatives and state support for renovation and energy efficiency measures in apartment blocks in certain areas.

Sweden is part of the Nordic Council of Ministers, which coordinates the national energy and climate plans in the Nordic region etc., under this the Nordic Energy Research programme (where carbon capture and storage R&I&D is a key topic). Sweden is also part of the Baltic Energy Market Interconnection Plan.

2.3 The pathway analysis on ‘Energy storage’

Terminology

Energy storage technologies are integral for smart sector integration as they allow flexible energy management to store excess energy and discharge it when demand exceeds generation. Energy storage facilitates sector coupling, linking together helping decarbonise previously separate systems (electricity, heating, mobility, industry). Energy storage deployment provides flexibility across different sectors at different timescales, from seconds and minutes, hours, weeks to even seasons.[23]

The range of energy storage technologies is wide. The most common energy forms are electrical, thermal, chemical energy, electrochemical and mechanical energy. Depending on the location, the scale of energy storage can be large-scale (GW), medium-sized (MW) or micro, local systems (kW).[24]

The main groups of energy storage are the following include:[25]

- **Electrochemical storage**: Battery technologies are the most central group of electrochemical energy storages. There are several different types, including developing and widely used, mature technologies. Lithium-ion batteries represent most of electrochemical storage projects.[26]
- **Mechanical storage**: The most widely deployed mechanical energy storage both in Europe and world-wide is pumped hydro storage power plant.
- **Thermal energy storage** technologies store energy in a medium. The most common thermal storage is a **hot water storage tank**. The size of storage can vary from individual household’s tank to industrial applications and recently, to a very large seasonal heat storage that can supply heat to district heating system during winter months. Another main group of thermal storage is **adsorption storage systems**. The current interest in adsorption energy storage is in large applications collecting waste heat, integrating renewable heat e.g., solar, and balancing CHP generation during low demand.

  Electrical storage: Technologies of this group include capacitors and superconducting electromagnetic energy storage. The former is commonly used in e.g. reactive power management in high voltage grids and in context of reactive loads. SMES is a developing technology, which has high cooling requirements to maintain superconductive state that allows storing electricity efficiently.
- **Chemical storage** encompasses hydrogen and power-to-X. These are discussed in more detail in the respective pathways.

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[23] https://ease-storage.eu/news/smart-sector-integration-puzzle/.

[24] https://ec.europa.eu/energy/sites/ener/files/energy_storage.pdf.

[25] https://ease-storage.eu/energy-storage/technologies/.

[26] https://op.europa.eu/en/publication-detail/-/publication/a6eba083-932e-11ea-aac4-01aa75ed71a1/language-en?WT.mc_id=Searchresult&WT.ria_c=37085&WT.ria_f=3608&WT.ria_ev=search.

Background information

Energy storage has a strategic role in the transition towards a carbon-neutral economy. Storage technologies help address several central principles of the Clean Energy for All Europeans package. By balancing power grids and saving surplus energy, energy storages represent a concrete means of improving energy efficiency and integrating more RES into electricity systems, while also helping to enhance European energy security and to create a well-functioning internal market with lower consumer prices.[27]

Energy storage is indispensable to balance supply and demand. Peaks and troughs in demand can often be anticipated and satisfied by increasing, or decreasing generation at short notice.[28] However, there are significant barriers to adoption of energy storages in terms of limited access to grids and excessive fees. The Commission published guiding documents on proposed definition and principles in June 2016 and the role of electricity in energy storage from February 2017.[29]

The European Commission has identified batteries as a strategic value chain for the EU. The governance framework of the energy union and the strategic action plan on batteries from to the Communication Europe on the move COM (2018)293, were important steps toward building an integrated, sustainable, and competitive industrial base on batteries. Batteries Europe, launched in 2019, is the European technology and innovation platform of the European Battery Alliance (EBA), run jointly by the Commission and industry stakeholders. The platform includes a wide representation of stakeholders and has a well-defined governance structure, including the six thematic working groups, which are building on the earlier work from the SET Plan action 7 on batteries.[30]

This energy storage policy analysis looks primarily at electricity storage and heat storage technologies for power and heat sectors in the context of variable renewable electricity. Hydrogen storage is addressed in the hydrogen pathway, whereby biogas respectively is discussed in the bioenergy pathway. Gas storage and CCUS are not addressed in this text.

The need for increasing flexibility arises throughout the NECPs, while the current degree of inflexibilities in the power system varies nationally. The NECPs discuss electricity storage mostly in the context of intermittent RES generation, while energy needs and feasible technologies vary by country.

The need and possibilities to take advantage of energy storages are centrally tied also to the level of interconnections and the status of regulation and energy markets, in particular the electricity exchange environment. For a number of Member States, increasing energy storage capacity is a central measure for improving security of supply, in particular if the existing generation assets have little flexibility.

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[27] https://ec.europa.eu/energy/topics/technology-and-innovation/energy-storage_en.

[28] https://ec.europa.eu/energy/sites/ener/files/energy_storage.pdf.

[29] https://ec.europa.eu/energy/sites/default/files/documents/swd2017_61_document_travail_service_part1_v6.pdf.

[30] https://ec.europa.eu/energy/topics/technology-and-innovation/energy-storage_en.

For remote areas, e.g., islands and archipelagos, storages may be especially valuable to due limited interconnections, while the range of feasible technologies may also be limited in these areas. Long-term seasonal heat storage is mostly in interest of the countries with significant wintertime heating need and established district heating systems.

Assessment of Energy Storage per Member State

Austria

The Austrian NECP reports several energy storage activities. The issue of storage systems (including hydrogen technology) is currently being treated as a top priority and cross-cutting issue, interwoven with mission-oriented priorities and broad implementation initiatives.

The following development plans are particularly interesting regarding energy storage:

- Mission Plus-Energy Neighbourhoods31 includes innovation activity Neighbourhood storage: Intelligent, flexible energy storage for local use in city neighbourhoods.
- Mission Integrated Regional Energy Systems includes innovation activities for Development of large-scale thermal storage and seasonal thermal storage, Hydrogen- and gas-based storage and Chemical energy storage for mobile and stationary applications.
- Mission Breakthrough technologies for industry involves utilisation of intermediate products in industrial processes as energy storage facilities; as well as digital and smart energy to ensuring system integration of new energy storage and energy supply flexibility technologies.

Austria will require new energy storage technology with a capacity of 5 TWh, in particular for electricity and heating in the housing, industry and mobility sectors. Storage facilities will be remunerated for operating in the interests of the system. The flexibility of the technology will be recognised in design of grid tariffs.

Significant investment in storage infrastructure, transmission, and distribution networks will be made, adapted to increased demand. Previous investment, e.g., in infrastructure facilities, pipelines, storage facilities, power plants, will also contribute to the transition. The existing and available infrastructure will take on new tasks such as power-to-X and wind-to-hydrogen.

As far as research and innovation is concerned, energy storage facilities are a focus of the Austrian energy innovation plan. Large scale, long-term storage facilities for RES electricity are becoming very important. Promoting applied research projects with pilot plants, demonstrating the marketability of scalable storage technology, will have special emphasis. The following sector coupling options are currently in use or being tested: power-to-gas, power-to-heat, power-to-chemicals, and cogeneration.

Electrochemical energy storage facilities will be promoted. Both large- and small-scale storage units can participate in balancing the supply-dependent characteristics of renewable energy generation. Austria is looking to take part in the IPCEI on batteries. Austria’s contribution from 2020 to 2023 will total EUR 50 million. Storage facilities in deep geothermal energy systems

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[31] https://nachhaltigwirtschaften.at/en/sdz/publikations/folder-plus-energy-neighbourhoods.php

will also benefit from support. Increased use of geothermal energy requires adaptation of the legal framework conditions.

Belgium

National objectives of Belgium include incorporating more of intermittent renewable energy. Enlisted in the NECP are the following means to increase flexibility: balancing supply and demand, developing connections between countries, making energy networks smarter and creating energy storage potential. Therefore, the key policies and measures of the Federal State include, among other goals, promotion of storage and flexibility projects (including DSM, integration of sectors through Power-to-X, etc., H2 transport).

The Regions and the Federal Government will ensure that new centralised and decentralised storage systems and potential for peak-load shifting in both industry and private households continues to be developed. Residential storage, SME storage, local storage potential, electric vehicles in storage mode and local tools will increase further by 2030, as will the volume of daily demand shifts.

The working group on energy has produced a detailed technical report on the investments needed to ensure the country's energy transition. To develop energy storage capacity, the report recommends securing 5 billion Euros for private sector investments.

The Flemish Region has following activities to increase energy storage: Encouraging energy storage through a purchase incentive, establishing a regulatory framework for market-based and competitive energy storage in addition to demonstration projects for energy storage, for longer-term in particular, and power-to-x.

Walloon region's intelligent specialisation strategy has identified energy, climate and mobility priorities that include, among other topics, integration of storage systems. Some related topics are smart/integrated communities, energy efficiency of buildings and new fuels (including electricity) and sustainable vehicles.

The strategic priority 'Smart/integrated communities' includes positive energy districts, self-sufficient 'renewable energy' communities, connected mobility systems and services, and digitalisation to improve the flexibility of energy systems, consumption/production management (buildings, mobility, public services and spaces, highways, etc.) and energy storage. The strategic priority 'Integration of storage systems', including batteries, will also be implemented to support the internal energy market.

Specific to the Walloon Government, the annual public spending on energy research averages between EUR 35 million - 40 million. Most of this sum is devoted to energy efficiency, which since 2012 has accounted for around two thirds of the total amount. All energy efficiency sectors are covered (industry, residential, transport, other). The rest of the sum is allocated to the development of renewable energy, smart power grids, hydrogen, and energy storage.

Bulgaria

The integration of renewable electricity into the transmission and distribution networks, the need for a more extensive use of smart networks and use of energy storage systems will be among the primary and important measures in the period 2021–2030. In the period 2021–2030, Bulgaria will seek investment support from the Modernisation Fund and the option for funding projects related to renewable energy production, improvement of energy efficiency, energy storage and upgrade of the energy networks will be considered.

One of the priority areas in the Innovation Strategy for Smart Specialisation 2014–2020 is the development of clean technologies with a focus on transport and energy (energy storage, energy saving and efficient energy distribution, electric vehicles and eco-mobility, hydrogen-based models, and technologies etc.) The Innovation Strategy for Smart Specialisation 2021–2027, will also address deployment of smart grids and energy storage.

Bulgaria plans to develop several electricity storage projects for balancing and ensuring the flexibility of its system, enhancing its position as exporter and ensuring cross-border flexibility. These projects will also facilitate the further development of renewable sources and their integration into the national energy system. The following projects are planned to be implemented:

- Increasing the operational capacity of the Chaira Pumped Storage hydropower plant through the construction of the Yadenitsata reservoir, which will enable power generation equipment optimisation. Investment needs are estimated at approximately EUR 220 million.
- Approximately EUR 200 million is to be invested in frequency regulation batteries with a total capacity of 180 MW.
- Approximately EUR 200 million is to be invested in new energy sources combined with electricity storage facilities, taking into account the most appropriate technological solution for each project (approximately 200 MW in total).

Bulgaria is rich in geothermal sites. The development of technologies for the utilisation of solutions enabling energy storage in the form of heat in ground reservoirs has been highly dynamic.

The Energy and Water Regulatory Commission (KEVR) aims to encourage TSO and DSOs to make available system services for electricity demand response measures. Providing access to the networks for energy storage facilities is one of the measures to be implemented.

Croatia

Croatia sets increasing gas and energy storage capacity in the energy system as one the central objectives within the dimension of energy security. In this context, energy security objective on the construction and use of energy storage facilities is to build additional reversible power plants with a capacity of 150 MW planned to build before 2030. The related objective is to increase the energy storage capacity and increase the system flexibility, e.g., to enable greater integration of variable renewable energy sources, primarily the sun and wind.

The development of heat storage tanks for end customers, the development of battery tanks, the introduction of charging stations for electric vehicles that allow energy storage, the development of underground energy storage in the form of compressed gas, and the use of other innovative energy storage technologies (EU-funded) will follow.

Croatia will seek support from the EU’s Modernisation Fund, taking advantage of funding for investments in: modernization of industrial production, production and use of electricity from renewable sources, improvement of energy efficiency, energy storage and modernization of energy grids, energy efficiency in transport, buildings, agriculture and waste management.

Croatia aims at primarily market driven introduction of low-carbon technologies. Regarding research and innovation, significant capacities of both industry and scientific community exist in advanced energy storage systems.

Cyprus

Electricity Storage Installations, framework development and possible financial incentives are included in the key policy planning priorities of renewable energy in the Cyprus's NECP. The plan considers primarily pumped hydro and battery electricity storage as appropriate energy storage technologies.

In the context of market integration and flexibility, the current Trade and Settlement Rules (TSRs) allow for the aggregation of RES-only generation limited to 1–20 MW of aggregated RES capacity. A new bill (submitted) will expand the aggregation scope to allow the aggregation of all sources of electricity generation, storage systems and demand response. Aggregators will also be able to participate in the wholesale energy market, the balancing and reserve markets as equal players. Estimated timeframe for meeting this objective is September 2021 to January 2022.

The Regulator on 5/7/2019 has published its Regulatory Decision No. 03/2019 (ΚΔΠ 224/2019), with which the Storage Systems installed upwards the metering point, and which are not combined with local consumption of electricity could potentially participate in the Wholesale Electricity Market.

Regarding security of supply dimension, introduction of natural gas via LNG imports and the development of the necessary infrastructure are planned.

In terms of research and innovation, energy storage is not actively visible in the Cyprus Strategy Framework for Research and Innovation 2019 – 2023, “Innovate Cyprus”, nor the Smart Specialization Strategy for Cyprus.

Czechia

Integration of renewable energy sources, demand-side response, energy storage and flexibility aggregation are addressed in the ‘National Action Plan for Smart Grids 2019–2030’. National targets, including the timeframe for achieving them, are set out in this document.

Czechia has a detailed research and innovation policy. “National Priorities of Oriented Research, Experimental Development and Innovation” were approved by the Government of the Czech Republic in 2012, and they are valid for the period up to 2030. Within the defined 6 priority areas, priority area “Electric networks” includes topic on electricity storage. The research programme recognises energy storage as a key element between production and consumption in the future.

Research aims to develop and test energy storage systems with different characteristics and with different carriers. Power-to-gas technology, i.e., converting energy into hydrogen or methane for energy storage, will also be a development focus under research on renewable energy.

Research on energy for transport includes the topic of integration with energy storage. Hydrogen technologies mainly for energy storage, as well as advanced energy storage are identified as topics of research in longer perspective.

Denmark

For Denmark, the flexibility of the energy system is expected to be facilitated largely by market-based solutions. Therefore, the objective is to support structures that favour demand response and energy storage markets. The district heating sector and its vast energy storage capacity is expected to provide a basis for increasing flexibility through increased demand response and energy storages. Energy storages contribute to key objectives of Danish NECP in the areas of energy security and internal energy market in terms of renewables, increased flexibility, and development of flexibility market.

In order to accommodate future needs, the Danish Government has established a fund supporting development and demonstration projects on energy storage. The fund’s size is 128 million DKK, and it was in December 2019 granted to two Power-to-X-projects.

Electrification of the Danish district heating system has a large potential for energy storage in the form of diurnal heat stores already operated by combined heat and power plants in addition to an increasing number of seasonal heat storage systems being deployed.

Nordic Energy Research has identified seven key areas for joint Nordic research efforts, among which is Energy Storage. NER Board Meeting in November 2018 decided to allocate up to 4 million NOK to each of the six key areas of technology research, as well as funds to researcher mobility.

Estonia

Estonian NECP brings up energy storages on several occasion. Estonian NECP foresees the coming years as the breakthrough of energy and carbon technologies. The need for energy storages, among other technologies, is recognised in context of investments needed for Estonia’s clean energy transition.

As a measure to protect energy security, the regulator (the Competition Authority) is eligible to require the system operator to invite tenders for the creation of new production capacities, energy storage devices or energy efficiency/DSM measures, if the national capacity reserve falls below that established in the grid code.

Two pumped-storage hydroelectric power stations with a total capacity of 550 MW are under development in Estonia, in Paldiski (500 MW) and at the Estonia mine (50 MW). The use of renewable sources such as biomass and peat are more vulnerable than oil shale energy due to their seasonality in harvesting and therefore, the need for intermediate storage.

Regarding energy storage, Estonia boasts being already on the global map as the home of Europe’s leading producer of ultracapacitors. In ultracapacitors, energy storage takes place electrostatically. Ultracapacitors as energy storage have a long lifetime (one million charging cycles, where batteries have several thousand charging cycles) and are 30% more energy efficient than batteries. They are used in several areas that are difficult to decarbonise, e.g., heavy industry, automotive industry and the transport sector.

Baltic Connector gas pipeline (in operation since 1/2020) improves security of natural gas supply in Estonia as well as Finland as well as opportunities for using renewable energy (biomethane).

Finland

Finland's NECP recognises that energy storage solutions is one of the areas that will require additional investments to progress in the transition to a low-carbon economy. Research, development and innovation activities and measures are needed to bring these solutions to market.

In 2018, the Smart Grid Working Group set up by the Ministry of Economic Affairs and Employment proposed an extensive operational programme to increase the demand-side response of electricity and the opportunities for customers to participate. One of the group's key proposals was "Clarifying the roles of actors in the market-based implementation of demand-side response (e.g., **principles for the storage of electricity**)".

In recent years, Finland has invested in research and innovations much above EU and OECD averages measured in percentage of GDP. Finland has invested heavily in particular to speed up the introduction of clean and smart energy systems and associated products and services. For example, the innovation funding agency Business Finland invested approximately EUR 150 million in energy-related projects.

The planned transport sector policy to increase the number of electric vehicles to 250,000 by 2030 significantly increases the amount of electricity used by the sector. Thereafter, road transport electricity is expected to double by 2040. Its impact on electricity generation is small on a yearly level but charging batteries and active use of them as two-way electricity storage can affect both the short-term electricity market and the local grid.

Finland is part of the Nordic Energy Research that has dedicated to funding to energy storage, among other priority topics. However, Finland's research for energy storage is not indicated in the NECP.

Finland has been actively involved in the operation of the SET Plan. Among other activities, Finland participates in the implementation eBattery plan, e.g. through Business Finland's ”Batteries from Finland” 2018–2020 activation programme. Finland is also active in SET Plan key action no 7. "Batteries for e-Mobility and Stationary Storage", leading the working group related to battery recycling.

France

The NECP acknowledges that the transition to a low-carbon economy involves a stepping-up of energy-related research and innovation measures for developing the technologies and behaviours that will stimulate emission reductions, while ensuring national competitiveness.

In energy-related sectors, decarbonisation of energy, energy efficiency, energy storage and smart management of transmission and distribution systems are some of the research and innovation requirements that have been identified. In recent years, France has earmarked around EUR 500 million of public funding per annum for research in the field of new energy technologies, in areas such as renewable energies, energy efficiency, carbon capture and use, storage and networks, and cross-sector fields.

The Batteries and Storage action plan is intended to cover batteries for electric mobility and stationary energy storage. The recommendations present in the action plan were developed within the research and innovation component of the European Battery Alliance. France chairs the working group for application of the action plan.

To develop a structure to potentially meet the major challenges with energy storage, France introduced the ‘Electrochemical Energy Storage Network’ (RS2E) in 2011. The RS2E is a research and technology transfer network dedicated to the various energy storage systems: rechargeable batteries, supercapacitors and alternative technologies intended for a variety of uses.

The French Ministry of Higher Education, Research, and Innovation, through the ANR, and the German Federal Ministry of Education and Research (BMBF) launched a bilateral call for projects in 2018 with funding of EUR 20 million on energy storage and distribution. The call supports collaborative projects of French and German partners, where the upstream research activities are aimed at developing economically, ecologically, and socially efficient solutions for energy storage and distribution in France, Germany and Europe. Projects were expected on one of the two principal themes: 1. Conversion and storage of energy from renewable sources; 2. Smart energy networks (for transport and distribution).

The need to optimise the use of existing infrastructures applies in particular to underground natural gas storage infrastructures.

Germany

The Federal Government has confirmed its intention to invest in energy storage technologies and smart marketing concepts in order to continue safeguarding the reliability of supply in all parts of Germany and minimise system costs and costs under the Renewable Energy Sources Act.

Further, the Federal Government aims to tap into the international demand for mobile and stationary electricity storage, by the development of industrial and research-based battery cell production. To this end, in the 2019 budget the Federal Ministry of Economic Affairs and Energy was given up to EUR 1 billion until 2022 under Energy and Climate Fund for investments in industrial production for mobile and stationary energy storage reservoirs (‘battery cell production’).

The Smart Border Initiative (SBI) is a showcase project for system integration in the form of a cross-border smart grid. It focused in particular on optimising the management of distribution networks in the Saarland-Lothringen region using a virtual management tool and a new physical connection at distribution network level. The project was supported both by the French and German Governments and the European Commission and recognised as PCI in 2017.

The research initiative ‘Building the energy transition’ links up the research fields for energy-optimised and climate-neutral buildings, energy transition at district level and supply of heating and cooling, and thermal energy storage reservoirs.

The Federal Government is planning to provide research funding and subsidies for energy storage technologies with a view to boosting Germany’s reputation as a location for battery cell production. Plans also exist to set up a new Fraunhofer Institute for Storage Technologies.

Greece

Greece has set an objective for a minimum share of 35% RES in gross final energy consumption, and RES in electricity consumption should exceed 60% by 2030. High levels of RES electricity generation require energy storage to help ensure flexibility and adequate system capacity. Therefore, Greece indicates several energy storage activities linked to the NECP key policy priorities, in particular ensuring Greece's power adequacy as well as research and innovation.

Greece aims to developing a pricing framework for promoting electricity storage systems both in the non-interconnected island systems and in the national interconnected system. On smaller islands, Greece aims to achieving over 60% RES deployment levels by promoting storage systems with RES plants. For island Agios Efstratios, the objective is to achieve RES contribution above 85%.

Greece plans also to promote small autonomous RES desalination plants to produce water for drinking or irrigation needs of islands and remote areas with weak to non-existent electricity grid and intense water scarcity. The small desalination plants will be combined with RES generation and energy storage systems, to achieve stable power supply.

The main projects in electrical interconnections and electricity storage units involve the development of electricity storage systems, such as the Amphilochia pumped storage project. A key objective of centrally distributed storage systems is the development of storage units, including existing ones (Sfikia-Thisavros ~ 700 MW) and projects of common interest (PCIs).

Policy measures to promote the installation of electricity storage systems may vary depending on the technology and type of the storage system, e.g., an appropriate purchasing mechanism, to motivate the construction of storage systems over other electricity generation plants.

Promoting research and innovation will continue to be a priority for Greece in the period 2020-2030. Gross domestic expenditure on research and technological development is expected to double in the period 2017–2030, reaching 0.13% of the GDP in 2030 in the energy-environment sector, compared to 0.06% in 2017.

The development of new or improved electricity or thermal energy storage technologies will aim at higher efficiency, availability, durability, and security at the lowest cost. Support will be provided for electrochemical energy storage technologies, primarily for RES applications in non-interconnected electricity networks or remote points of the grid. Some topics of the extensive battery technology research include:

- Developing lithium-ion batteries for all vehicle power applications and other battery technologies for electromobility
- Studying the effect of quick/very quick charging of lithium-ion batteries on materials and battery degradation
- Batteries for static energy storage applications: Achieving fixed interfaces for extending the life cycle and lifespan of the systems
- Li-ion battery recycling (improved reverse logistics business model and secure low-cost packaging)
- Hybrid battery systems for static energy storage applications (new materials, design of components and systems, e.g., advanced battery management systems for specifically hybrid systems).

- Second use and smart integration of batteries into the grid.

Hungary

Hungary plans to encourage use of energy storage systems to integrate renewable energy production. Hungary balances short-term fluctuations in weather-dependent production currently mainly with gas-fired power plants and deems it necessary to prevent a decline in the necessary amount of dispatchable power plant capacities, but also to enable the spread of new, innovative solutions – such as energy storage and demand side response.

The Energy Innovation Council (EIC) set up by the Minister for Innovation and Technology in 2018 has thus defined possibilities of intervention regarding energy storages as “Innovative system balancing (flexible storage and demand management)”; and “Encouraging innovative seasonal electricity and heat storage solutions”.

- As regards innovative system balance (**flexibility energy storage** and demand management), the following pilot projects are planned:
- The launch of pilot projects is recommended for DSOs and TSOs within energy storage systems.
- The establishment of a complex, pilot-scaled research and development centre is desirable to coordinate and complete currently fragmented research, to test the systemic interconnection of various renewable sources of energy and energy storage technologies.
- Testing of complex DSR solutions within a pilot programme, on the level of individual prosumers.

The encouragement of innovative, seasonal electricity and heat storage solutions aims at facilitating the development of technologies for storage of large quantities of energy (even for months), in particular for the use of the natural gas network as a ‘seasonal energy storage facility’ for the feeding in of methane, biogas produced with power-to-gas technology and ‘clean’ hydrogen. Beyond electricity storage, the programme can also be extended to storing thermal energy and cold energy. Use of the particular technologies can be tested within the framework of pilot projects, subject to review of regulation concerning the feed-in of hydrogen, and biomethane and biogas produced with power-to-gas technology.

Ireland

Ireland identifies the level of its large-scale energy storage infrastructure low, in comparison to some other EU Member States. The only large-scale energy storage device in Ireland is a pumped hydro station at Turlough Hill, consisting of 4 x 73 MW generators, and with a storage capacity of 1,750 MWh.

Irish projects in ENTSO-E 10-Year Network Development Plan (2018) includes Marex Organic Power Energy Storage, a **pumped hydro energy storage** unit of a third-party project developer.

Ireland is looking at green hydrogen as the main flexibility mechanism in the energy sector. The production and use of hydrogen is expected to have a key role to play in Ireland’s transition to a low carbon economy and society.

The Government's Energy Policy (White) Paper, Ireland's Transition to a Low Carbon Energy Future 2015-2030, states that Carbon Capture and Storage (CCS) is recognised as a potential bridging technology that could support the transition to a low carbon economy.

Italy

Italy intends to accelerate the transition to renewable sources, and exceed, if possible, the 30% target set. The intention is to make widespread use of built-up areas by raising the profile of self-consumption, including through distributed generation and storage.

The main measures for energy storage in the Italian NECP address that following:

- RES Electricity: Support for installing distributed storage systems.
- Gas security: Upgrading of concentrated storage systems.
- Electricity market: Development of distributed storage systems; Development of storage systems coherent with the safe and effective management of the national transmission network (RTN).

The objectives for the energy security of the electrical system regarding energy storages are following:

- For existing pumping systems, expected increased hours of use with respect to current levels of 90% for systems located in northern Italy and of 80% for those located in the south (equating, for both, to over 600 storage hour equivalents).
- Installation of new storage systems amounting to at least 6 GW by 2030, mainly to offer network services and located primarily in the south, followed by Sicily and Sardinia, on the market. At least 50% of the storage power required of the electricity system will be provided by pumping systems, and the remainder by electrochemical storage systems with a capacity/power ratio of about 8 kWh/kW.
- About 4.5 GW of storage systems coupled with distributed systems is envisaged, mainly to maximise self-consumption (charging in the central hours of the day and discharging in the evening).
- Reduction of over-generation to values of around 1 TWh by 2030, by upgrading the network, introducing new dispatching resources and storage systems, and making more use of existing storage systems.
- Integration of renewable gas sources by using existing gas system infrastructure for transport, storage and distribution.

In terms of research and innovation related to energy storage, Italy pursues two main goals:

Goal 1) Monitor and develop product and process technologies vital to the energy transition, including RE energy storages:

- storage systems, including thermal, electrochemical and power-to-gas, and related interfaces with the networks, to guarantee high levels of penetration for non-programmable renewables.
- power-to-gas storage systems, particularly for the purpose of storage of excess production of non-programmable renewables by means of secure and reliable storage of hydrogen in liquid and gaseous energy carriers.
- for mobility, the trialling and testing of various storage systems, as well as the development of innovative thermal electronic and battery controls for electric vehicles.

- technologies for end-use: in particular, complex heat pump systems or linked to non-conventional storage systems.

Goal 2) Promote the introduction of technologies, organisational and operational models and systems used to promote the integration of renewable, non-programmable energy production, self-production, *storage*, energy communities and aggregators.

Latvia

In Latvia, R&I is developed in accordance with the Smart Specialisation Strategy (RIS3), where smart energy is one of the five areas of specialisation.

The RIS3 specialisation area "Smart energy" includes the development of clean technologies or new materials, research and development of engineering and digital solutions for acquisition, storage and integration of RE into the energy system, improvement of energy efficiency in construction and automation and optimisation of production processes, as well as the development of alternative fuels for transport.

Subsequently, the plan defines "Innovative solutions for energy storage, integration and smart transmission" as one of the potential priority action lines in RIS3 for energy.

Within R&I, support will be provided to research, demonstration projects and development of new technologies, solutions and user centred products and services in the following areas:

- Production of renewable electricity and thermal energy, for example: research into materials and engineering technologies for the acquisition and storage of RE (in particular, solar, hydrogen energy), research into the sources and acquisition technologies for bioenergy (biomass, biogas) and ways of improving these, research into wave energy acquisition technologies.
- Smart grids, energy storage and recovery, and integration of renewable energy in the energy system, for example, automation of management of energy systems (electricity and heat), digitalisation and energy transformation and storage technologies, including batteries, for automation of industrial production, self-generation of energy and development of electric mobility.

Latvia indicated investments in SET Plan priorities as share of investment in total R&I investments in the field of energy. Both actual and planned funding is indicated in shares of total R&I. In planning period from 2021 to 2027, funding for RE will be 15%, for smart energy systems 20% and for energy efficient systems 38% of total investments in energy.

In the heating sector, in the period until 2020, EU structural funds provided support for the promotion of energy efficiency and the use of local RES in district heating, providing support for 104 projects that have invested in the installation of a storage system, investments in the heating generation source and renovation of heating pipes.

To support the use of zero-emission technologies in electricity generation, the possibility of establishing a support programme in the form of financial instruments or loans for solar electricity generation and storage facilities is considered.

For promoting economically justified own-use generation, own-use consumption of energy and renewable energy communities, key actions in Latvia involve extending the range of persons involved in production of electricity and encouraging the production of RE for own needs in rural areas. Related funding aims to encourage the installation of zero-emission technologies, including storage facilities, in rural holdings, thus also enabling farmers to reduce energy expenses.

Lithuania

Lithuania plans to achieve 45% RES in final energy consumption by 2030. Investment in smart energy systems, including transmission, distribution, and storage infrastructure, and in increasing the balancing capacity are envisaged to successfully integrate larger volumes of renewable energy and a large number of electricity generating customers.

In Lithuania, the district heating system is an integral part of the overall energy sector, closely linked to the electricity system and fuel supply. All Lithuanian cities have well-developed district heating systems, which supply heat to about 53% of all buildings in the country and 76% in the cities. Lithuania will aim at a 90% share of district heating from renewable and local energy sources in total district heating by 2030.

Existing policy measures for RES in the heat sector up to 2030, involve assessing the potential for using solar technologies, heat pumps and heat storage facilities in district heating systems. Planned measures for RES in the heat sector up to 2030 continue the action by promoting the use of RES in district heating (using solar technologies, heat pumps and/or heat storage).

A specific measure also promotes the use of heat from waste generated by industry, the waste sector or due to cooling energy in district heating. The priority in the heat sector is collection, storage, and efficient use of energy from the environment and waste energy by power plants, industrial installations and buildings.

Planned policy measures for RES in the electricity sector up to 2030 include e.g., financing of energy generation from RES and storage solutions. EU support to promote the use of RES in 2021–2027 is planned. The support will be targeted to prosumers, energy communities, businesses or individual energy consumers installing low-power RES electricity generation. The measures and expected results in this area, as well as need for funding from the EU are being assessed.

The national TSO Litgrid is currently conducting a pilot battery project to examine the potential of battery storage systems under realistic operating conditions of the Lithuanian power system. The project aims to increase frequency management, ensure system stability and security, and to determine the technical parameters that best meet the system’s needs.

Kruonis Pumped Storage Plant near Kaunas has currently four hydraulic units installed, while the original design of the power plant provides the possibility of constructing another four units. In order to maintain reliable local generation, expansion by building a fifth 225 MW asynchronous hydraulic unit is envisaged.

Intra-Baltic and Baltic Nordic energy research projects are funded by the Energy Research Programme of the Nordic Energy Research (NER) platform of the Nordic Council of Ministers and the three Baltic States’ ministries responsible for energy. The total funding for period 2018– 2022 is EUR 2.3 million.

Luxembourg

The energy transition has already been addressed in Luxembourg in recent years as a part of the Third Industrial Revolution process, which was initiated in 2015. The cornerstones of TIR process involve energy efficiency in new buildings, developing renewable energy on a large scale and incorporating it into the energy network, developing decentralised energy storage, digitalising the energy networks, and using more sustainable means of transport.

The inclusion of self-consumption concepts (in conjunction with energy storage) and energy communities will play a new, specific role in the PV sector. Both concepts, as provided for in Directive 2018/2001, have already been enshrined in a legislative amendment (on the electricity market), allowing accompanying measures and support measures to be implemented quickly.

Low-emission or zero-emission hydrogen is recognised as a potential technology for energy storage, primarily suitable for seasonal storage of renewable energy. The NECP states that the hydrogen strategy for Luxembourg is currently being prepared.

Regarding energy security, Luxembourg has neither large power plants for electricity generation nor gas production and storage facilities and is therefore highly dependent on imported energy. In the Greater Region of Luxembourg, the Vianden Pumped Storage Power Plant is one of Europe’s largest pumped storage power plants. It makes a significant contribution to system flexibility and security of supply in the wider region.

The Pentalateral Energy Forum has adopted the common plan to further develop the internal energy market through coordinated activities. The role of storage technologies is one aspect to consider among other measures to increase flexibility. Luxembourg does not indicate a research plan or funding specific to energy storage technologies.

In the context of Research and innovation, Luxembourg intends to become a pioneer for the successful implementation of a large-scale nationwide energy transition. Sustainable and energy efficient buildings with local flexibility options and/or energy storage capacity, as well as sustainable mobility components (smart grids) will form the main pillars of this system.

Malta

The key objectives, policies, and measures of the Maltan NECP addresses decarbonisation and reducing import dependency through the deployment of indigenous RES, whereby *energy storage solutions* and demand management are among the measures to employ. The Government is closely monitoring the development of the energy storage market considered essential for further deployment of photovoltaic capacity and for optimization of the power system by providing for demand management and peak demand shaving.

The range of potential storage solutions in Malta is limited. For instance, pumped-storage hydropower is not obtainable in the Maltese context. As per projections under the ‘With Planned Measures’ scenario, the capacity of solar photovoltaics is expected to increase from 112 MW in 2017 to 266 MW by 2030.

The electricity distribution system covering Malta remains under the responsibility of one distribution system operator, Enemalta plc. Enemalta is the only undertaking, which is licensed to carry out all the three activities of generation, distribution, and supply. Enemalta is obliged to dispatch electricity based on their order of economic merit, irrespective of whether this is from local generation plants, from the interconnector or from storage.

Energy storage is becoming ever more essential for the integration of higher shares of intermittent RES. Thus far, the intermittent nature of renewable electricity sources has been mitigated by relying on the interconnector to provide balancing services and to a lesser extent on local conventional facilities. However, further installation of renewable energy capacity, particularly in large scale, will necessitate different mitigating strategies, namely storage, dispatching, and curtailment, which shall be dealt with in the study being commissioned by the Government.

As of 2020, a pilot scheme supporting the integration of battery storage with PV systems will be launched. Early adopters of solar PVs whose feed-in-tariff has expired will be eligible to receive a 25% grant (capped at EUR 1,000) against the purchase of a battery storage system and so increase the share of self-consumption. A preliminary study was conducted in 2019 to assess the feasibility of such a measure. The pilot project will feed into this continuing assessment. It is likely that a large-scale roll-out of battery storage systems for households, PV-integrated or stand-alone, would require a significantly higher level of support or lower cost of storage than at present. In this regards Malta shall be seeking EU funds (including Cohesion funds) to bridge the gap.

The Research Innovation and Development Trust (RIDT) is a funding system established by the Government of Malta in 2011 and run by the University of Malta. A project aimed at developing of a model offshore hydraulic energy storage system (FLASC) is one of the projects which has received funding under the RIDT.

Netherlands

The Netherlands aims at an electricity system completely CO2-free in 2050, in addition to a CO2-free built-up environment in 2050. As the share of weather-dependent RES electricity is increasing, the energy system must become more flexible by developing more demand response, energy storage and contributing to interconnection.

The Netherlands does not have separate targets for increasing flexibility in the system. Flexibility from demand response, storage or adjustable capacity is interwoven in the electricity market and traded across the various markets. Regulation of the electricity market will be organised in the next few years to reward investments in the use of flexibility in accordance with the market. Any obstacles to storage will be eradicated. The transition to electric vehicles can contribute to this regard.

As far as research and innovation is concerned, specific innovation policy focuses on nine so-called top sectors. These are clusters of companies and knowledge institutions in which entrepreneurs, researchers and public authorities collaborate on international competition strategies, earning power and innovation. The Dutch Top Sectors intend to focus on the economic opportunities of four social themes Energy transition and sustainability is one of the four social themes.

The Dutch MMIPs are Multi-annual Mission-oriented Innovation Programmes, that address these Dutch climate action missions. The annual available resources for all MMIPs are EUR 570.6 million of public and roughly equal EUR 572.9 million of private funding.

The core innovation programmes that address energy storage are 1) heating and cooling in built environment, large-scale energy storage for seasonal energy; 2) robust and socially supported energy system “Large-scale energy storage, energy transport and hybridisation of the energy demand” and 3) CO2-free industrial heat system with heat recycling, upgrading and storage.

Poland

As part of meeting the EU-wide 2030 target, Poland affirms to achieve a 21%-23% share of RES in gross final energy consumption by 2030. The scale of use of RES will largely depend on technological progress –in existing energy generation methods, new technologies, and in the area of energy storage technologies.

Energy security is treated as a priority in Poland. Poland expects an increase in demand for energy and power in context of economic recovery and consumer protection. Poland has developed a capacity market to ensure sufficiency of electricity generation to end consumers in the national system. The CM creates the conditions for the stable operation of existing generation sources and provides clear pricing signals for coordinating construction of new generation capacities. The amount of remuneration under the scheme is determined through auctions. Capacity auctions are open to existing and new generation units, irrespective of the fuel and technology, including also energy storage facilities and demand-side entities.

Poland has set an objective to develop environment-friendly and efficient district heating systems. Within this frame, Poland will pursue promoting heat storage facilities and smart networks. The improvement of flexibility is a priority for the entire chain. In addition to the development of interconnections, generation and transmission infrastructures need to be expanded to safeguard electricity supply to consumers. Among other measures, energy storage technologies, especially for renewable energy will be developed.

Within Renewable energy (2030 Framework Target) policies, the mechanisms for supporting energy production from renewable energy will be tailored to market needs, and will prioritise the following solutions:

- Ensuring maximum availability (high efficiency and utilisation rate, controllability, the use of an **energy storage facility**), with a relatively lowest energy generation cost.
- Satisfying local energy needs (heat, electricity, transport), but also those relating to waste treatment and disposal (consistent with the waste management hierarchy) and the use of local potential.

In terms of research and innovation, in 2017, the Ministry of Energy developed the document Directions for Energy Innovation Development. The document covers energy innovations from the perspective of technologies, processes, funding sources and the implementation of new solutions. The expenditures on research and development activities in Poland are planned to be increased to 1.7% of the GDP in 2020 and to 2.5% of the GDP in 2030.

In the energy-related R&I, a central focus will be on supporting investments in infrastructure (including technologies) for the production, storage and use of hydrogen (e.g., support for research into hydrogen- and coal-based fuels), synthesis gas, and methanol for energy purposes. R&D and commercialisation support in the area of carbon cells and carbon nanostructures in energy storage will be also important.

Portugal

Portugal will continue to focus on developing a highly decarbonised electricity-generation sector, considering the availability of endogenous renewable resources, such as water, wind, solar, biomass and geothermal energy. Renewables are expected to contribute at least 80% of electricity generation by 2030.

Storage systems in different forms are considered fundamental to ensure better management of the national energy system, as a tool promoting the flexibility and stability of the national electricity system.

Storage capacity is expected to increase by 2030, fundamentally by means of reversible hydroelectric pumping facilities and, later in the decade, through a contribution by battery and hydrogen technologies. A significant part of this capacity is associated with generation facilities via wind and solar technologies while the remainder is dedicated storage.

As the two coal-fired power plants remaining in the country will cease electricity generation by 2023, possibilities to recycle and reuse their equipment will be studied and assessed. First study involves installation of thermoelectric solar capacity with storage to produce renewable steam, which can directly feed the existing turbines. The second study will look at direct use of green hydrogen as a fuel to substitute coal.

Portugal aims to create (expected 2020–2021) a legal framework that makes it possible to promote the implementation of different forms of storage systems, particularly for the electricity sector.

A further objective is to create a Roadmap for storage in Portugal. The main objective of this Roadmap is to provide a practical, independent and objective analysis of the various possible trajectories to implement storage systems. National and local level planning methods will also be addressed.

The implementation of storage projects associated with centres generating electricity from renewable sources will be promoted, supporting pilot projects of technologies not yet widespread or not yet mature, with focus on the association between renewable production and storage.

Electricity storage capacity in island territories with isolated electricity networks will be increased between 2020-2030, using reversible hydro systems, batteries, hydrogen, and other technologies. Smart electricity grids will be implemented to strengthen the stability and resilience of small-scale isolated electricity systems and increase the utilisation of intermittent RES.

New management instruments for the national electricity system will be introduced, in particular the Demand Aggregator. The demand aggregator allows different entities, such as end users, small producers, storage and charging points for electric vehicles, to participate in the electricity market and system services as a single, grouped entity.

In terms of research and innovation, Portuguese National programmes to promote Research, Development & Innovation, will include at least the following topics: (i) Energy management smart systems and new infrastructures; (ii) Energy Storage; (iii) Low-carbon technologies; (iv) Energy Efficiency; (v) Hydrogen as an energy source.

Energy Storage is included in national R&D programmes to support technological development during period 2020–2030. The topic area of energy efficiency will involve promoting energy efficiency projects for new residential buildings, thermal and energy rehabilitation, integrating RES, storage, management of consumption and information. Possible funding sources are enlisted. e.g.: FCT; Horizon Europe; Innovation Fund; Structural Funds; InnovFin Energy Demo Projects. The NECO does not indicate direct R&D budgeting, but it mentions that investment in R&D in recent years has fluctuated in Portugal. In 2018, total investment recovered the value for 2012, 1.38% of GDP.

Romania

The development of energy storage capacities is a central solution for Romania in securing the energy supply. In order to achieve this, Romania plans the following four measures:

1. to clearly define the concept of energy storage in the primary law.
2. to lay down the conditions for release of energy storage licences and for connection to the network.
3. to define standards for deployment and use of various storage technologies; and
4. to develop a market design which facilitates integration of storage capacities in the electricity market.

The opportunities identified to date (of NECP) are related to the conclusions of the NES adequacy study developed by Transelectrica. Storage of energy in the NES through the Battery Energy Storage System (BESS), may have an overall positive impact by improving adequacy (at least 10%) when integrated to electricity transmission network. To flatten the load curve and to secure an additional reserve would call for integrating at least 400 MW capacity of battery energy storage systems in the NES. Romania will support the development of these technologies in order to ensure the adequacy of the NES. The development of energy storage capacities will contribute to the integration of RES in NES, considering their intermittent/variable nature.

There will be measures to boost the R&I activities, the pivotal step being to attract Horizon type funding sources for projects involving storage of energy in the electricity grid or low-carbon mobility. Moreover, active participation in the European Battery Alliance will be sought. On the short term, the Romanian State will provide for regulation for quantifying the existing local projects (e.g., two objectives in the Constanta area), which are developed with the support of private operators, and inclusion of this topic among the strategic research and development priorities.

Slovakia

In terms of ensuring the flexibility of the energy system, one of the Slovak Republic’s objectives is to provide sufficient flexibility for market participants, primarily for entities with variable generation sources such as renewable energy sources. It is the intention of the Slovak Republic – in line with European legislation – to create conditions for the provision of support services which will allow the aggregation of collection facilities, energy storage facilities and electricity generating facilities for the purpose of offering regulatory services.

The priority of research and development in the energy sector is to ensure sustainable energy in Slovakia. The objectives of energy research and development are in line with the “Research and Innovation Strategy for Smart Specialisation of the Slovak Republic.” (2013).

Research and development in this area will focus on new and renewable energy sources, the rationalisation of energy consumption in all sectors and energy distribution, among other topics "development of energy storage and energy conversion technologies (Power to X) to interconnect sectors".

Renewable energy and energy efficiency policies relate to energy storage in period 2021-2027, in particular on providing support for plants using RES, energy distribution and storage facilities (including smart management systems) to increase the efficiency of existing installations, and the installation of new plants using RES (business, public and households sectors).

The priorities for increasing energy efficiency, promoting RES and reducing greenhouse gas emissions in the programming period 2021–2027 will include (among other topics) promoting RES and efficient district heating systems (DHS) in heat and cold supply and smart energy systems, as well as energy storage.

Slovenia

Slovenia's overarching objective is to provide additional resources to speed up the integrated development and management of the electricity distribution network. Further, Slovenia aims at improving connectivity and adaptability, towards exploiting flexible sources and loads and to accelerate the incorporation of heat pumps, e-mobility, the integration of RE generation and storage facilities.

One of Slovenia's marked targets for 2030 in the dimension is the development of energy storage technologies, infrastructure, and services. Closely related goal is to provide appropriate conditions to maximise the share of renewable energy stored and used, and to maximise the capacity of RES generating facilities.

"The storage of electricity and the integration of different sectors are an ever-increasing challenge, and Slovenia is seeking to participate actively in the development of centralised and decentralised solutions and to support the implementation of demonstration and pilot projects on energy storage up to 2030".

This includes 1) installation of battery capacity, and other storage apparatus on the transmission and distribution networks (including pumped hydro-electric power plants), 2) heat storage in district heating systems and 3) using gas pipelines to store surplus electricity in the form of CNG/H2. Different options for 4) seasonal energy storage should also be considered. To maximise the share of RE in gross final energy use by 2030, Slovenia plans build a sufficient number of different energy storage facilities, appropriate in terms of technology, size and duration of storage, connected to the transmission or distribution network to ensure that the maximum possible share of daily electricity needs is stored in the Slovenian electricity system.

Slovenia aims to ensure technical capacity for the conversion of renewable electricity into renewable gas, hydrogen or synthetic methane and heat toward seasonal storage of renewable energy, in addition to storage of renewable gases for a short term to offset daily fluctuations.

As regards research and innovation, Slovenia confirms as a target increasing investment in R&D by at least 3% of GDP by 2030 (of which 1% of GDP is public funding), with funds earmarked for climate-neutral goals and projected to be directed towards targeted research projects, multidisciplinary programmes and demonstration projects. Slovenia will encourage the development of technologies in various areas, including also energy storage.

Proposal for additional instruments in the area of energy infrastructure, energy transmission infrastructure, market integration and energy poverty involve energy storage in the following:

- Reinforcing participation in European research projects in the area of new advanced technologies, the market, quality assurance of infrastructure, energy storage, positioning, staff training, participatory planning, etc. [2021–2030].
- Encouraging the involvement of stakeholders to undertake joint demonstration projects (‘Power2Gas’, biomass gasification, energy storage, advanced system services, etc.) [2021–2030].

Spain

Spain seeks to make the energy system flexible by allowing demand and storage management to contribute to the security and quality of supply. Both the development of storage and demand management are promoted to support the integration of renewables in the electricity sector. The Plan foresees that by 2030 there will be an additional capacity of 6 GW of pumps and batteries.

In the electricity system, the integration of a significant volume of renewable generation requires reinforcing and expanding the transmission and distribution lines. Likewise, it is necessary to develop management and storage mechanisms for non-dispatchable renewable energies. The national TSO optimises the proper integration of renewable energies. The means to achieve this involve the storage of electrical energy, the optimisation of the use of water resources and providing information to consumers.

Measure “Demand management, storage and flexibility” contains main actions regarding energy storage:

- Development of the regulatory and legislative framework for demand management, including energy storage management, e.g., introducing storage operator in sectoral legislation and analysing the need to establish remuneration frameworks to assure storage capacity
- promoting pumped storage hydropower plants to enable the management of renewable production and planning additions in thermal storage capacity, associated with CSP installations
- Promotion of the coupling of sectors
- Development of the legal framework to enable DSOs obtaining flexibility and balancing services from distributed generation suppliers, demand response or energy storage
- Pilot projects for demand and storage management

The integration of the electricity market involves energy storage activities:

- Increasing the contribution of renewable energies to adjustment and balancing services. The necessary measures will be provided for storage development and demand management.
- Improving the capacity to manage hydroelectric power, in order to maximise the integration of renewable energies.

- Analysing the development of capacity mechanisms compatible with the new European directives and regulations that will contribute to meeting the objectives of this Plan, including energy storage and demand management.

As far as research and innovation, advances in batteries will require the development of new advanced materials and technologies. Collaboration between industry and academic research includes developing pilot lines for the manufacture of new generation batteries, as well as addressing battery sustainability in terms of materials and raw materials, reuse, and recycling, in accordance with (Action 7 of the SET Plan).

Energy storages are addressed in particular in a plan to relaunch CIUDEN, the City Foundation for Energy, which has the objective to Promotion of Just Transition actions and promotion of economic and social development and employment in the mining districts of Castile and Leon through research actions and activities in renewable energies, energy storage and efficiency.

Sweden

In a future electricity market with a higher share of variable wind and solar power, it will be important to utilise all flexibility resources, in other words flexible production, storage and demand response.

Sweden continues to promote demand response, for example by removing regulatory obstacles to new business models. The Forum on smart electricity networks is a national forum set up by the Swedish government in 2016. Participation of renewable energy, demand response and storage, including via aggregation, is ensured in the Nordic electricity system, as discrimination is not permitted. Specific measures for ensure non-discriminatory participation are not needed.

Supporting policies and measures for storage are:

- A grant for storage of self-generated electrical energy was introduced in November 2016
- Refunding of energy tax on electricity after battery storage, since January 2019

In terms of research and innovation, the NECP does not specifically address energy storage or related research agenda. There are a number of national centres and research and innovation programmes relating to smart electricity, namely SamspEL, the Swedish Centre for Future Electricity Grids and Energy Storage (SweGRIDS) and KTH ACCESS Linnaeus Centre (ACCESS-Autonomic Complex Communication Networks, Signals and Systems).

2.4 The pathway analysis on ‘Hydrogen’

Terminology

Hydrogen may be produced through a variety of processes, which are associated with a wide range of emissions, depending on the technology and energy source used, and have different cost implications and material requirements:[32]

- ‘**Electricity-based hydrogen’** refers to hydrogen produced through the electrolysis of water (in an electrolyser, powered by electricity), regardless of the electricity source. The full life-cycle greenhouse gas emissions of the production of electricity-based hydrogen depends on how the electricity is produced.
- ‘**Renewable hydrogen**’ is hydrogen produced through the electrolysis of water (in an electrolyser, powered by electricity), and with the electricity stemming from renewable sources. The full life-cycle greenhouse gas emissions of the production of renewable hydrogen are close to zero. Renewable hydrogen may also be produced through the reforming of biogas (instead of natural gas) or biochemical conversion of biomass, if in compliance with sustainability requirements.
- ‘**Clean hydrogen**’ refers to renewable hydrogen.
- ‘**Fossil-based hydrogen**’ refers to hydrogen produced through a variety of processes using fossil fuels as feedstock, mainly the reforming of natural gas or the gasification of coal. This represents the bulk of hydrogen produced today. The life-cycle greenhouse gas emissions of the production of fossil-based hydrogen are high.
- ‘**Fossil-based hydrogen with carbon capture**’ is a subpart of fossil-based hydrogen, but where greenhouse gases emitted as part of the hydrogen production process are captured. The greenhouse gas emissions of the production of fossil-based hydrogen with carbon capture or pyrolysis are lower than for fossil-fuel based hydrogen, but the variable effectiveness of greenhouse gas capture (maximum 90%) needs to be considered.
- ‘**Low-carbon hydrogen**’ encompasses fossil-based hydrogen with carbon capture and electricity-based hydrogen, with significantly reduced full life-cycle greenhouse gas emissions compared to existing hydrogen production.
- ‘**Hydrogen-derived synthetic fuels**’ refer to a variety of gaseous and liquid fuels on the basis of hydrogen and carbon. For synthetic fuels to be considered renewable, the hydrogen part of the syngas should be renewable. Synthetic fuels include for instance synthetic kerosene in aviation, synthetic diesel for cars, and various molecules used in the production of chemicals and fertilisers. Synthetic fuels can be associated with very different levels of greenhouse gas emissions depending on the feedstock and process used. In terms of air pollution, burning synthetic fuels produces similar levels of air pollutant emissions than fossil fuels.

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[32] A hydrogen strategy for a climate-neutral Europe.

Background information

Hydrogen will be an important part of the overall EU strategy for energy system integration.

In 2020, the Commission adopted a new dedicated strategy on hydrogen in Europe. It will bring together different strands of action – from research and innovation via production and infrastructure to the international dimension.

The strategy will explore how producing and using renewable hydrogen can help decarbonise the EU economy in a cost-effective way, in line with the European Green Deal.

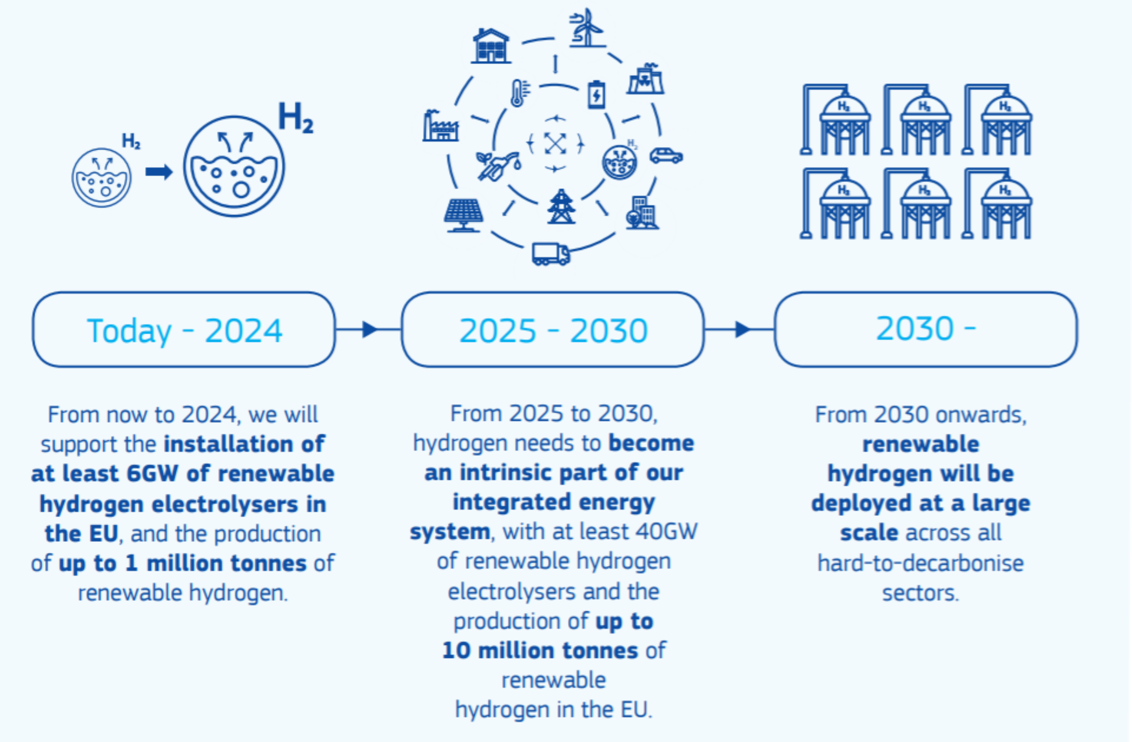
The EU Hydrogen Strategy addresses how to transform the potential of hydrogen into reality to support the decarbonisation of industry, transport, power generation and buildings across Europe through investments, regulation, market creation and research and innovation (R&I).

Hydrogen can power sectors that are not suitable for electrification and provide storage to balance variable renewable energy flows, which can only be achieved with coordinated action between the public and private sectors at the EU level. The priority is to develop renewable hydrogen, produced using mainly wind and solar energy. However, in the short- and medium-term other forms of low-carbon hydrogen are needed to rapidly reduce emissions and support the development of a viable market.

This gradual transition will require a phased approach:

- From 2020 to 2024, the EU will support the installation of at least 6 GW of renewable hydrogen electrolysers in the EU and the production of up to one million tonnes of renewable hydrogen.
- From 2025 to 2030, hydrogen needs to become an intrinsic part of our integrated energy system, with at least 40 GW of renewable hydrogen electrolysers and the production of up to ten million tonnes of renewable hydrogen in the EU.
- From 2030 to 2050, renewable hydrogen technologies should reach maturity and be deployed at a large scale across all hard-to-decarbonise sectors.

The phased approach to the hydrogen transition



From now to 2024, we will support the **installation of at least 6GW of renewable hydrogen electrolysers in the EU**, and the production of **up to 1 million tonnes** of renewable hydrogen.

From 2025 to 2030, hydrogen needs to **become an intrinsic part of our integrated energy system**, with at least 40GW of renewable hydrogen electrolysers and the production of **up to 10 million tonnes** of renewable hydrogen in the EU.

From 2030 onwards, **renewable hydrogen will be deployed at a large scale** across all hard-to-decarbonise sectors.

Figure 2. The phased approach to the hydrogen transition. [33]

Based on the analysis of NECPs, four main areas with good practices to boost hydrogen have been identified: Hydrogen production using renewable electricity; use of existing infrastructure; creation of market demand; and collaboration.

Hydrogen production using renewable electricity

According to the EU hydrogen strategy, the short-term objective (2020 to 2024) is to install at least 6 GW of renewable hydrogen electrolysers in the EU and the production of up to 1 million tonnes of renewable hydrogen, to decarbonise existing hydrogen production. In a second phase, from 2025 to 2030, the strategic objective to install at least 40 GW of renewable hydrogen electrolysers by 2030 and the production of up to 10 million tonnes of renewable hydrogen in the EU29.

The large majority of EU Member States indicates that decarbonised hydrogen should mainly be produced by electrolysers using renewable electricity. Nevertheless, the following best practices have been identified in the NECPs of Bulgaria, Denmark, Netherlands, Hungary and Portugal.

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[33] Source: European Commission, A hydrogen strategy for a climate-neutral Europe.

- In Bulgaria, a Power to X pilot project for a hydrogen plant with total installed capacity of 20 MW will be developed. Based on the project results, an analysis of prospects of further development of hydrogen power plants after 2030 will be conducted.
- In December 2019, 128 million Danish krons were granted to two Power-to-X-projects establishing big scale production and storage of green hydrogen.
- Netherlands has also agreed to start a hydrogen programme. In the short term this programme focuses on gradually scaling up the generation of green hydrogen from renewable energies.
- Pilot projects are planned and can be implemented with carbon credit funds in Hungary.
- Portugal aims to implement a cluster for the production of renewable gases, in particular green hydrogen, leveraging solar energy as a factor for competitiveness. The installation of an industrial unit in Sines to produce green hydrogen (1 GW) is currently being studied

According to the NECPs, several Member States also foresee to support hydrogen production demonstration and pilot projects (e.g., Austria, Czechia, Germany, Ireland, Greece, Italy, Romania, Slovakia, Slovenia and Spain).

In addition, the production of low carbon hydrogen through other pathways, such as from fossil fuels with CCS (Carbon Capture & Storage) is also mentioned in several NECPs. The Swedish-Norwegian joint project combines CCS in hydrogen installation at Lysekil refinery to reduce CO2 emissions of the refinery; this seems to be produced from fossil sources. In addition, Czechia, Croatia and Netherlands have also identified hydrogen produced with CCS.

Use of existing gas Infrastructure

The backbone of a pan-European grid will need to be planned and a network of hydrogen refuelling stations to be established. Therefore, the existing gas grid could be partially repurposed for the transport of renewable hydrogen over longer distances and the development of larger-scale hydrogen storage facilities in order to lower the overall cost of the transition, both in terms of reduced investment in hydrogen infrastructure and avoided investment in the expansion of the electricity grid.

In this regard, several Member States refer to their intention of using the existing methane infrastructure for hydrogen purposes, such as Romania. Romania may consider using the existing methane infrastructure for hydrogen transmission and distribution by injecting hydrogen into the public natural gas network on the short term (2025-2030) and the medium term (2030-2040) and by increasing hydrogen contribution to the long-term transmission and distribution network (>2040).

Several Member States, among which Austria, Czechia, Croatia, Germany, Greece, Hungary, Ireland, Latvia, Portugal, Slovakia, Slovenia and Spain, consider that the existing natural gas infrastructure will facilitate the development of hydrogen.

Italy is interested in increasing the growing share of renewable gas (biomethane, synthetic methane and, eventually, hydrogen) in the gas network. The ten-year development plan for Italian gas grid will include studies for possible integration of hydrogen. Nevertheless, Italy considers fundamental to have a clear legal and regulatory framework for the introduction of hydrogen into the current gas infrastructures as a further source of energy in a mixture with natural gas.

Creation of market demand

The creation of new lead markets goes hand in hand with the scaling up of the production of hydrogen. Two main lead markets, mobility and industrial applications can be gradually developed to use the potential of hydrogen for a climate-neutral economy cost-effectively.

Mobility

To reach required emission reductions in the transport sector, a switch to renewable or low-carbon energy carriers is essential. Hydrogen can play a key role in this domain.

According to the EU Hydrogen strategy, fuel cells should be further encouraged in heavy-duty road vehicles, alongside electrification, including coaches, special purpose vehicles, and long-haul road freight given their high CO2 emissions.

In transport, hydrogen is also a promising option where electrification is more difficult. In a first phase, early adoption of hydrogen can occur in captive uses, such as local city buses, commercial fleets (e.g., taxis) or specific parts of the rail network, where electrification is not feasible.

Several initiatives are mentioned in the NECPs of Germany, Italy, Czech Republic, Hungary and Spain in relation to use hydrogen in the transportation sector in the short-term.

- The Federal Government of Germany will support the development of several initiatives, such as the purchase of heavy goods vehicles with climate-friendly propulsion systems including hydrogen technologies; passenger cars with hydrogen / fuel cell drive systems benefits until 2025; a system of carbon-differentiated truck tolls favouring climate-friendly fleet; development of market-ready commercial vehicles with hydrogen fuel cells; and publicly accessible filling and charging infrastructure including hydrogen supply infrastructure for fuel cell vehicles.
- In Italy, a national strategic framework for the transport sector promotes the use of alternative fuels, in particular electricity, natural gas and hydrogen. Hydrogen is projected to contribute around 1% of the target RES for the transport sector, through direct use in cars, buses, heavy goods vehicles, and non-electrified trains. Eventually sea transport use, or in-put into the methane network may be included.
- In Hungary, hydrogen will play a major role along with biofuels and electricity in view of renewable energy in transport sector. Hungary could cover about 1% of its transport needs with hydrogen by 2030. In terms of new car technologies, hydrogen fuel cell vehicles will be available from 2025, according to their NECP.
- In Spain, a significant percentage of electric vehicles would be used through Mobility as a Service by 2030. The use of hydrogen in heavy road transport, marine transport and industrial sector to replace fossil fuels is recognised.
- The updated National Action Plan for Clean Mobility of Czech Republic notes that hydrogen mobility should be supported by the same measures as electromobility. Accordingly, 80 Hydrogen Refuelling Stations will be installed to operate 40,000 to 50,000 fuel cell cars and 870 fuel cell buses by 2030.

Other several member states also mention hydrogen as a promising area as the energy carrier in transport (e.g., Greece, Luxembourg, Netherlands, Lithuania, Poland, Portugal and Sweden). Nevertheless, their policies or objectives are quite general.

Industry

An immediate application in industry is to reduce and replace the use of carbon-intensive hydrogen in refineries, the production of ammonia, and for new forms of methanol production, or to partially replace fossil fuels in steel making. In a second phase, hydrogen can form the basis for investing in and constructing zero-carbon steel making processes in the EU, envisioned under the Commission's new industrial strategy.

Several Member States (e.g., Germany, Hungary, Netherlands, Ireland, Lithuania, Luxemburg, Portugal, Slovakia, and Sweden) indicates in their NCEPs that hydrogen can also play a role in reducing CO2 emissions in industry, by partially replacing the use of fossil-based hydrogen or natural gas as feedstock in several sectors, e.g., oil refining, steel, cement, ammonia, fertilisers, and pharmaceutical sectors.

Collaboration

Clean hydrogen offers new opportunities for re-designing Europe's energy partnerships with both neighbouring countries and regions and its international, regional, and bilateral partners, advancing supply diversification and helping design stable and secure supply chains. An example is the Pentalateral Energy Forum.

The Pentalateral Energy Forum

Figure 3. Pentalateral Energy Forum

The Pentalateral Energy Forum is a framework for regional cooperation involving Belgium, Luxembourg, the Netherlands, France, Germany, Austria, and Switzerland. Penta countries work jointly on energy-related issues, such as among other things, the role of hydrogen in flexibility measures in cross-border infrastructure, standards for hydrogen blending and best practices for support schemes and innovation. Penta countries recognise that hydrogen can help increase the flexibility of their internal electricity markets.

Regarding the potential future role of increasingly renewables-based hydrogen as an energy carrier, Penta countries will consider the following issues: possible common approaches to Guarantees of Origin (GO), a cross-border infrastructure, the respective role of transmission system operators (TSOs) and distribution system operators (DSOs), and standards for hydrogen blending.

Cooperation opportunities of the Nordic countries and Baltic States are also sought for the development of future technologies (such as hydrogen, energy storage, CCUS, etc.).

At local level, the Ministry of the Environment of Estonia has launched a Hydrogen working group, the aim of which is to analyse the opportunities for implementing hydrogen and fuel element technology in Estonia, e.g., NGO Estonian Hydrogen Association participates in the working group. The Estonian Hydrogen Association has also joined the international hydrogen initiative, which has the objective of achieving the decarbonisation potential of hydrogen technology-based economic sectors, the energy system and the EU's long-term energy supply.

In addition, the Commission has launched the European Clean Hydrogen Alliance with industry leaders, civil society, national and regional ministers and the European Investment Bank. The Alliance will build up an investment pipeline for scaled-up production and will support demand for clean hydrogen in the EU. The Clean Hydrogen Alliance will act as a platform that enables close cooperation and coordination along the value chain.

The Alliance will be open to any public organization in the EU working on for clean hydrogen. Members will include Member States, regions, companies, civil society, associations, hydrogen experts and research and innovation communities being **industry in the driving seat, especially companies with significant investment potential into clean hydrogen.**

Eventually, main objective of Mission Innovation on Hydrogen (IC8) is to accelerate the development of a global hydrogen market by identifying and overcoming key technology barriers to the production, distribution, storage, and use of hydrogen at gigawatt scale. Its members (e.g. Germany, Austria, France, Italy and Netherlands) will collaborate to identify and accelerate key breakthroughs needed to achieve a cost-competitive hydrogen value chain. Innovation Challenge 8 will provide a platform to understand and progress selected issues around how a global hydrogen market would function as a system (particularly where these issues are not being actively contemplated in other forums).

Assessment of Hydrogen per Member State

In this section of the document, the role of hydrogen within the National Energy and Climate Plans (NECPs) will be analysed to identify opportunities and best practices across Member States for hydrogen to contribute to achieving the 2030 climate and energy targets of the EU and its Member States.

Hydrogen strategies per Member States

As reported in the map below, member States follow different paths to deploy hydrogen within their national contexts, such as enacting a hydrogen strategy, integrating it into other policies (e.g. mobility, industrial policy, etc.) or through sector-specific strategies.

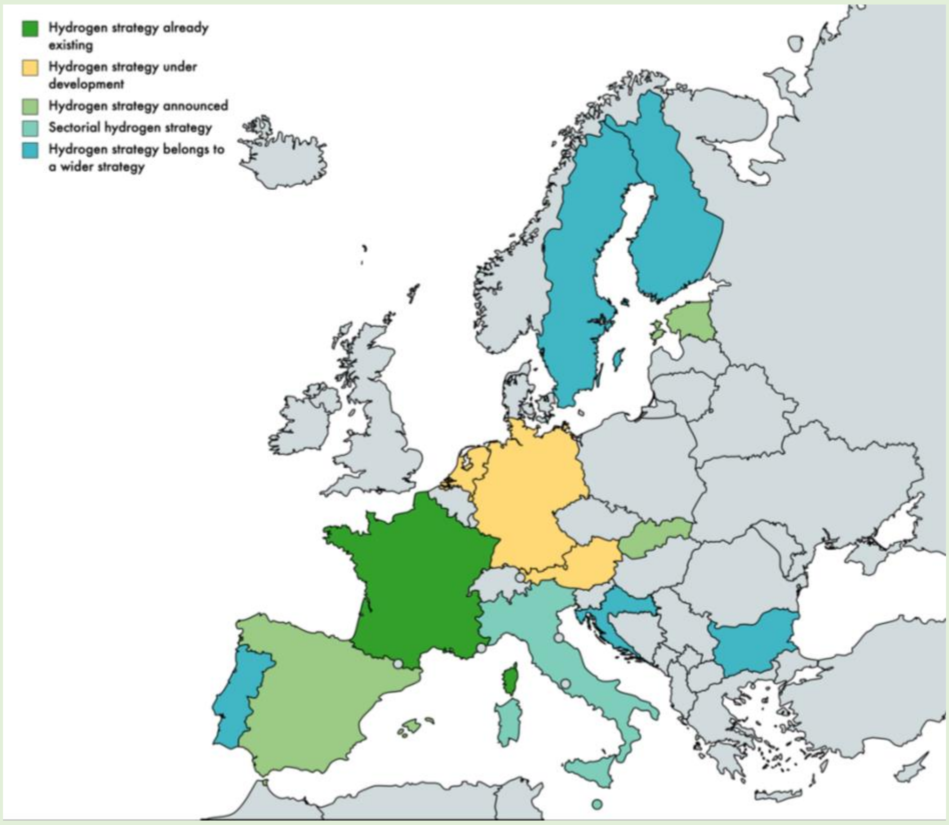

Figure 4. Hydrogen strategies per Member States

Austria

Austria anticipates that renewable hydrogen will play a critical role in achieving the conversion of the energy system in future. The objectives of the Austrian Climate and Energy Strategy require a considerable expansion of renewable energies. This position guides the development of the national Hydrogen Strategy, which at the time of the publication of the Austrian NECP was scheduled to be accepted in 2020. The national strategy is expected to include measures to transform today's society into a hydrogen-based society free of fossil-fuel energy.

Austria's NECP identifies renewable hydrogen as a crucial technology for sector integration and coupling and sets the target for 2030 of a renewable electricity-based hydrogen consumption of 1.1 TWh (4 PJ). Moreover, the NECP looks at hydrogen to increase the share of renewable sources in the final energy consumption to 45-50% by 2030 and, ultimately, achieve the complete sourcing of its national energy consumption through renewables. The development of a hydrogen strategy will be pivotal to attaining this objective and identifying the primary conditions for feeding biogas and renewable hydrogen into the already existing natural gas infrastructure. The strategy will detail actions on the following topics: Generation, infrastructure, and storage; "Greening the gas"; Hydrogen in industrial processes; as well as Mobility and buildings — fuel cells in final consumption.

In its "Energy research initiative 2 – 'Mission Innovation Austria' programme", Austria allocates up to EUR 120 million through Austria's Climate and Energy Fund to support three flagship projects: WIVA P&G5 (an association for the promotion of research and development in the fields of application, network and storage technologies of hydrogen and renewable gases), NEFI (to achieve the goal of sourcing the 100% of the domestic energy supply via RES) and GreenEnergyLab (which focuses on Smart Grids, Demand Side Management and Demand Response).

In its 7th flagship project on "Renewable hydrogen and biomethane", Austria foresees to act on promoting investments, exempting taxation for sustainable hydrogen, and addressing the legal framework for renewable gases. In addition, in the context of photovoltaic (PV) self-production, it will foster the use of appropriate flexibility technologies, such as electrolysis installations.

In addition, Austria belongs to the Pentalateral Energy Forum, a framework for regional cooperation on energy-related issues. Penta countries work jointly on, among other topics, the role of hydrogen in flexibility measures in cross-border infrastructure, standards for hydrogen blending and best practices for support schemes and innovation.

Austria also calls the Commission for the development of a European strategy on hydrogen that takes account of the emerging and future global hydrogen trade and sets out increased funding opportunities for hydrogen.

Belgium

Belgium's NECP addresses hydrogen deployment in relation to the mobility sector. Belgium foresees 1% private hydrogen vehicles and 5% hydrogen buses by 2030. It is estimated that by 2025 Belgium will have 20 hydrogen fuelling stations, which will be increased to 30 by 2030. The use of hydrogen train lines is also under review. Moreover, the NECP maintains that Flanders has the ambition to become a European leader in the hydrogen technology sector. However, specific plans and strategies to achieve this ambition are not stated in the NECP. Belgium is part of the Pentalateral Energy Forum.

Bulgaria

Among Bulgarian's R&I goals are eco-mobility – i.e., developing electric cars, more reliance on hydrogen and fuel cell technologies.

Bulgaria aims at producing green hydrogen. To ensure that sufficient hydrogen is available to meet the demand, steps will be taken to launch hydrogen production via Power-to-X plant solutions. Moreover, the country expects to use surplus electricity generated from solar and wind power for hydrogen production. A pilot project for a hydrogen plant with a total installed capacity of 20 MW will be developed. The project results will allow conducting an analysis of prospects for further development of hydrogen power plants after 2030.

Croatia

Croatia emphasises the need to enhance its collaboration in scientific and research projects. Hydrogen, along with battery development, and CCS are deemed particularly important. Since the role of hydrogen is expected to grow significantly in the future in the energy and transport systems, establishing a platform for hydrogen technologies will be a central measure. Such a platform will bring together national stakeholders relevant to the research and application of hydrogen technology, monitor their development at EU and international level, and serve as a link between national, EU and international levels.

Strengthening the infrastructure for the distribution of alternative fuels – hydrogen included – is considered a prerequisite for the development of a national market for vehicles and vessels using electricity, compressed natural gas (CNG), liquefied biogas (LBG) and hydrogen.

Czech Republic

The Czech Republic aims at significant hydrogen development, in particular in the mobility sector. Even if there are already hydrogen-powered vehicles within the country, the government aims to increase their share of both public and private mobility as it is believed that alternative fuels from renewable energy sources (RES) can play a leading role in reducing CO2 emissions.

The National Action Plan for Clean Mobility (NAP CM) states the inclusion of hydrogen in the national policy framework for alternative fuels in transport as one of Czechia's interests. Initially, the national target was building 3–5 hydrogen filling stations by 2025, to later increase this number to at least 12. Nevertheless, the forthcoming updated version of the NAP CM is expected to increase the number of stations to be built to 80 and to have 40,000 to 50,000 fuel cell cars and 870 fuel cell buses operative by 2030. The plan also claims that hydrogen mobility should be supported by the same measures as electromobility. It follows that hydrogen vehicles should have the same benefits as electric ones in terms of urban parking, preferential lanes use and exemption from motorway toll charges. To implement these benefits, hydrogen vehicles will eventually be classified as 'electric vehicles', carrying special registration plates. As a functioning and safe filling station infrastructure is one of the main requirements for developing hydrogen mobility, the expectation is that the government will support the construction of both public filling stations for citizens and the hydrogen infrastructure for public transport and municipal services.

Regarding the production or origin of hydrogen to be used in the mobility sector, the NECP is not quite as detailed. It refers to hydrogen production using domestic electricity from RES and mentions that hydrogen produced with CCS could also contribute to emission cut targets.

Denmark

Denmark's NECP considers hydrogen mainly on a general level in line with Denmark overarching goal to become increasingly independent of fossil fuels. Hydrogen development is in a demonstration stage. In December 2019, 128 million DKK was granted to two Power-to-X projects. The projects will establish big scale production and storage of green hydrogen. Both projects have the ambition to replicate the production and consumption of green hydrogen on near market-based conditions.

Estonia

Estonia acknowledges the role hydrogen can play in storing renewable energy and its uses in transport, buildings, and electricity generation. The Estonian NECP states that by 2040, hydrogen as an energy carrier may play a role in harmonising consumption in the network, as it will help to cover peak hours' consumption through stored energy.

The Ministry of the Environment has launched a Hydrogen working group to analyse the opportunities for implementing hydrogen and fuel element technology in Estonia. The NGO Estonian Hydrogen Association, which is part of the working group, has also joined the International Hydrogen Initiative, which aims to achieve the decarbonisation potential of hydrogen technology-based economic sectors, the energy system, and the EU's long-term energy supply.

Cooperation opportunities with Nordic countries and the Baltic states are also being considered to develop future technologies such as, energy storage, CCUS, hydrogen, etc.

France

The French NECP describes the role and usage of hydrogen in different sectors, including mobility, industry, and storage. Overall, France has a high hydrogen market in the industrial sector, estimated at 1Mt. The document also identifies hydrogen as the most promising inter-seasonal large-scale storage medium for intermittent electrical renewables.

As far as the transportation sector is concerned, France is considering hydrogen usage for both light commercial vehicles (hydrogen taxis) and heavy vehicles such as buses, trains, and trucks. Specific targets for the development of hydrogen fuel in the mobility sectors are indicated. The number of hydrogens fuelling stations is expected to increase from 30 in 2019 to 400-1,000 by 2028. The rate of incorporation of decarbonised hydrogen into industrial hydrogen is awaited to increase from 10% in 2023 to 20-40% by 2028. Similarly, the number of hydrogen light commercial vehicles will increase from 5,000 in 2023 to 20,000-50,000 by 2028, and the number of hydrogen heavy goods vehicle will increase from 200 in 2023 to 800-1,000 by 2028.

Hydrogen direct injection into the gas network is under review, even though the NECP recognises that, beyond a certain concentration, hydrogen may raise the question of technical compatibility and safety for the network.

France puts in place a support mechanism for the development of decarbonised hydrogen worth up to EUR 50 million per year and launches calls for projects on hydrogen mobility and hydrogen production using the electrolysis method. Moreover, France has other measures that support hydrogen deployment, including a traceability system for decarbonised hydrogen, extended measures providing additional depreciation for the purchase of hydrogen vehicles, and simplifying and harmonising procedures for the authorisation and accreditation of vessels and associated hydrogen refuelling solutions.

Research and development in hydrogen is also supported by different programs, including Investment for the Future programme (PIA) and the National Research Agency (ANR).

Eventually, France is part of the framework for regional cooperation Pentalateral Energy Forum.

Germany

The Federal Government of Germany has the ambition to become a global leader in hydrogen technologies and intends to invest EUR 100 million per year in research on hydrogen technologies.

Germany will develop a national hydrogen strategy. In the view of the government, only so-called ‘green’ hydrogen is sustainable in the long term. Nonetheless, also carbon-neutral hydrogen (‘blue’ or ‘turquoise’ hydrogen) will be important and is expected to be used on a transitional basis. Hydrogen, together with electricity, will be a crucial element for the decarbonisation of Germany and hence to move away from fossil fuels.

In the transportation sector, the Federal Government will support the purchase of heavy goods vehicles with climate-friendly propulsion systems, including hydrogen technologies. Until 2025, a purchase premium will be available also for passenger cars with hydrogen/fuel cell drive systems. Moreover, a system of carbon-differentiated truck tolls favouring the climate-friendly fleet is planned. National goals for publicly accessible filling and charging infrastructure includes hydrogen supply infrastructure for fuel cell vehicles.

The National Innovation Programme for Hydrogen and Fuel Cell Technology supports technology development and market entrance, with a focus on fuel cells for electric powertrains, filling station infrastructure, hydrogen generation from renewable energies, integration into the energy system and fuel cells for stationary energy supply.

Germany also belongs to the Pentalateral Energy Forum.

Greece

The Greek NECP sets ambitious RES and energy efficiency targets.

Policies and measures to promote R&I, relating to electric vehicles and recharging, emphasise that the electricity consumed should come from RES and hydrogen produced from various forms of energy. Related actions include, among others, supporting the production of renewable hydrogen from electrolysis of water and electricity from RES through, for instance, the installation of electrolytes at renewable hydrogen refuelling stations.

Hungary

Hungary considers ‘clean’ hydrogen as an alternative to natural gas in addition to biogas and aims to examine means of feeding hydrogen into its natural gas network. Regulation concerning the feed-in of hydrogen will be reviewed, keeping into consideration, among other things, the security of supply.

In view of reducing natural gas consumption through renewable energy development and power-to-gas production (biomethane, hydrogen), pilot projects are planned. These projects can be implemented with carbon credit funds to test complex demand-side response solutions, independent aggregators, and renewable communities, and promote the flexibility of the distribution network and integration of renewable producers.

Hungary is also planning to launch a pilot project to test blending clean hydrogen on the level of natural gas transmission, storage, and distribution. The country will also assess options for converting some of the natural gas storage capacities for hydrogen storage.

Further, Hungary is planning a pilot project to enable the support of necessary innovative solutions in the storage of seasonal energy, which will include the development of optimal storage and consumption of hydrogen produced with electricity as one aspect.

Regarding industrial gas consumption, Hungary supports the decarbonisation of industrial production by implementing pilot projects encouraging the use of 'clean' hydrogen. As far as renewable energy in the transport sector is concerned, hydrogen will play a significant role along with biofuels and electricity by the end of the 2020s.

Ireland

The production and use of hydrogen are expected to have a central role in Ireland's transition to a low carbon economy and society. Ireland has ambitious plans for renewable electricity, with 70% of its electricity to be generated from RES by 2030. Defining the role of hydrogen in the decarbonisation of the national energy system is one of Ireland's critical objectives in terms of R&I – including the potential production of renewable hydrogen from excess renewable electricity. For this reason, funding has been allocated to support hydrogen research.

The Irish NECP starts from the premise that to decarbonise fully, it is vital to prioritise the development of green hydrogen. Producing it and having an integrated energy system would enable Ireland to fully utilise RES and help reduce the overall cost of decarbonisation. Hydrogen produced via underutilised renewable electricity could be stored in the gas grid and used in the heating and transport sectors. This would benefit all sectors and help decarbonise, among others, the industry sector, and heavy goods vehicles. Current Combined Cycle Gas Turbines (CCGTs) could be reconfigured for hydrogen, and, potentially, hydrogen turbines could be developed as backups for intermittent renewables.

In terms of mobility, to incentivise the growth of low emission vehicles in addition to electric ones, the government is considering supporting the development of CNG, Liquid Natural Gas (LNG) and hydrogen vehicles – especially heavy-duty ones. Adequate fuelling infrastructure should also be facilitated nationally.

Beyond 2030, Ireland aims to demonstrate new green technologies such as the generation of green hydrogen as a by-product of offshore wind.

Italy

Italy aims at increasing the growing share of renewable gases (biomethane, synthetic methane and, eventually, hydrogen) in its gas network. Hydrogen could contribute to achieve the objectives of security and flexibility and encourage to explore the integration of the electricity and gas network infrastructure. Hydrogen synthesis from excess renewable electricity is deemed of particular interest for storage or injection into the gas network. Coherently, the ten-year development plan for the Italian gas grid will include studies for possible integration of hydrogen.

The expected reduction in the cost of electrolysis technology will make it possible to obtain renewable hydrogen to decarbonise energy-intensive industrial sectors and long-haul commercial transport.

As far as mobility is concerned, a national strategic framework for the transport sector promotes the use of alternative fuels, especially electricity, natural gas, and hydrogen. Moreover, a pathway towards the possible use of hydrogen in the transport sector has been established. Hydrogen is projected to contribute around 1% of the target RES for the transport sector through its direct use in cars, buses, heavy goods vehicles, and non-electrified trains. The use in sea transport and input into the methane network might also be included. The production and use of hydrogen generated from RES will be promoted through research, development, and demonstration activities.

The development of power-to-gas storage systems – particularly for storage of excess RES production, secure and reliable hydrogen storage in liquid and gaseous energy carriers – is cited among the research objectives crucial to the energy transition. Regarding the development of a hydrogen supply chain in the road transport sector, the primary need is to invest in research and development and the supply infrastructure. Considering the above, it will be fundamental to develop a clear legal and regulatory framework for the introduction of hydrogen into the current gas infrastructures as an additional source of energy in a mixture with natural gas.

Latvia

The Latvian NECP discusses hydrogen in the context of R&I. The production and use of hydrogen may be included as a potential priority action line within energy research programmes under the theme “Innovative solutions in the field of RES technologies.” More specifically, hydrogen appears in research topics related to smart mobility, RES electricity and thermal energy. Infrastructure development plans address evaluating the possibilities of adapting the natural gas infrastructure to hydrogen and other gaseous fuels. If applicable, drafting an action plan for the development of hydrogen infrastructure and market conditions may ensue.

Lithuania

The Lithuanian NECP recognises the use of hydrogen technologies and systems as a promising area in energy, industry, and transport, and defines them as a strategic value chain. Hydrogen and fuel cell technologies are studied at the Lithuanian Energy Institute's Centre for Hydrogen Energy technologies.

Luxembourg

A hydrogen strategy for Luxembourg is currently being prepared as part of the European Green Deal and the European Hydrogen strategy. Luxembourg aims to become a globally recognised financial centre for investments in energy efficiency, renewable energy, electric and hydrogen mobility. Verifying and certifying the origin of green hydrogen is essential in ensuring genuine emission reductions.

Transport fuels account for two-thirds of the total national final energy consumption of Luxembourg. Therefore, supporting low carbon transport modes, including, among other things, hydrogen fuel cell vehicles, is central for Luxembourg's clean energy transition. Moreover, the country aims to contribute to a Europe-wide network of hydrogen refuelling motorway stations to enable longer journeys within Europe, particularly for the trucking and logistics industry. Hydrogen can also play an important role in reducing CO_2 emissions produced from the national industry sector, especially from steel and cement factories.

Luxembourg belongs to the Pentalateral Energy Forum.

Malta

The NECP of Malta recognises hydrogen as a 'green fuel' that may be available in the future. However, hydrogen technologies in Malta are in very early stages, an instance being Transport Malta working on a pilot project to demonstrate hydrogen propulsion. Nevertheless, the government attempts to follow the development of hydrogen technologies.

Netherlands

The Netherlands highlights the cross-national nature of the development of hydrogen and its related infrastructure, a view that shares with the other members of the Pentalateral Energy Forum. Penta countries recognise that hydrogen can help increase the flexibility of their internal electricity markets. Regarding the potential future role of increasingly renewables-based hydrogen as an energy carrier, the Netherlands, together with other Penta countries, will consider the following issues: possible common approaches to Guarantees of Origin (GO), a cross-border infrastructure, the respective role of transmission system operators (TSOs) and distribution system operators (DSOs), and standards for hydrogen blending.

In an emission-free mobility system, green hydrogen – together with electricity – is deemed to have an important role. The aim is for all new cars (i.e., hydrogen-powered, and electric cars) to be emissions-free by 2030 at the latest. The Dutch government envisages an important future role for hydrogen also as the energy carrier in heavy transport, such as trucks, public transport buses, and potentially replacing diesel-powered trains and passenger transport.

Industrial energy policy also sees an important role for ‘green hydrogen’, but also so-called ‘blue’, fossil and CCS based hydrogen. Moreover, concerning heating and cooling, hydrogen can play a role in the transition of the industrial sector.

Poland

The draft NECP of Poland identifies hydrogen as a national raw material from coal mining. In addition, electric and hydrogen-fuelled vehicles are set in the context of air quality. Legislation is in place so that municipalities can establish clean transport zones in high-density housing areas, where public buildings are concentrated. Access to such zones for vehicles other than those fuelled by electric, hydrogen, or natural gas would be restricted. Developing a charging and refuelling infrastructure for electric and hydrogen vehicles throughout the country is included among the policy measures to create an energy-efficient transportation sector. Moreover, support mechanisms are planned to promote renewable and 'low carbon' gaseous fuels. These mechanisms will encompass different means of transportation, infrastructure development, purchase premiums, education, research, and the elimination of legal barriers.

Portugal

According to the Portuguese NECP, the Government supports an industrial policy centred on hydrogen and renewable gases. Public policies will be enacted to mobilise and coordinate public and private investment towards projects for the production, storage, distribution, and consumption of renewable gases. Developing a green hydrogen national industry will eventually make it possible to decarbonise various sectors of the economy. Research programmes will be introduced for the development of hydrogen end-use technologies.

Portugal aims to implement a national cluster with export potential to produce renewable gases – in particular green hydrogen – leveraging solar energy and other renewables as a factor for competitiveness. Suitable locations have already been identified, for instance, Sines, where studies are underway to develop an industrial unit fuelled by solar energy to produce green hydrogen (1 GW). The project is based on strategic partnerships at both national and European level.

In the short term, Portugal will implement mechanisms aiming at: regulating the injection of renewable gases into the national natural gas network; (ii) implementing a guarantee of origin system for renewable gases; (iii) concentrating financial resources available in national and European funds to support energy production through the production of renewable gases, particularly hydrogen and biomethane; (iv) assessing the setting of binding targets by 2030 to incorporate renewable gases into the natural gas network." On the other hand, future uses of hydrogen include energy storage produced with low-cost renewable electricity – especially solar, power production, industry and alternative to electrified transport.

As of today, Portugal considers mobility fuelled by advanced biofuels and hydrogen as alternative solutions and complementary measures to electric mobility since all of them allow to leverage the decarbonisation of consumption and promote increased consumption of renewable energy sources.

Romania

Romania plans to use hydrogen and other alternative fuels to pursue decarbonisation objectives, especially in the industry sector. The use of these fuels may be accelerated by dedicated R&I measures and demonstration projects supporting the sustainable development of hydrogen production from renewable and low-carbon sources within the national territory. Romania also aims to support hydrogen use in electricity production and the industrial sector.

Two areas are targeted. The first is the flexibility of the energy system, given the significant opportunity of tapping the excess potential in the generation of electricity from renewable sources to produce hydrogen by electrolysis. The second is power transmission infrastructure by reconverting the existing methane infrastructure for hydrogen transmission and distribution. In the short to medium term (2025-2040), this would mean injecting hydrogen into the public natural gas network. In the long term, it would involve increasing hydrogen contribution to the transmission and distribution network.

The National Energy Strategy deems the development of the technical and economic potential of RES dependent on the availability and development of storage capacities, technologies for hydrogen injection in the form of synthesis gas from RES, and the use of hydrogen in industrial processes.

Slovakia

Slovakia lists the promotion of RES use for hydrogen production among its energy policy priorities. The NECP discusses the use of hydrogen in the context of several end-use sectors.

Given Slovakia's extensive gas grid, a possibility could be to incorporate biomethane and hydrogen into the already existing national gas infrastructure. The contribution of hydrogen would be small yet embedded in policies. Hydrogen or biomethane fuel cells may become eligible for support for introducing low-power electricity and heat generation installations in family houses and apartment buildings. A mixture of natural gas and hydrogen is also considered in relation to energy storage.

The government is expected to support the production of hydrogen generated from RES and low-carbon sources. The underlying objective is achieving 100% coverage of the consumption of hydrogen filling stations and the partial replacement of hydrogen generated from fossil fuels in the industry by 2030. Nevertheless, the projected final energy consumption of hydrogen from RES in 2030 is small (2.0 ktoe) compared to biogas (100 ktoe) and biomethane from recycled carbon fuels (20 ktoe).

Planned support for RES in transport infrastructure includes refilling hydrogen-powered vehicles and the hypothesis of introducing electric public passenger transport vehicles. Moreover, vehicle using hydrogen would receive tax reduction.

Slovenia

The key objectives of the Slovenian NECP include supporting the implementation of pilot projects to produce synthetic methane and hydrogen. From a regulatory perspective, the underlying aim is to create a supportive environment for alternative renewable gas sources within the natural gas network.

The maximum permissible fraction of hydrogen in the natural gas network will be analysed. An indicative target is to inject 10% renewable methane or hydrogen into the transmission and distribution network by 2030.

Slovenia also lists amongst its objectives ensuring appropriate technical capacity for the conversion of renewable electricity into renewable gas, hydrogen or synthetic methane and heat (power-to-gas and power-to-heat). This will allow the seasonal storage of renewable energy in the form of methane, including in warehouses in neighbouring countries. By converting and storing surplus electricity to gas fuels and heat, Slovenia will link its gas, heat, and electricity sectors. Sustainably available wood biomass and waste can also be used for the production of synthetic gas and hydrogen.

Spain

Spain aims at producing hydrogen of 100% renewable origin (both in terms of the resource and the energy used in the process). In the long term, the introduction of 100% green hydrogen could be an important flexible energy vector, allowing the integration of surplus variable renewable electricity and the use of gas infrastructures. However, water requirement in the catalysis process to produce hydrogen could be of concern, which is acknowledged in the National Climate Change Adaptation Plan.

Spanish national targets for renewable fuels for the transport sector include, among other things, hydrogen produced using 100% renewable sources and its use as stationary storage for large quantities and long periods. Moreover, measures are taken to promote electric vehicles and reduce the overall fleet's energy consumption. Actions to implement these measures include purchasing new electric vehicles and the deployment of related charging/filling infrastructure (it has to be taken into account that the national definition of electric vehicles encompasses both vehicles with batteries and those with hydrogen fuel cells). In addition, by 2030, a significant percentage of electric vehicles would be used through Mobility as a Service (MaaS).

The use of hydrogen is also acknowledged for heavy road transport, marine transport, and to replace fossil fuel in the industrial sector.

Regarding the integration of the gas market, The NECP maintains that Spain should take advantage of the existing plants for their storage capacity for LNG and their capacity for regasification and to convert them into a physical hub at EU level, for both natural gas and renewable gas or hydrogen.

Sweden

In the transportation sector, hydrogen is included in the support for the vehicle charging and renewable fuels infrastructure and location information. Nevertheless, Sweden does not mention the production of green hydrogen in their NECP.

The Swedish Energy Agency and the Norwegian state-owned company Gassnova are funding a bilateral three-year demonstration project for carbon capture and storage (CCS) at the Preem refinery in Lysekil. The project is investigating the possibility of setting up a full-scale CCS plant at the refinery’s hydrogen installation which will reduce its CO2 emissions by up to 500,000 tonnes a year.

One research project is indicated in the Swedish NECP (HYBRIT). HYBRIT seeks to develop various fossil-free steel production methods from iron ore, e.g., using hydrogen direct reduction.

2.5 The pathway analysis on ‘Solar power’

Terminology

Solar energy technologies convert energy from sunlight to electricity, either directly through photovoltaics or indirectly through concentrated solar power or a combination of both.

- **Photovoltaics (PV)**: It is a method to generate electric power by using solar cells to convert energy from the sun by the photovoltaic effect. These solar cells are assembled into solar panels, and then installed on the ground, rooftops or floating on dams or lakes.
- **Concentrating Solar Power (CSP)**: Plants use mirrors to concentrate sunlight and produce heat and steam to generate electricity. They can be coupled to heat storage technologies to be able to produce electricity both day and night.

Solar energy can also be used for heating and/or cooling. Solar thermal collectors are used mainly for producing domestic hot water in residential buildings, but also in industrial applications.

Background information

In December 2018, the recast Renewable Energy Directive 2018/2001/EU entered into force, as part of the Clean Energy for all Europeans package, aimed at keeping the EU a global leader in renewables and, more broadly, helping the EU to meet its emissions reduction commitments under the Paris Agreement.

The recast directive moves the legal framework to 2030 and sets a new binding renewable energy target for the EU for 2030 of at least 32%, with a clause for a possible upwards revision by 2023 and comprises measures for the different sectors to make it happen (e.g., new provisions for enabling self-consumption of renewable energy, an increased 14% target for the share of renewable fuels in transport by 2030).

The Renewable Energy Directive is an essential piece of the Clean Energy Package, to deliver the EU’s ambition of being the leader in renewable energy globally. It addresses key issues for solar sector in Europe, such as setting the level of ambition of the European Union in developing renewables up to 2030; the regulatory framework related to support and tendering schemes for solar installations, the treatment of solar prosumers and communities; and the removal of administrative barriers to unlock the development of all solar projects across Europe.

Assessment of solar power per Member State

The NECPs were analysed considering the following aspects:

- Level of maturity of the member states and experience in the solar energy production
- Solar energy targets
- Different schemes at the country level for achieving the solar energy targets
- Administrative procedures
- Regional corporation and power purchase agreements
- The technological development and research funding

- Challenges and obstacle in achieving country-level targets

In general, the NECPs predict a high growth for solar energy production in the next 10 years, being Germany, Spain, and Italy the front runner in terms of current capacity. Nevertheless, other countries foresee a drastic growth in solar energy generation until 2030, such as the Netherlands.

In addition, most of the countries consider future developments both at the small scale (community level) and large scale (solar plants or farms). However, the increase in solar power will mostly be driven by self-consumption and rooftop panel installation.

Eventually, the NECPs can facilitate solar energy deployment by suggesting best practices related to funding mechanisms, enabling regulatory frameworks, and simplifications in the permitting processes.

Austria

One of the main objectives of the NECP of Austria is to increase the share of renewable energy in gross final energy consumption of energy to 46-50%, and source 100% of electricity consumption from renewables. In order to achieve that objective, one of the envisaged measures is the expansion of renewable energy by creating ‘100,000 rooftops solar panel and small-scale storage programme’**.** To that end, the elimination of legal obstacles in housing law that impede this kind of renovation method is envisaged, together with measures for the promotion of investment and tax exemption.

The NECP also indicates that photovoltaic systems on buildings and built structures should be given priority so that other uses are not prevented on valuable land, in particular arable land, and grassland.

With building-integrated photovoltaic systems as a research and innovation priority, the Austrian industry may be able to enter a niche market, opening opportunities on major export markets worldwide. As a strong incentive for installing solar panels in these areas, large photovoltaic systems with a capacity of 250 kW or more will also in principle be able to participate in tenders as an alternative to investment support.

In addition, subsidies are expected both for photovoltaic systems and for storage systems, taking self-consumption into account. A total of EUR 108 million will be made available to investment subsidies for this purpose over the next three years (per year photovoltaics: EUR 24 million, storage systems: EUR 12 million).

According to the Austrian NECP, the Climate and Energy Fund for photovoltaic, solar thermal and bioenergy is one of the key financial instruments for promoting renewable energy in Austria.

Eventually, the following measures are envisaged to implement the energy research initiative for the 2020-2030 period are:

- Mission Plus-Energy Neighbourhoods. This plan envisages Innovative low-tech solutions for Plus-Energy Neighbourhoods with a high level of solar coverage.
- Mission Integrated Regional Energy Systems. Making electricity generation installations flexible optimising the conversion of solar energy into energy sources for heat, mobility, and electricity.

Belgium

In Belgium, the potential for renewable energy production is relatively low. Belgium is rather flat, densely populated and not very sunny. According to Belgium NECP, large-Scale use of hydropower, wind turbines, and solar solutions are difficult due to the great challenges of land use planning and public transport.

Based on the 2017 estimation, total electricity production was 7,854 ktoe in 2017. The share of renewable electricity production was 17.24%, of which solar energy accounted for about 20%.

In terms of measures and policies distinct policies for the Federal, Flanders and Walloon region exist. However, the Flanders policies are more concentrated on solar energy production.

In the Flanders region, different solar energy production promotive strategies exist, such as:

- Expansion of cheap energy loans.
- Development of standard specifications to encourage public authorities to provide the roofs of their public buildings so that third parties can install photovoltaic systems.
- Remove the restrictions on PV installation.
- Development of a solar map with suitable roofs for potential investors.
- Calculation of solar potential at the city level.
- Weather forecast on regional television channels and websites with information on solar energy production.

Bulgaria

The Bulgarian NECP indicates that Bulgaria will expand its generating capacity with an emphasis on wind and solar power. Solar power is projected to increase from 1.18% in 2020 to 3.95% in 2030.

According to their NECP, during the period 2020-2030, the net installed capacity of power plants generating electricity from renewable sources is expected to increase by 2,645 MW. This increase will be accompanied by a parallel increase of the net installed capacity of photovoltaic plants by 2,174 MW. In addition, during the period 2026-2030, approximately EUR 7 million will be invested in solar thermal plants.

Policies and measures in the household sector and the public sector are envisaged in the Bulgarian NECP, such as the installation of solar collectors.

Croatia

The Croatian NECP indicates that a relatively rapid drop in the levelized costs of electricity generation from solar and wind power is expected to reach the market price level, implying their rapid integration into the operation of the system without additional incentives.

In the building sector, a continuation of good practices and strengthening of energy efficiency of all buildings (residential and non-residential) is expected, targeting renovation according to the nearly zero-energy buildings (nZEB) standard, which also implies a greater utilization of RES (e.g., photovoltaic systems and solar thermal collectors).

In terms of electricity generation for own needs, the largest contribution is expected from photovoltaic systems integrated into buildings. According to estimates, the installed capacity of such systems is expected to be around 300 MW in 2030.

Regarding network expansion requirements at least until 2040, the Croatian NECP also indicates the construction of a total of 144 MW to 387 MW in solar power plants connected to the transmission grid.

In addition, significant increases in the transmission power of the Croatian grid are foreseen to support the construction and production of wind and solar power plants.

Eventually, a total investment of 3.04 HRK billion is expected in the period 2021-2030 for solar-thermal systems and 60.08 in the period 2031-2050.

Cyprus

Solar thermal technologies and photovoltaics are already within the priorities of the Smart Specialization Strategy of Cyprus.

The replacement of old solar collectors for households, commercial purposes, and the use of solar technologies for high process heat and/or solar cooling is one of the key policy planning priorities for renewable energy sources in Cyprus.

In the heating and cooling sector, the installation of solar water heaters to produce hot water, especially in residential buildings, is very popular and is expected to continue and get enhanced in the future by introducing new innovative technologies. Nevertheless, more emphasis will be given to heat pumps.

The envisaged scenario for 2050 shows that Cyprus will become an exporting country in electricity generation mainly produced from solar energy. From the preliminary results of the model, it appears that in addition to photovoltaics, other technologies such as concentrated solar thermal systems will contribute to the dominance of RES in the energy system.

Regarding infrastructure, the deployment of the EuroAsia Interconnector will enable further penetration of solar PV. If the interconnection is established, Cyprus can become a net exporter of electricity, especially to Israel or Greece.

As planned policies and measures, the NECP foresees the development of a 50 MW CSP plant by 2021, followed by an additional 390 MW of solar PV between 2021 and 2030. The increase in solar PV in this period coincides with the development of two new combined cycle gas turbines with a total capacity of 432 MW, which can operate as baseload and offer flexibility to the system.

A substantial deployment of solar PV occurs in the period 2020-2030. This deployment is enabled by the deployment of Li-ion batteries during the same period, as these reach 41 MW in 2030. Another factor that leads to the expansion of solar PV is the electrification of the transport sector, as this raises the demand for electricity throughout the year.

Eventually, several projects are highlighted in the NECP related to the solar sector:

- **NESTER project** upgrades the scientific and innovation performance of the Cyprus Institute in the field of Solar-Thermal Energy.
- **INSHIP project** focuses on engaging major European research institutes with recognized activities on Solar Heat for Industrial Processes, into an integrated structure.
- **CySTEM project** consolidates and upgrades the already substantial activity at the Cyprus Institute in Solar Energy, principally solar-thermal and related activities. This will be accomplished by attracting and installing a cluster of outstanding researchers to maximally utilize and upgrade the existing facilities and pursue a program of excellence in Cyprus with a local and regional focus in the region of Eastern Mediterranean and the Middle East.

Czech Republic

The NECP indicates that the installation of photovoltaic/solar (photothermal) systems is supported under the New Green Savings Programme, which is one of the most effective programmes in the Czech Republic focused on energy savings in family houses and apartment buildings. The development of new photovoltaic systems including control elements is also identified as a priority area in the State Energy Policy.

According to the National Research and Innovation Strategy, the use of solar energy should focus on the expansion of roof photovoltaic installations combined with appropriate storage to maximise domestic consumption and on innovative solutions for solar thermal systems (e.g., cost reduction, combination with unconventional heat storage solutions, etc.). Development must also focus on the use of heat pumps – increasing the state of charge, gas pumps, combination with other technologies at house or small-site level.

Denmark

According to the Danish NECP, Denmark is subsidizing renewable energy through multi-technology tenders for wind power and solar PV. New multi-technology tenders are being planned for the years 2020-2024 (market-oriented subsidies). Moreover, residential wind turbines and solar PV systems receive an indirect subsidy by being exempted from electricity tax, public service obligation and grid tariffs of the part of the produced electricity that is used for self-consumption behind the meter.

In addition, a technology-neutral support scheme of 114 million DKK for investments in heat production capacity at decentralized natural gas-based district heating plants is being established from 2020. This scheme will support investments in electric heat pumps, biomass boilers, and solar thermal plants.

As for cooperation, Denmark has entered a cooperation agreement with Germany which will result in statistical transfers from Denmark to Germany, corresponding to the electricity production from 50 MW solar PV financially supported by Germany.

Estonia

An envisaged measure indicated in the Estonian NECP is to invest in energy savings in greenhouses and vegetable warehouses and the introduction of renewable energy therein. The objective of the measure is to increase the share of renewable energy in horticulture and to increase energy savings through the introduction of modern technologies, such as solar panels.

Related to the promotion of the role of local renewable energy communities, the Tallinn Energy Agency includes, among other activities, directing the energy savings of the communities in Tallinn. For instance, up to 100 solar electricity stations will be installed on the roofs of buildings by the end of 2020.

Finland

The Finnish NECP indicates that the Finnish long-term renovation strategy aims at decarbonising the current building stock by 2050, in which the installation of solar panels is mentioned as a measure to be implemented.

Finland also participates in Clean Energy Ministerial (CEM) cooperation, in which the solar sector is one of the topics.

France

In 2016, total solar thermal power resources in Metropolitan France occupied an installed area of 2.29 million m² with a total production of 1.17 TWh/year. The installed floor area in the residential sector represents 54% of the total area, with 43% in the tertiary sector and 3.5% in industry and agriculture. France has particularly good solar resources, ranking fifth in Europe. The maximum potential of solar thermal energy is estimated as 6 TWh (by 2050).

French regional distribution of connected photovoltaic generation capacity

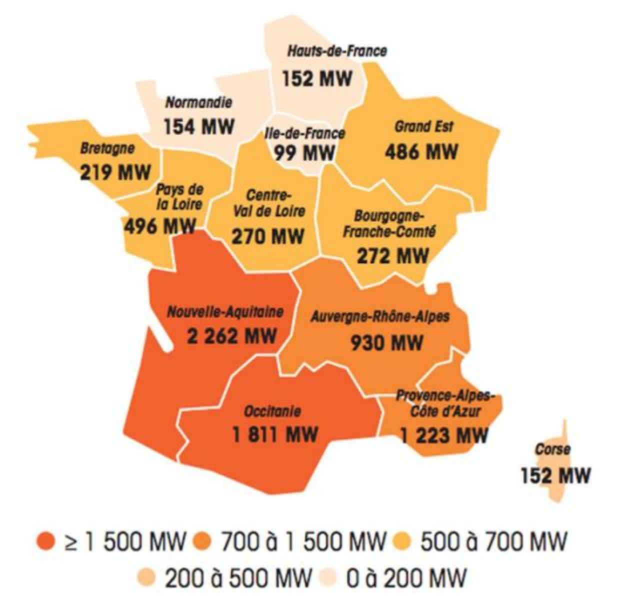

Figure 5. French regional distribution of connected photovoltaic generation capacity [34]

The French NECP indicates the following targets for PV: installed photovoltaic capacity in France of between 330 and 400 km^2 of ground-mounted panels and between 150 and 200 km^2 of roof-mounted panels by 2028 (compared to 100 km^2 of ground-mounted and 50 km^2 of roof-mounted panels).

In 2018, photovoltaic installations with a total capacity of 0.862 GW were connected to the grid. As of 30 September 2018, 424 805 facilities had an installed capacity of 8.9 GW. Photovoltaic solar energy represented 2.4% of French electricity consumption in 2018, an increase of 12% compared to 2017. The Nouvelle-Aquitaine, Occitanie, Provence-Alpes-Cote d'Azur and Auvergne Rhône-Alpes regions have the highest installed capacities, representing nearly 70% of the total connected power in France. However, there is an increasing number of projects in the north and east of the country.

For solar thermal, the targets for 2023 are based on the installation of around 100,000 m^2 per year of solar thermal in the buildings sector (with half of this figure on privately owned buildings) and 150,000 m^2 in the industrial sector (around 50 solar power plants). The targets for 2028 are based on the installation of between 150,000 m^2 and 350,000 m^2 per year in the buildings sector (with 70% of this figure on privately owned buildings, and assuming significant developments in the field of combined solar systems) and 300,000 m^2 in the industrial sector (around 100 solar power plants).

The French NECP indicates the following measures to supplement cross-sector connection for solar thermal:

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[34] Source: Réseau de Transport d'Électricité (RTE), 2018, in French NECP, page 193.

- Extend the call for Heat Fund project proposals for large solar thermal units for at least three years.
- Enable grants from the Heat Fund for the repair of faulty installations.
- Since 2019, the supply of district heating systems through solar thermal energy has been considered for the application of reduced-rate VAT for heat delivered by renewable and recovered energy networks.
- Integrate a technical and financial assessment of solar or geothermal heat generation into energy audits on large and medium-sized enterprises.
- Develop a communication about the value of solar thermal energy for the agriculture sector.
- Diversify the role of wood energy promoters to include other technologies such as solar thermal.

For photovoltaics, the following measures to supplement cross-sector connection are indicated in the NECP:

- Promote ground installations on urbanised, or degraded land, or parking areas to enable the emergence of less costly projects while continuing to apply the strict requirements about agricultural land and the absence of deforestation.
- Maintain a target of 300 MW installed per year for installations on small and medium-sized roofs (smaller than 100 kWp), guiding projects towards self-consumption; boost the development of projects over the 100–300 kWp tranche by making them eligible for the open window system; and accelerate the development of projects on large roof areas (> 300 kWp).
- Support innovation in the sector through tenders, to encourage the emergence of innovative solutions, agrivoltaic projects that generate real synergies between agricultural production and photovoltaic energy, maintaining current tender volumes (140 MW/year).

As for cooperation, France is involved in SOLAR ERANET and SOLAR COFUND 2.

Germany

The Regulation on Joint Tendering Procedures for Onshore Wind and Solar Energy has been in force since August 2017. Under this Regulation, 400 MW a year are being tendered out on a technology-neutral basis for onshore wind and photovoltaics respectively between 2018 and 2020. In total, an additional 4 GW of capacity will be tendered out by 2021 for solar and onshore wind, respectively. Depending on the specific nature of the projects. The capacities tendered will not count towards the current 52 GW ceiling for PV systems. The special tendering procedures formed part of the ‘Omnibus Energy Act’ (Federal Government bill dated 5 November 2018).

The Federal Office for Economic Affairs and Export Control awards investment grants for small installations, being solar thermal collectors eligible for funding. Larger installations are eligible for Federal Government subsidies under the KfW programme Renewable Energies – Premium.

Within the framework of the funding initiative ‘Solar Construction/Energy-Efficient City’, the Federal Ministry of Economic Affairs and Energy and the Federal Ministry of Education and

Research will be promoting the energy transition in buildings and urban neighbourhoods. The focus is on the efficient, system-based energy supply of neighbourhoods across sectors based on renewable energies. The flagship projects address existing, redeveloped, and new-build areas. The initiative, launched in mid-2017, has a total funding volume of EUR 120 million.

The tendering quantities stipulated in the Renewable Energy Sources Act 2017 between now and 2030 are for photovoltaic plants from 750 kW, 600 MW a year. The overall goal for photovoltaics is an expansion corridor of 2 500 MW a year; the Omnibus Energy Act provides for special calls for tender covering an additional 4 GW over the period 2019-2021. This is a technology-neutral and innovation-focused procurement plan: Joint calls for tender which cover both photovoltaic systems and onshore wind farms mean that the different technologies are forced to compete against each other.

Greece

In relation to the penetration and share of RES to meet thermal needs in final consumption, the NECPs envisages an increased share of thermal solar systems.

Reference should be made to the possibility of using RES systems for desalination. An effort will be made to promote the use of small autonomous RES desalination plants to produce 130 drinking water or to cover irrigation needs on the islands and in remote areas. The small autonomous desalination plants will be combined with RES systems to cover their need for energy.

Successful and efficient policy measures, such as the mandatory installation of solar thermal systems in new buildings and those undergoing a major renovation, will be continued, and improved as appropriate.

Research and innovation activities related to improving the energy efficiency of buildings will include prefabricated active roof and facade elements, such as roofs combining photovoltaic and thermal solar systems.

The Greek NECP indicates the following Research and Innovation actions related to solar thermal energy for electricity generation:

- Implementation of linear CSP collector’s technology with storage capacity at a commercial scale.
- Reduction of the costs and increase of the efficiency of Fresnel CSP linear collectors.
- Development of new heat storage materials and techniques suitable for CSP systems.

As for solar thermal energy for heating and cooling applications, the Research and Innovation actions will include:

- Development, standardisation, and implementation of hybrid systems in intelligent buildings.
- Digitisation of solar thermal systems
- Work models and pilot applications for the integration of solar thermal systems into smart grids, integrated hybrid RES systems for heating and air-conditioning in buildings with a priority in solar thermal systems.
- New materials, production methods, solar thermal system parts to ensure cost savings and to be used in integrated systems.

- Development of standardised solar thermal systems for heat generation in industrial processes.

Finally, the Research and Innovation actions for PV energy are the integration of PV systems into buildings and other infrastructures; the development of high energy efficient multi-contact technology photovoltaic cells, and PV plants and facilities monitoring and operating systems.

Hungary

The Government aims to ensure that most of the power generated in Hungary originates from two sources: nuclear energy and renewable energy – the latter produced mainly by solar power stations.

As regards generated electricity, solar power and biomass represent a dominant share. In 2030, PV power plants and biomass power plants will account for 45% and 35.7% of renewable based generation, respectively.

Assuming current network connection and network usage practices applicable to PV power plants, the amount of public and private investment necessary for new PV connections expected up to 2030 exceeds HUF 300 billion.

As a result of additional measures, among regenerative sources of energy, the use of solar energy is expected to increase most in the electricity sector. The total installed PV capacity of over 1 GW in 2020 will increase to 2.5 GW by 2025, to over 6 GW by 2030, and may approximate even 12 GW by the 2040s. Thus, with additional measures, the system may have available around 4,000 MW and over 8,000 MW more PV capacity in 2030 and 2040, respectively, than under the WEM scenario.

The increase of PV capacities is at the core of ‘greening’ the electricity sector, which will increase from just under 680 MW in 2016 to roughly 6,500 MW by 2030. Hungary plans to install power generating PV panel systems to partially supply its own electricity consumption. The aim is to have at least 200,000 households with roof-mounted PV panels with an average capacity of 4 kW by 2030

Regarding the measures indicated in the Hungarian NECP, the Credit scheme of the Hungarian Development Bank offers credit to private persons, apartment blocks and housing co-operatives, subject to a minimum 10% own contribution for the installation of renewable sources of energy, among other measures i.e., PV panels, solar thermal collectors, heat pumps and modern wood gasification equipment.

One of the key decarbonisation tasks in Hungary is the conversion of the lignite fired Mátra Power Plant based on low carbon technologies, thereby the phasing out of coal and lignite from national power generation by 2030. It includes the construction of a new PV power plant and industrial energy storage unit, and the energy recovery of refuse derived fuel (RDF). They also plan to install power generating PV panel systems to partially supply local electricity consumption.

Ireland

Among the key policy measures for renewables, the NECP indicates support efforts to increase indigenous renewable sources in the energy mix, including wind, solar, and bioenergy, and the development of up to 1.5 GW of grid scale solar energy.

Ireland is committed to supporting customers' participation in the energy system and enabling them to sell excess electricity they have produced back to the grid. In this regard, the Government announced a new pilot scheme to support microgeneration in July 2018. This first phase of support for microgeneration is targeting solar PV installation and domestic customers for self-generation and consumption. A grant of up to a maximum EUR 3 800 is now available (max 4kWp + battery) for homes built pre-2011. The new solar PV support scheme also aligns with the recast Renewable Energy Directive which brings the 'prosumer' to the heart of new energy policy across the EU.

The new Renewable Electricity Support Scheme (RESS) is being developed under the aegis of the Climate Action Plan and commits to 70% of electricity from renewable sources by 2030. There will be approximately six RESS auctions up to 2030 to connect circa 13,000 GWh of renewable electricity, in which solar will be a preference category in the first RESS auction.

Ireland is also developing a framework, known as the Renewable Electricity Policy and Development Framework (REPDF), that will guide the development of renewable electricity projects on land which are key objectives of Irish energy policy. The framework will identify strategic areas on land for large-scale renewable generation (50MW+). In addition, the scope will include renewable electricity projects below this threshold (including Solar PV) at a national level.

Italy

The Italian NECP indicates that renewable sources – among them solar PV and CSP, represent the subjects that have sufficient focus among research bodies, a considerable industrial basis and are of significant interest to the system, not only for the 2030 objectives but also and especially in the longer-term view, looking ahead to 2050.

Tax deductions for energy-efficient retrofitting of buildings are currently in place and have played a vital role in the development of energy efficiency and thermal renewable energy sources in the housing sector.

The Conto Termico is also an incentive in place for promoting the production of renewable thermal energy and, at the same time, to permit access by public sector bodies to energy-efficient building works and installations. Concerning the production of heat from renewable sources, several interventions are incentivised. In the case of solar, it is mentioned the fitting of solar thermal installations to produce domestic hot water and/or for the integration of the winter heating system, including linked to solar cooling systems to produce thermal energy for production processes or networking of district heating and district cooling systems.

To promote the widespread use of solar thermal energy, regulations will be also updated regarding mandatory integration of a minimum renewable energy quota in new buildings or buildings subject to major renovation. In addition, to promote the fitting of solar thermal installations that can handle the heat demand in a more flexible and effective way, it will be important to demonstrate the promotion of hybrid systems as a part of the incentives.

Latvia

Latvia is planning to increase the share of RES in the production of electricity by increasing the installed capacity of solar photovoltaic components and by increasing the use of solar energy in the production of thermal energy in heating and cooling.

Electricity operators are offering a broader range of services, including the installation of solar panels and the conditions for payment for the electricity transferred to the network, which is an indication of the general public’s interest in producing electricity for their own use.

Lithuania

The expansion of solar power plants started in 2011 and it is estimated that they will not require modernisation in the 2020–2030 period given their useful life of around 20 years. The installed capacity of solar power plants is expected to increase to 117 MW between 2020 and 2030.

Production of solar technologies will be encouraged by establishing Lithuania as the largest centre of excellence and exporter of solar technologies in the Baltic and Nordic regions.

The development of small energy aimed at consumers who produce electricity themselves is one of the priority activities of the Lithuanian Ministry of Energy. Preconditions, development and production permits and in some cases projects are no longer required, the cost of connecting prosumers to the networks has been reduced, enterprises are allowed to become prosumers, the capacity limitation requirements have been revised, the financial incentives for solar installations have been modified, control accounting has been eliminated, and the investments needed for the sustainable integration of prosumers are provided for in the DSO’s investment plan. The aim is to create a sustainable ecosystem for prosumers and ensure its sustainable development.

Luxembourg

The Luxembourg government is aiming at accelerating the push for renewable energy with a target of 25% by 2030 and supports further development through investment aid and subsidies for private individuals and businesses. The following measures for solar will be implemented:

- Feed-in tariffs: Attractive feed-in tariffs for small installations up to 10 kW should allow all households to fit their own installation. After the introduction of a new category, collective installations in the range of 30 to 500 kW can now benefit from a feed-in tariff. Municipalities will be encouraged to make their roof areas available to cooperatives. More than 100 of these large ‘solar power plants for the people’ are currently in the pipeline.
- Calls for tender: (≥ 500 kW) was launched for the first time in 2018.
- Self-consumption: The ‘30-200 kW’ category for self-consumption will be specifically targeted in the overall photovoltaics approach – attractive tariffs for small installations, special categories for cooperatives for citizen participation, calls for tender for larger and major installations from 200/500 kW – to create incentives for SMEs and office buildings.
- A national solar map will also facilitate the planning of large and smaller solar plants.

Regarding research and innovation, Luxembourg has three research teams in the field of materials research for solar photovoltaics, which are working on the further development of resource-optimised thin-film PV. In addition, Luxembourg is a member of the International Renewable Energy Agency (IRENA) and has applied to join the International Solar Alliance (ISA).

Malta

According to its NECP, the Government increased its efforts to support the deployment of renewable energy, especially photovoltaics, solar water heaters and heat pump water heaters.

Key policies and measures are the extension of current policy framework in the area of RES for the period until 2030 whilst providing new initiatives tailored to local specificities; financial support schemes for Solar PV; and schemes to support solar water heaters and heat pump water heaters.

Netherlands

The Netherlands' NECP foresee a drastic growth in solar energy generation until 2030. The vast upsurge in the established capacity of solar power and wind energy results in investments that account for almost 70 to 80% of total investments in renewable energy between 2020 and 2030.

In the Netherland sustainable energy transition subsidy grant (SDE++) promote the deployment of renewable energy including solar energy projects. Similarly, solar energy generation is also encouraged on a small scale (homeowners) using a VAT refund on the purchase of solar panels and a net-metering scheme in which the electricity from renewable energy generation fed back into the grid is deducted from the electricity purchased from the grid.

Additionally, the government gives strong commitment to upsurge the security of supply of raw materials for the energy transition under the circular economy policy, particularly for the critical metals that are used in the solar PV panels.

The NECP of the Netherlands introduces some social aspects on the transition toward renewable energy projects. For instance, despite the sound aspects towards increased climate neutrality in some parts of the Netherlands, opposition to the emergence of projects including infrastructure, solar farms, and wind farms exists. This is because some residents acknowledge these types of projects as an encroach on their living environment.

Poland

The total installed capacity of the solar-photovoltaic technology is bound to have a growing importance for the National Power System. Photovoltaic sources are expected to achieve economic and technical maturity after 2022 in the sense that they will not require operational support past this date. Per the projections to the National Energy and Climate Plan, the capacity achievable in PV installations is expected to increase to approx. 7.3 GW in 2030 and approx. 16 GW in 2040.

It is of key importance for the current dynamic development of micro-installation, strengthened by dedicated financial support schemes.

To give a boost to prosumer energy production, schemes were put in place, such as ‘My Electricity Bill’ (Mój Prąd) with a pool of funds of PLN 1 billion. The Scheme with the goal to increase energy production from solar sources foresees the co-financing of new 2-10 kW solar photovoltaic micro-installations. It is estimated that 200,000 beneficiaries will take advantage of the subsidies.

Portugal

Portugal has enormous potential to produce clean energy from renewable resources, most of their solar energy resources are not exploited to their full potential. Therefore, the state is considering some reinforcing mechanisms for achieving the target of 80% renewable energy production by 2030.

Based on the Portugal NECP, two main mechanisms exist to support and reinforce solar energy production. First, through the auction mechanism, in which new capacity will be injected into the network. Secondly, through the possibility of promoters to develop network expansion and network operators in the circumstance where there is no reception capacity. The auction mechanism was applied in 2019 and has resulted in a lower price and direct gains of consumers.

Portugal is expecting a drastic growth in solar energy production from 2 GW in 2020 to 9 GW in 2030. Reflecting the forecast evolution of the electricity production sector in Portugal, renewables are projected to contribute at least 80% of electricity generation by 2030, in which solar energy will be accounting for 27%.

Romania

The energy sector in Romania is considered the most significant contributor to carbon emission. The NECP acknowledges that under Romania's long term renovation strategy (LTRS) solar energy generation will be promoted. The adaptation of Law No 184/2018 also established some sort of regulations for the prosumers to promote renewable energy production in Romania. Under this law, prosumers get the possibility to sell electricity to suppliers and they are exempted to purchase green certificates. These promotive regulations are only applicable for small scale renewable energy production.

Romania foresees substantial growth in solar energy production in the next 10 years. Their solar energy production from 170.4 Ktoe (2 GWh) in 2020 will be enhanced to 632.6 Ktoe (7.36 GWh) in 2030. Solar PV installations will be considered on both large scale and small scales (on top of roofs).

Slovakia

In order to achieve RES targets by 2030, it will be necessary to consider operating funds for the production of heat from RES linked to the construction of new solar plants, among other technologies.

In addition, by 2030, it will be necessary to address the replacement of approximately 530 MWe of existing photovoltaic power plants that were connected to the grid between 2010 and 2012. These power plants are subject to contracts with a feed-in subsidy guarantee for 15 years, which means there will be a loss of financial support between 2025 and 2027 and that can be disconnected from the system.

To promote the development of household appliances, it is proposed to continue support through subsidies for the purchase and installation of equipment using RES. Experience from the currently running Green for Households II subsidy programme has so far been positive. This is the National Project of the Slovak Innovation and Energy Agency (SIEA), in which family houses and apartment buildings can apply for support through a voucher for small installations using renewable energy sources. The project is financed from the Operational Programme Quality of Environment.

Slovenia

The generation of electricity in solar power plants represents the greatest developmental and environmentally acceptable potential for increasing renewable electricity generation in Slovenia. In terms of sustainable use of space, it is rational to steer future development towards the priority of integrating solar energy into buildings, where technical electricity generation potential about the available surface area is estimated at more than 20 TWh.

In the solar power plant development scenarios provided by its NECP, different intensities of development are analysed, which increase electricity generation between 0.6 and 1.9 TWh (between 492 MW and 1,650 MW) by 2030 and between 0.9 and 5.4 TWh (between 742 MW and 4,400 MW) by 2040.

The installation of solar power plants on roofs of buildings and in degraded and industrial areas (if the construction of buildings is not rational or feasible) is indicated in the NECP as among the conditions and criteria for the award of investment incentives.

Sweden

The Swedish NECP indicates the following policies and measures to achieve the national contribution to the binding 2030 Union target for renewable energy:

- Changes to investment support for photovoltaic cells connected to the grid, with a maximum of 20% of the eligible installation costs
- Tax deduction for renovation, conversion, and extension applies to the labour costs for house repairs, maintenance, conversions, and extensions. Private individuals can obtain a deduction of around 9% of the investment costs for installing photovoltaic cells or solar heating systems
- The Solelportalen.se web portal, launched by the Swedish Energy Authority, provides owners of small domestic properties and commercial premises with independent, factual information about photovoltaic systems from pre-installation planning to decommissioning. It is intended to help people considering investing in photovoltaic cells to make wise decisions.

- Electricity consumers who have their own small generation plants and who consume self-generated electricity in addition to electricity purchased from the grid are exempted from electricity feed-in charges.
- The requirement for planning consent for many types of installation and solar collector has been removed from the planning and building legislation to facilitate the installation of photovoltaic systems.
- Simplified administration of support for photovoltaic cells.

As for collaboration, Sweden participates in SOLAR-ERAN NET COFUND 1 and 2.

2.6 The pathway analysis on 'Wind energy'

Terminology

Wind is a free, clean and abundant energy source used to generate electricity through **wind turbines** collecting the kinetic energy generated by air flows and powering a generator that supplies an electric current. More turbines are usually joined together into a **wind farm**, which usually extends for several square kilometers of either land or sea to exploit both **onshore** and **offshore** wind.[35]

Wind farms deliver 100% of the energy they generate to the national electricity transmission network. Conversely, **small** (<100 kW) to **medium-scale** (100-500 kW) **turbines** produce electricity for on-site use (households, farms, large businesses and small communities) with surplus electricity fed into the national electricity transmission network. Small and medium-scale turbines, usually installed as single units, also have the advantage of being able to be incorporated into urban and peri-urban locations.

Offshore wind has a greater output than onshore, because over the sea mass there are no obstacles that may slow down the wind. The most prevalent and developed technology is **bottom-fixed or siting turbines**, in the manufacture and use of which the EU is a world leader.

On the other hand, **floating wind turbines**, are more flexible as compared to the former in adapting to the wind direction and the different European sea basins. However, they are still at an earlier development stage, with different floating designs already existing and/or under development.[36] In the future, they are expected to ease the shift away from siting turbines in deeper marine waters.

Background information

Wind, together with other renewable energy sources (RES), will play the most important role to deliver a sustainable energy transition, with offshore wind considered being one the most promising avenues. Because of its advantages, offshore wind can produce clean energy at a competitive cost – and in some cases even cheaper – as compared to fossil-fuel-based technologies.

In 2019 wind energy provided 15% of the total EU electricity consumption (169 GW) and, as of 2017, it employed 300,000 people across the continent. It provides key contributions in terms of energy security and independence, and its added value to the economy is undeniable.[37] Nevertheless, its use needs to increase even more to meet the goal set by the EU Green Deal of producing 50% of European electricity through wind energy.[38]

The EU is a global leader in renewable energy offshore technology and industries and there is potential for further development cost-effectively. EU offshore wind market accounts for 42% (12 GW) of the global market in terms of cumulative installed capacity. It is also a strong

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[35] EU Commission – Onshore and offshore wind.

[36] EU Commission – Offshore Renewable Energy Strategy - Key Technologies.

[37] Directive (EU) 2018/2001 – WindEurope feedback.

[38] WindEurope 2020 report.

domestic market: in 2019, 93% of its operating bottom-fixed offshore capacities were produced within Europe, despite the rising competition from Asian companies. The development of floating offshore wind can give access to 80% of the global offshore wind resources, which are located in waters deeper than 50 meters.[39]

In 2018, the EU Commission approved the recast Renewable Energy Directive 2018/2001/EU, which, together with the Clean energy for all Europeans package, aimed to ensure the EU's role as the global leader of renewables.

Two years later, the Offshore Renewable Energy Strategy followed. It aims to ensure that the EU's role as a world leader in offshore renewable energy production and technologies is preserved and fostered in line with the sustainable energy transition. Moreover, it forecasts that the offshore energy sector could yield significant benefits in the post-Covid-19 recovery and develop exponential growth in the coming decades.[40]

The analysis shows that countries with coastline generally are interested in offshore development, while landlocked countries tend to face constraints in identifying suitable locations with wind potential. Offshore and onshore locations for wind farms and the related ecological concerns in terms of environmental impact, conservation and protected areas are discussed in this report. The issues of acceptance and eliciting participation are mentioned in several NECPs. In terms of absolute values, if NECPs' objectives are met, by 2030 in the EU, there will be an installed wind capacity of 339 GW, split between 268 GW onshore and 71 GW offshore. From a broader point of view, according to the submitted NECPs, by 2030, 33% of the EU's final energy mix will be supplied by RES, which is in line with the EU target set at 32%.[41]

Several Member States already have a significant onshore capacity. For instance, in 2017-2018, within the national production of electricity, wind power accounted for 18% in Spain, 11% in Sweden 11%, 10% in Austria and 9% in Finland 9%. By 2030, Ireland aims to produce through wind energy as much as 70% of its national electricity supply, while Portugal over 30%. By and large, European countries express a great interest in offshore wind development. Notably, North Sea Energy Cooperation and the Baltic countries' offshore wind cooperation appear to be the essential coordination platforms for these efforts. In addition, decreasing prices are foreseen in wind development projections, onshore power maintaining lower cost than offshore wind power.

However, there are several development needs and bottlenecks related to wind power, both onshore and offshore. One of the most urgent is the impacts on the power system from increasing intermittent generation and lacking 'flexibility capacity' to handle the varying supply. To address the latter, it would be required to develop better storage and grid capacity, interconnections and flexible demand, which are generally not in place yet.

Market impacts of policies – such as price effects of subsidies and grants used to stimulate the expansion of RES generation and decommission polluting capacity – create transition issues whose impact keeps evolving continuously as the energy transition progresses.

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[39] ETIP Wind – Floating Offshore Wind.

[40] An EU Offshore Renewable Energy Strategy COM(2020) 741 final.

[41] Wind Europe – NECP analysis: permitting problems still a major stumbling block.

North Seas Energy Cooperation (NSEC)

The North Seas Energy Cooperation (NSEC) supports and facilitates the development of a regional offshore grid and the full exploitation of the enormous renewable energy potential of the region. These are long-term energy priorities for both the EU and the Member States in the region. The European Green Deal stresses the crucial role of offshore RES in meeting EU's 2030 and 2050 climate and energy objectives and emphasises the importance of regional cooperation.

The NSEC consists of 9 countries with participation from the European Commission: Belgium, Luxembourg, France, Germany, Ireland, Netherlands, Norway, Sweden and Denmark. Before Brexit, the UK used to be a member. It will now be invited to participate only in exceptional circumstances when necessary in the interest of the EU.

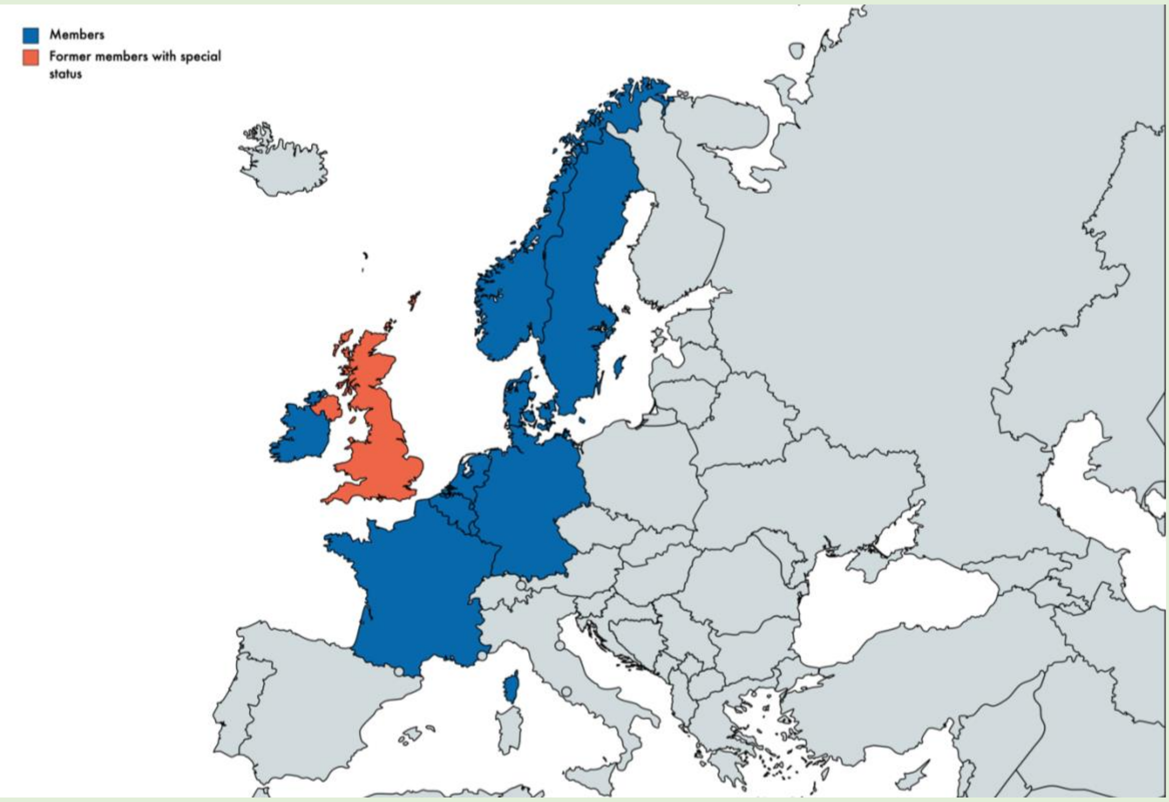

Figure 6. North Seas Energy Cooperation (NSEC)

The wider North Sea region has impressive renewable energy potential; the European Commission estimates that offshore wind energy from the North Sea could cover up to 12% of the EU's electricity consumption by 2030.

The NSEC has identified a list of potential areas and projects in the region where joint projects could be particularly beneficial. The NSEC allows its members to share and exchange tried-and-tested approaches to designing funding programmes and developing new concepts for overcoming new challenges in funding offshore wind energy, and developing potential options for future joint wind energy projects.

In addition to joint offshore wind energy projects, which connect several Member States and are funded by them, the cooperation also includes work on possible 'hybrid' solutions that would use cross-border infrastructures to connect offshore wind farms to the grid. Moreover, it will strive to achieve synergies across countries, enhancing their interconnectedness and work on corresponding market rules.

Offshore wind generation and grid infrastructure projects may have cross-border effects on energy prices, security of supply and the environment, including the availability of marine space and the pace of innovation. The North Seas countries, therefore, have significant benefits to gain from cooperation.

The aim is to coordinate and facilitate further cost-effective deployment of offshore renewable energy, particularly wind, ensuring a sustainable, secure and affordable energy supply in the North Seas countries through increased and better coordinated offshore wind deployment and potential joint or cluster projects.

In terms of research and knowledge sharing, North Seas countries will continue to cooperate closely on maritime spatial planning, environmental research, and cumulative impact assessment of wind farms between responsible authorities for energy, maritime spatial planning and the environment.

The NSEC has identified a list of potential areas and projects in the region where joint projects could be particularly beneficial, such as in the case of wind: IJmuiden Ver offshore wind farm to the UK, German offshore wind farm connected to the Netherlands and the North Seas Wind Power Hub.

Nordic Energy Research (NER)

The Nordic Energy Research (NER) is a platform for cooperative energy research and analysis in the Nordic region under the auspices of the Nordic Council of Ministers.

According to its strategy (2018−2021), NER's vision is to create the knowledge basis for the Nordic countries to become global leaders in smart energy. The mission is progressed through Nordic collaboration. In 2015 NER selected three ambitious projects to serve as 'Flagships' for Nordic research cooperation in energy for the coming 4-year period. One of the Flagships' area covers flexible electricity market design to allow for more wind and solar energy.

Nordic countries already have a regional partially integrated electricity market, which allows them to buy and sell electricity across borders. For instance, Denmark can sell electricity generated from wind to Norway and Norway can sell electricity from hydropower to Denmark.

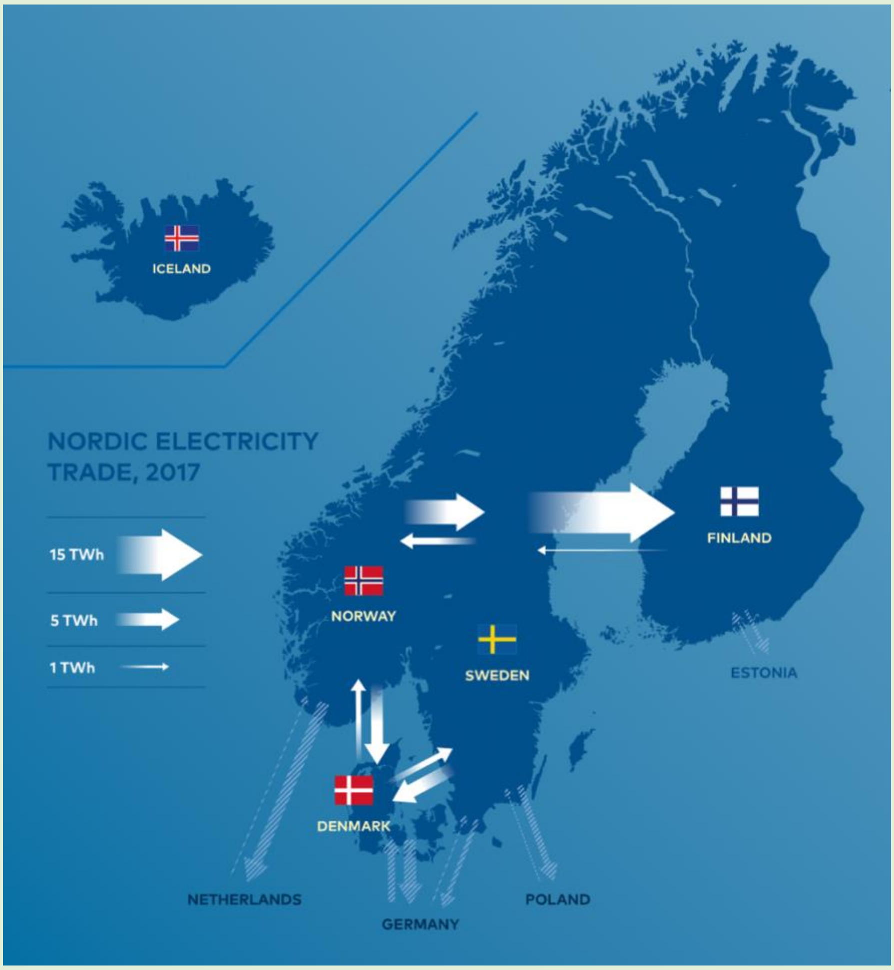

Figure 7. Nordic Energy Research (NER)[42]

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[42] Source of the image: Nordic Electricity Trade in 2017, Nordic Energy Research.

Assessment of wind energy per Member State

Austria

Austrian NECP set for 2020 to increase the share of renewable energy in gross final energy consumption to 34%. In, the share of RES under EU Directive 2009/28/EC was 32.6%. In 2017, Austria had wind turbines with a rated capacity of 2.8 GW, which generate between 6.5 and 7 TWh of electricity each year, corresponding to approximately 10 to 11% of electricity consumption in Austria.

Wind power is growing constantly and rapidly. In line with The Green Electricity Act amendment adopted in October 2019, 622.4 MW of new wind power capacity will be created. The total amount of support funding is EUR 266.5 million.

Although the Federal Act imposes a tax on the supply and consumption of electricity, the electrical energy produced from renewable primary energy sources, e.g., wind turbines, has a tax-free allowance of 25 MWh, with the aim is to support sustainable domestic electricity production through tax measures.

The existing support for green electricity will be revised from 2020 to benefit more renewable generation while funding will be made more cost-effective. In terms of modernising existing wind turbines, previous investments in existing sites will be kept, and it will be possible to continue using it, where it would be technically and economically feasible to do so.

Austria's electrical grid must be capable of absorbing and transporting large and increasing levels of electricity generation from solar and wind power. Mission 2 of the Austrian Climate and Energy Strategy involves utilising a growing percentage of RES, up to 100%, and the development of integrated regional energy systems and grids, which will increase flexibility in energy systems and enable integrating sectors energy sources and infrastructure. Activation of flexibility capacities helps contain the effects of intermittent solar and wind energy in the regional grid and limits the consequence from passing to the overall system level.

National objectives regarding flexibility of the national energy system, the existing capacity that should be used and the existing network infrastructure must take on additional tasks (e.g. power-to-gas, wind-to-hydrogen).

Belgium

In 2017, Belgium's total electricity production was 7,854 ktoe. The share of electricity generated from RES was 17.24%, of which wind accounted for the largest share at 41%. As of October 2018, Belgium had an installed offshore wind power capacity of 1.6 GW. Within the next decade, the federal government plans to install new offshore wind turbines to increase its capacity by 4 GW. Moreover, it programmes to renovate the existing onshore wind power plants and it is considering increasing this type of power generation from 50 to 100 MW per year.

The national "Windkracht 2020" wind plan lists amongst its objectives the support of annual average growth of 150 MWe of additional wind power capacity from 2016 to 2020. This corresponds to 1.5 GW of installed power by 2020, of which 80 MW are likely to be achieved after 2020. According to later forecasts, the average growth for the period 2021-2030 continues at the rate of 59 MW per year for new locations and 49 MW per year for repowering existing locations. Therefore, the installed power will reach 2.5 GW by 2030. According to the last estimates, it is possible to generate 10,081 GWh of renewable electricity, which corresponds to around 37% of renewable electricity production in the final electricity consumption of 2030. 40% of the Belgian target will be achieved through the development of offshore wind power alone.

At the federal level, there are plans for the reinforcement of the energy storage systems to face possible disruption of supply caused by the increasing reliance on wind and solar energy generation.

Belgium is part of the North Seas Energy Cooperation (NSEC) a regional scheme to foster cooperation across North Sea coastal states in the area of renewable energy, increase offshore wind capacity, expand grid infrastructure and maritime spatial planning in the North Sea. Belgium's contribution to NSEC pooled wind power capacity in 2030 is expected to be 4 GW of a planned total of at least 70 GW. Within the NSEC, Belgium has worked to development of a common methodology for assessing the environmental effects of large-scale deployment of wind power to the North Sea to foresee the possible ecological limits of such a project.

Regarding internal regional policies, in the Flemish region, "La note conceptuelle Énergie éolienne 2020" adopted by the Flemish government involves several actions to support wind power development. Budgets are foreseen to stimulate small and medium-sized wind turbines through investment aid (EUR 4.2 million per year) and facilitate the installation of wind turbines on radar/airport sites (EUR 3 million). In the Walloon Region, the local government has enacted the “Pax Eolienica” policy to promote and renovate the regional wind power system. In Wallonia, a Biodiversity fund has been put in place and will be fed by wind promoters, whose revenues will be allocated to biodiversity restoration projects.

Bulgaria

Bulgaria has raised its national ambition for 2030 on the share of energy generated from RES of the gross final energy consumption from 25 to 27%. To achieve this, the country will increase its generating capacity with a particular emphasis on wind and solar power.

In 2018, the production of electricity from renewable sources was 8,583 GWh, with an installed capacity of 5,305 MW. In the same year, energy generated from RES accounted for 33.1% of the national gross final energy consumption. Bulgaria aims to diversify its energy sources to increase the use of renewables, with biomass, solar power and wind power projected to increase by 2030 up to, respectively, 17.1%, 3.8% and 1.5%. In absolute terms, during the period 2020-2030, RES generating electricity capacity is expected to increase by 2,645 MW. This growth will come along with a parallel increase of the net installed capacity of photovoltaic plants by 2,174 MW and wind farms by 249 MW – assuming accelerated technology development and lowering investment costs.

Electricity generated from wind farms is expected to reach 15% of electricity gross production generated from RES although nuclear energy is expected to continue to play an important role in energy production in 2030. According to the WAM scenario[43] projections, between 2020 and 2030, electricity output from wind farms will increase from 1,450 GWh to 2,049 GWh. This

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[43] WAM is the Bulgarian projected scenario with additional policy measures vis-à-vis the WEM projected scenario with existing policy measures.

means both the development of new wind farms and the expansion of the capacity of existing ones. The projected gross domestic consumption of wind power is estimated to rise from 125 ktoe in 2020 to 164 ktoe by 2030 and further to 310 ktoe by 2040.

According to the WAM scenario, investments needed for wind power electricity plants are EUR 57 million during 2021-25 and EUR 213 million in the period 2026-2030. Regarding support schemes, in the period 2021-2030, support will continue to be provided in the form of preferential prices under contracts already concluded for the purchase of renewable electricity generated by power plants with a total installed capacity of less than 1 MW. In the future, wind farms and solar and biomass plants will be constructed in line with market principles, without any investment or operational financial aid to investors.

Among the EU Commission's comments to the Bulgarian NECP are setting more ambitious targets for energy generated from RES – especially solar and wind power – and identifying measures for lowering administrative barriers.

While Bulgaria has suitable weather conditions for the development of renewable energy facilities, there are some specific areas where no facilities of such kind may be constructed. These include, in particular, areas along the boundaries of the protected sites within the Natura 2000 network, where the construction of wind farms is prohibited by the National Action Plan for Renewable Energy Sources (NPDEVI) 2011-2020.

Croatia

The existing wind power capacity in the Republic of Croatia is around 600 MW, while the expected value for 2030 is 1,364 MW. Among the projections of network expansion requirements for 2040 is the construction of a total of 1364-1634 MW in wind farms – an increase of 788 MW-1,058 MW compared to the existing wind farms.

Given the local climate, the Dalmatia region is particularly suitable for the development of wind and solar power, and there is strong investor interest in the construction of new facilities in the region. Before the wind capacity exceeds 1,000 MW, it will be necessary to upgrade the internal 400 kV grid in the Konjsko substation (Split) – Melina substation (Rijeka) to ensure transmission to remote areas. The preparations for the construction of this line have begun.

A first step to encourage RES is good spatial planning, hence analysing the existing state of spatial capacities and defining guidelines and criteria for specific spatial planning elements for RES at the state, county, and local level. This latter will include, for instance, the following activities: analysis of spatial plans with review of planned locations, mapping of resource potential for individual RES (wind, solar, hydropower, geothermal water for energy purposes), possibilities of energy storage from RES and integration into the existing distribution system.

Regarding RES cost, a relatively rapid drop in the levelized cost of electricity generation from solar and wind power is expected to reach the market price level. This implies their rapid integration into the operation of the system without additional incentives.

Cyprus

In 2018, Cyprus produced 220.6 GWh of electricity from wind, which accounted for 8.2% of all RES production. 2030's capacity projection for wind power is 198 MW, which means a 40 MW added capacity compared to 2020.

The Planned Policy Measures (PPM) scenario expects an increase in total cumulative investments in the RES electricity sector (mainly PV, wind and biomass) up to 1 billion EUR. In the period 2021-2030, subside to RES producers are likely to reach an average of 15.8 million EUR per year. According to the PPM scenario (hence without considering the Electricity Market operation), the average subsidy is not expected to change significantly until 2030. For wind farms, there is a provision to compensate with fewer subsidies if the projects exceed a certain limit of production. In the specific, these provisions include that no subsidies will be given to two wind farms after their first 7,000 hours of operation and to all the production that exceeds a certain threshold, while the new wind parks of at least 30MW will receive no subsidy at all. Given these measures, it is expected that the average subsidy will be reduced by 20% owing to all the energy produced from wind parks.

Wind energy is regarded as one of the national R&I priority areas. The EU-funded BestRES project on wind energy by the University of Cyprus/FOSS aims to develop innovative business models for the integration of RES by aggregating distributed generation such as wind, PV, biogas, biomass, hydro, Combined Heat and Power (CHP) and combining these with demand side management and energy storage.

Czech Republic

In 2016, wind power generation in the Czech Republic was 1,867 TJ, with a capacity of 282 MWe. In the same year, the share of RES energy production was very low, with wind accounting for only 0.16% of the gross final consumption.

The expected development of wind power in the electricity production sector for 2030 is 6,460 TJ (970 MWe). However, the operating time of existing wind power plants is not expected to continue until 2030. Therefore, it is necessary for these sources either to be upgraded to remain in operation or to be substituted with new sources.

Support to new electricity plants for the production of electricity from RES will be applied by an hourly green bonus, with a division into electricity plants, which will compete for the support in an auction. For sources up to 6 MW in the case of wind power, support will be provided in the form of a green bonus laid down in a regulatory price decision, and for sources above 6 MW or 6 units for wind power plants, the support will be provided by means of auctions in the form of a mandatory ‘auction bonus’. The duration of the support will remain unchanged over the lifetime (20 or 30 years).

Priority areas of research in the use of wind energy include development of solutions to reduce losses (gearing, etc.) and trouble-free integration into the electricity grid. Funding for wind power plants is seen in the financing programmes Operational Programme Competitiveness (OPC) 2021–2027 and Modernisation Fund.

Denmark

According to the Danish NECP, in 2020 wind energy was expected to cover about 50% the national electricity consumption, while projected wind power generation for 2030 was 10,147 MW.

The share of offshore wind power in the overall renewable energy mix is expected to increase from 3%-point in 2017 to 12%- point in 2030 to 10%-point in 2040. On the other hand, the share of onshore wind power will grow from 5%-point in 2017 to 8%-point in 2030 to 10 pct.-point in 2040.[44] As far as renewable energy share in electricity (RES-E) by technology is concerned, the share of offshore wind power is due to increase from 15% in 2017 to 48% in 2030. The share of onshore wind power is expected to increase from 29%-point in 2017 to 33%- point in 2030 to 34%-point in 2040 (RES-E by technology).[45]

With regards to infrastructure, since the cost of offshore wind is expected to continue to decrease in the coming years, the Energy Agreement of 2018 provides to gradually reduce the number of onshore wind turbines from approximately 4,300 today to a maximum of 1,850 in 2030.

As far as grid integration with regional cooperation is concerned, Denmark coordinated with the other North Seas Energy Cooperation (NSEC) members in relation to the areas pertaining to planned offshore wind deployment until 2030 and the related grid planning aspects. Denmark acknowledges that one of the most important solutions to the problem of fluctuating energy sources is to ensure sufficient interconnections with neighbouring countries. For this reason, it is among the countries in Europe with the strongest interconnectors to neighbours compared to the national electricity demand. Moreover, the Viking Link project, aiming at managing supply fluctuations through interconnectors, will increase the value of wind power. Better possibilities for cross-border electricity trading will contribute to lower wholesale prices for electricity in Great Britain.

In terms of maritime spatial planning and environmental assessment, Denmark will contribute to establishing a common environmental impact assessment methodology within the NSEC. Further work on this topic is needed to be able to utilise the potential of the North Seas.

As far as investments for new infrastructures are concerned, the Danish Energy Agency was responsible for tendering these new offshore capacities: The Horns Rev 3 tender of 400 MW in the North Sea with commercially operative since August 2019, the Kriegers Flak-tender of 600 MW in the Baltic Sea with commercial operation in 2021 and the so-called near shore tender of 350 MW – Vesterhav Nord and Syd – with expected commercial operation in 2023. Also, as a part of the 2012 Energy Agreement, Denmark was responsible for tendering a 28 MW offshore test project at Nissum Bredning.

Offshore wind will continue to increase rapidly, in part due to 3 new offshore wind parks which will generate at least a total of 2,400 MW. The tender for the first park is to be finalised in 2021 and will have a capacity of 800-1,000 MW, while the next two tenders will take place in 2023 and 2025, respectively. Additional tenders for three offshore wind parks of a total of at least 2,400 MW have also been decided.

In 2019 the new Government launched the North Sea Wind Power Hub (NSWPH) project that will screen Danish waters to identify locations suitable for future offshore wind farms and assess the viability for a so-called “hub-and-spoke” concept, an energy island with a capacity of 10 GW offshore wind production that will be connected to a central offshore hub and then to the European mainland using interconnectors. It should enter in force by 2030. Moreover, parties agreed to allocate funds to support large-scale power-to-X technologies up to 30 million DKK in 2020, 27 million DKK in 2021 and 8 million DKK in 2022.

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[44] Austria’s NECP, Figure 30. RES by technology 2017-2040 [%].

[45] Austria’s NECP, Figure 32. RES-E by technology 2017-2040 [%].

Estonia

In 2019, Estonia had an offshore wind capacity of 2.5 GW and expected to increase it by an additional 5 GW. 2030's envisaged electricity production from wind is 2,640 GWh (1,200 MW). More than 4 GW of wind farms onshore and in coastal waters are already in the development stage. After the mitigation of the restrictions, the potential for wind energy development is 300 MW in Eastern Estonia and 850 MW in Western Estonia. The potential offshore wind farms capacity in the Estonian marine area is estimated to be 7 GW divided between Area No. 1 (3,000 MW), Area No 2 (4,000 MW) and Area No 3 (150 MW)

As a result of the added major capacity from the development of the offshore and onshore wind farms, the national electricity system will need to improve connections between West Estonia and its islands.

Preliminary plan for the Estonian marine area

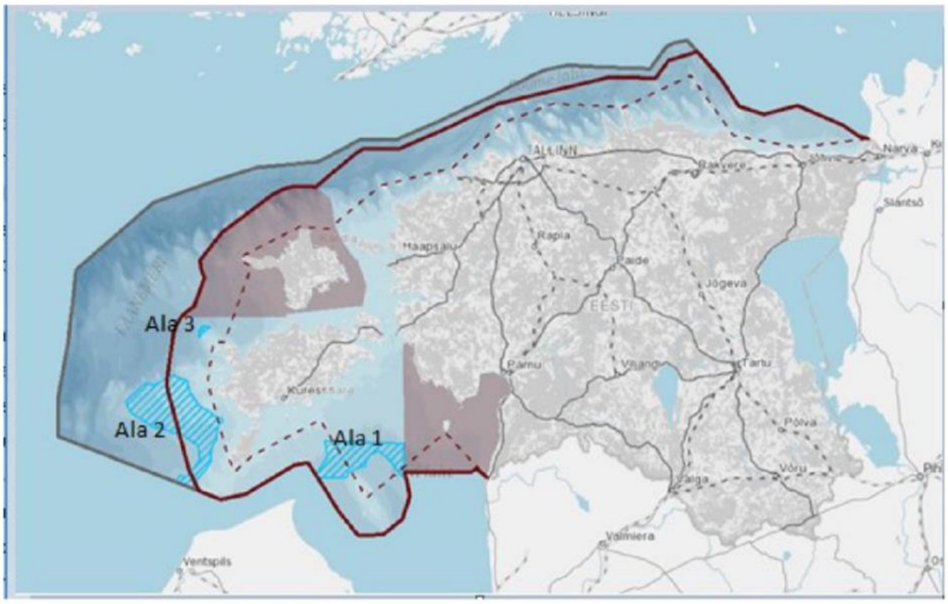

Figure 8. Preliminary plan for the Estonian marine area [46]

Looking to the future, it is expedient for local governments to add guidelines to their comprehensive planning using for planning infrastructure sites (e.g. cable connections of wind farms) related to offshore activities via public procedure on land. On this basis, Elering AS will build the West Estonia Harku-Lihula-Sindi 330/110 kV high voltage overhead line, which is one of the biggest national infrastructure projects, capable of integrating up to 1,000 MW wind farms.

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46 Source of the image: Estonia's NECP, page 77.

The wind energy potential of the Baltic Sea

Figure 9. Eastern part of the Baltic sea

A recent study of the wind energy potential of the Baltic Sea estimates that the total offshore wind power capacity of the region exceeds 93 GW that could be generated through the installation of 187 wind power units, with a capacity of 500 MW each, including respectively:

Estonia: 14 wind parks with a capacity of 7 GW and annual energy production of 26 TWh;

Latvia: 29 wind parks with a capacity of 15.5 GW and annual energy production of 49.2 TWh;

Lithuania: 9 wind parks with a capacity of 4.5 GW and annual energy production of 15.5 TWh.

The conditions for the implementation of the projects will be examined throughout 2021 and 2022.

Cooperation has begun with Latvia to develop joint projects (e.g. a Latvian-Estonian joint wind farm in the Gulf of Riga) that would be eligible for co-financing for developing the connections via the Connecting Europe Facility (CEF). Consultations with neighbouring countries and maritime spatial planning analyses determined the opportunities for regional cooperation on renewable energy and associated technologies, specifically in the development of offshore wind farms on the Estonian-Latvian and Latvian-Lithuanian borders.

Estonia will install air surveillance radars for the development of wind farms, owing to the altitude constraints arising from national defence considerations in force in large parts of Estonian onshore and offshore areas. These are especially stricter in the north-eastern, south-eastern and western parts of the country.). Hydrogen generation from wind is briefly mentioned.

Finland

Domestic electricity generation in Finland in 2018 was 67.5 TWh, of which wind power accounted for 9%, with an installed capacity of 2,041 MW. The promotion of wind power is one of the critical current Finnish energy and climate policy measures. Moreover, it is estimated that Finland's wind power potential will grow due to the expected increase in windiness of the country.

The electricity and heating markets are competing industries, and the government lacks a vision of how each technology's installed capacity will develop in the future. However, assuming 3,200 peak load hours, the wind power volume in the projection with additional measures (WAM) in 2030 would reach an installed capacity of 5,500 MW (equals 18 TWh of the final gross consumption). This expected value is 2.7 times the installed capacity at the end of 2018. Installation of large wind farms requires strengthening the electricity grid at both the local and national grid level.

Finland is part of Nordic Energy Research (NER), a platform for cooperative energy research and analysis in the Nordic region under the auspices of the Nordic Council of Ministers.

In 2016, a survey was conducted to let citizens evaluate different proposals of new policy measures through a system of pluses and minuses. One of the most opposed stated "Finland will prepare to utilise its wind power potential extensively". Despite the high number of minuses (-70), it also got many plusses (+106).

On 31st December 2018 ended the tendering process carried out by the Finnish Energy Authority. Among the 20+ tenders received for new power wind infrastructure, 7 were accepted in the rising price order. According to a report carried out by SKM, the investment cost for wind power is EUR 1.5 million/MW, which in turn means that the overall investment cost would be EUR 600–750 million.

France

In 2018, wind energy accounted for 5.9% of French electricity generation. At the end of the same year, there were 1,808 wind facilities operational across France mainland, Corsica and the overseas territories. The French stock of existing installations accounted for 15,075 MW, of which 1,470 MW generated from 150 wind farms connected to the grid.

French regional distribution of connected wind generation capacity

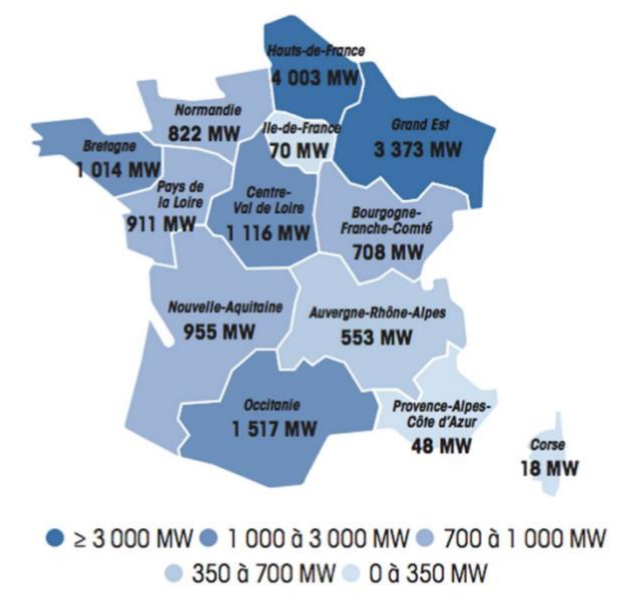

Figure 10. French regional distribution of connected wind generation capacity [47]

French law has set a target of 40% renewable energy in electricity generation in 2030. Electricity generated from Onshore wind and photovoltaic is projected to deliver the most significant renewable generation capacity increases toward this objective. France also aims at increasing its onshore wind generation capacity to a level of 33.2–34.7 GW by 2028 – onshore wind being the technology expected to produce the largest share of renewable electricity.

France is part of the wider North Sea region, an area with considerable potential in renewable energies. According to Commission's estimates, by 2030, North Sea offshore wind could cover up to 12% of the EU's electricity consumption. In 2019, France and the other North Seas Energy Cooperation (NSEC) members agreed to work together toward achieving a joint installed capacity for offshore wind of at least 70 GW by 2030, in accordance with national plans.

France supports the development of wind power and other renewable electricity through a tendering system, so the wind capacity expansion continues on a planned path. Three types of cross-sector actions have been initiated to promote renewable electricity development: the reform of support mechanisms, administrative simplifications and crowdfunding.

Further forthcoming measured regarding onshore wind energy will include, e.g. mandatory recycling of materials used in wind farm components after decommissioning, promoting the reuse of wind farm sites at end-of-life for the installation of more efficient machines,

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[47] Source: Réseau de Transport d'Électricité (RTE), 2018, taken from French NECP, page 189.

simplification the legal framework for permitting the construction of onshore wind farms, addressing light and noise pollution, and augmenting grid management.

Offshore wind turbines (fixed and floating) raise environmental issues related to the biodiversity of the sites, and maritime space uses other than energy production. These issues are governed by the Environment Code's regulations relating to environmental authorisation.

NSEC members joint their efforts in addressing the potential environmental limits to the large-scale development wind projects in the North Sea. However, further work is needed in terms of maritime spatial planning and environmental impact assessments before the North Sea's full potential can be leveraged. The NSEC aligns technical requirements and standards that are likely to reduce further the cost of offshore wind deployments.

French NECP mentions collaboration in several domains, particularly with countries sharing borders with France and those whose energy systems are linked to the French system. The intermittent nature of some of the renewable energies currently in development across Europe heightens the need for interconnections between France and its neighbours and the development of new flexibility tools.

Germany

Projections for 2030 estimate onshore wind electricity to generate 140-145 TWh, with an installed capacity of 67-71 GW, and offshore wind to produce 78-84 TWh, with an installed capacity of 20 GW. As a percentage of the total energy consumption, onshore wind share is expected to account for 19.7% in 2030 and 22.9% in 2040, while the share of offshore is projected at 10.3% in 2030, and 10.9% in 2040.[48]

Under the Regulation on Joint Tendering Procedures for Onshore Wind and Solar Energy – in force since August 2017 – 400 MW a year are being tendered out on a technology-neutral basis for onshore wind and photovoltaics, respectively, between 2018 and 2020. As a result of new special tendering procedures, the tendered quantities for onshore wind and solar will increase from 1 GW per technology in 2019 and 1.4 GW per technology in 2020 to 1.6 GW per technology in 2021.

Special calls for tenders were published as part of the Renewable Energy Sources Act from 2019 onwards, in addition to the volumes of calls for tenders planned up until then as an additional effort towards the achievement of the climate goals. In total, an additional 4 GW of capacity will be tendered out by 2021 for solar and onshore wind, respectively.

On the basis of the expansion of corridor targets, and as stipulated in the Renewable Energy Sources Act 2017, the annual gross increase for onshore wind is expected to be 2,800 MW between now and 2020 and 2,900 MW from 2020 and 2030. The annual increase for offshore wind is expected to be 500 MW in 2021 and 2022 and 700 MW between 2023 and 2025. The increase will accelerate to 840 MW a year from 2026 onwards.

Germany is part of the Baltic Energy Market Interconnection Plan (BEMIP) – Working Group on Renewable Energy, which works towards developing a shared vision for the EU's Baltic Sea coastal states in respect of renewables growth, especially offshore wind, and identifying potential cooperation projects. Potential cooperation projects in the Baltic Sea area include

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[48] Germany's NECP, table B11 p. 135; higher figures in Table B28 page 153.

the shared use of electricity infrastructure for the construction of additional offshore wind capacity.

Germany is part of NSEC, the regional scheme to promote cooperation in the North Sea in offshore wind capacity and expand the grid infrastructure. If follows that Germany's expansion of offshore wind in the North Sea will be carried out within the framework of NECP cooperation, along with a project pipeline which is as well-coordinated and smooth as possible.

Moreover, the NSEC works as a platform for its members to stage work on potential joint projects for offshore wind energy use and 'hybrid projects', i.e. projects where the network and grid connection of the offshore wind farms is used simultaneously as an interconnector and to discharge the electricity generated. In 2019, NSEC coastal states agreed to cooperate towards achieving a shared total installed capacity for all NSEC member states of an estimated minimum of 70 GW by 2030 based on national planning. Germany's indicative contribution to this aggregated capacity for 2030 is 15 GW.

Greece

By 2030, Greece expects to have an installed wind capacity of 7.05 GW with a net power generation of 17.21 TWh. It is estimated that uncontrolled RES (wind power stations and solar parks) shall increase by 2020 to 6.5 GW and 14.7 GW by 2030 (45% of the total electricity supply). It is estimated that 800 MW of cumulative new power from wind energy stations and solar parks will have to be installed on average every year to reach these goals.

The integration of uncontrollable RES plants increases the need for system flexibility. High penetration levels require energy storage for sufficient take-up of the energy generated by RES plants, also depending on the system interconnection level and the conditions of neighbouring systems. Moreover, storage also contributes to adequate system capacity. For RES to become the primary source of energy in the mainland electricity system (and in island systems that will remain autonomous), major system transformation is needed to maintain and strengthen the security of supply.

The substations already constructed by producers (primarily for connecting wind farms) could be utilised based on the pilot project under implementation to cover network distribution lines, hence allowing for connecting more RES plants to the network. This should be accompanied by the modernisation of the regulatory framework in this direction.

The reform of the physical planning framework should identify specific prohibited areas for wind farms and redefine the carrying capacity, with due account taken of environmental considerations. The specific requirements should be associated with the development of the licensing and physical planning framework for offshore wind farms.

In terms of R&I, wind park electrical infrastructures are currently under development, including wind park coupling equipment with network support services, underwater power cables for up to 200m installation and connection to floating wind turbines. As far as offshore wind farms are concerned, these developments are undergoing: pre-industrial fixed-type offshore wind turbines for depths of 50-60m, float type 80-200m depths and floating platform for measurement, floatable wind turbine fastening system for depths of 80-200m, feasibility studies for development of floating wind turbine construction centres.

These projects are carried in relation to the operation and maintenance of wind farms: data collection-processing system for continuous operational control of wind turbines, software for processing large volumes of data from the operation and maintenance of wind farms and analysis of operating parameters, drones or robotics for control and maintenance of wind turbines, evaluation methodologies for the residual life of wind turbines. In terms of small wind turbines, R&I focuses on pre-industrial standards with improved aerodynamic efficiency or low sound footprint, small wind turbine quality control and certification procedures & infrastructures.

Hungary

Hungary total wind capacity in 2020 is 328 MW, accounting for 11.9% of electricity generation from renewables. No target has been set for wind electricity for 2030, but the government plans to increase the share of renewable resources within gross final electricity consumption to at least 20% by 2030.

Ireland

Ireland has ambitious plans for renewable electricity, with 70% of total electricity due to be generated by renewable sources by 2030. The country has significant potential for the production of electricity from RES, specifically onshore and offshore wind and solar.

As part of this goal, Ireland aims to reach at least 3.5 GW of offshore wind capacity and increase the onshore generation up to 8.2 GW from 3.6 GW of 2018. Measures for regulatory streamlining of renewables and grid development aim to develop a high-level network to integrate higher levels of RES-E and that appropriate and timely generation planning guidelines (including wind) and grid connection policies are in place.

A core objective of changes to market trading rules of recent years has been to facilitate a more flexible energy system with increased cross-border trade efficiency and the additional volumes of renewables, DSU and storage required to facilitate decarbonisation.

Related to offshore wind is the development of the National Marine Planning Framework (NMPF), which will set out the Irish Government's long-term planning objectives and priorities for the management of Irish seas over a 20-year period. The plan will cover objectives and planning policies for all the activities taking place in the Ireland's seas, including aquaculture and wastewater treatment, in compliance with the pillars of their economic, environmental and social considerations. The NMPF will also set out the proposed future approach to the adoption of spatial designations for marine activities, including offshore renewable energy development or designated marine protected areas.

The Marine Planning and Development Management (MPDM) bill, which the Department of Housing, Planning & Local Government is working on, seeks to establish into law a new marine planning system underpinned by a statutory Marine Planning Statement and guided by the National Marine Planning Framework.

The Offshore Renewable Energy Development Plan (OREDP) of 2014 identifies resources for increasing indigenous production of renewable electricity. The development of a new OREDP is due to commence in 2020 and to set out the Government’s policy for the sustainable development of offshore RES. The development of offshore wind will take place in three phases.[49]

Phase 1 represents the foundations and early projects for offshore wind and will take place in the first half of the decade. This initial phase requires achieving several key actions and milestones, including ensuring the enaction of MPDM to allow for a consenting regime for offshore wind, and a revision of the OREDP in conjunction with the Marine Spatial Plan to help identify suitable areas for future offshore wind projects. Moving to this plan-led approach, Ireland will designate an Offshore Renewable Energy Development Body. This Body will undertake grid development.

Phase 2 focuses on achieving the 2030 target of at least 3.5GW of offshore wind to be operational and moving towards full decarbonisation. In the latter part of the decade, Ireland will focus on plan-led offshore wind projects using sites previously identified for development, including on the South and West Coast.

Phase 3 looks beyond 2030 with longer-term options. At this stage, Ireland is expected to be able to deploy commercially operating floating wind farms. Ireland will scale up offshore renewable energy to fully decarbonise electricity generation in Ireland. There is an intention to examine whether any surplus generated could be used for interconnection with another market or for export alone. Ireland will demonstrate new green technologies such as the generation of green hydrogen as a by-product from offshore wind.

Ireland is developing a framework, known as the Renewable Electricity Policy and Development Framework (REPDF), that will guide the development of renewable electricity projects on land, which are key objectives of Irish energy policy. The framework will identify strategic areas on land for large-scale renewable generation (50 MW+) with this analysis including a spatial component. In addition, the scope will include renewable electricity projects below this threshold (including wind and solar PV) at a national level.

Ireland is committed to exploring further opportunities for hybrid interconnection/offshore assets as part of the North Seas Energy Cooperation (NSEC) and implementing regulatory arrangements to support new interconnection, including hybrid assets as set out in Action 23 of the Climate Action Plan.

Updated Wind Energy Guidelines are expected to be published by the Department of Planning, Housing & Local Government in H1 2020 following the conclusion of a strategic environmental assessment process. A critical aspect of the new Guidelines will be new noise regulations for wind turbines in line with World Health Organisation recommendations. The Guidelines will also set out clear rules for planning authorities to follow regarding early community engagement and community benefit measures for onshore wind farms.

Italy

In 2017, wind power accounted for 17% of the total electricity generated from renewable sources.

The significant expansion of technologies for renewable electricity production – primarily photovoltaics and wind power – will enable the sector to cover 55.0% of gross final electricity

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[49] Ireland's NECP, p. 87-88.

consumption with renewable energy, compared with 34.1% in 2017. The significant technically and economically feasible growth potential of photovoltaic installations and wind parks, along with the reduction in associated costs, should enable the generation from PV to triple and from wind more than double by 2030.

Growth targets for wind power capacity are to increase 2017's value of 9,800 MW to 16,000 MW in 2025 and 19,000 MW in 2030. These capacities are expected to deliver TWh 17.2 in 2017, 31 TWh in 2025, 41.5 TWh of electricity in 2030. On the other hand, with existing policies, the annual generation from RES-E. National targets for wind for the 2020-2040 period with existing policies are 20.1 TWh in 2020, 21.8 TWh in 2025, 25.1 TWh in 2030, 33.2 TWh in 2040.

Flexibility requires a strong push for new storage systems that give benefits not just in terms of shifting production from the peak of non-programmable renewables (photovoltaics and wind power in particular), but also in terms of providing the system with the actual services needed for security.

Regional cooperation on RES between neighbouring countries (namely, Malta, Croatia, Austria, Greece and France) could be based on sharing projects for the development of sea plants (offshore wind, marine and wave energy plants) and broadening support mechanisms.

Latvia

The amount of electricity produced in wind power plants will increase due to installation of the total capacity of approximately 1100 MW.

For an estimate of the wind energy potential of the entire Baltic Sea region.

Latvia is planning to increase the share of RES to produce electricity by increasing the installed capacity of wind generators and solar photovoltaic components, taking into account the capacity of Latvian electricity transmission networks, which currently allows an increase in the volume of electricity transferred to networks by 800MW.

Whether and to what extent large-scale wind park projects will be implemented in Latvia in the coming years will depend on the need to increase the capacity of the transmission system. Therefore, such an assessment should be carried out by 2023, when the revision of the plan is due. In addition, it is necessary to evaluate the ability of the Latvian energy system to include electricity generated by large-capacity wind parks and to analyse potentially the best technologies for balancing this capacity.

Lithuania

At the beginning of 2019, the total installed capacity of the Lithuanian power system was 3,684 MW, of which the installed capacity of wind power plants accounted for 533 MW. In 2028, the installed capacity of RES power plants is expected to include 1,000 MW from onshore wind power. The objective set for 2030 is to increase the share of RES-E in the gross final electricity consumption to 45%. Wind energy is expected to remain the primary resource for electricity generation, accounting for at least 70%.

Throughout 2021 and 2022, the Ministry of Energy will assess the possibilities of wind energy development in the Baltic Sea and the conditions for the implementation of such infrastructure, based on the previous study of the wind energy potential in the region.

Lithuanian total wind farm capacity is expected to 1,700 MW by 2028, assuming that until 2025 only terrestrial wind farms will be developed, and the construction of maritime wind farms parks (with a 700-1,400 MW capacity) will begin only after 2025. The country is expected to reach an electricity output of about 20.1 TWh by 2040.

To connect the planned wind farm in the Baltic Sea to the transmission network, a 330 kV substation should be built at sea, a new cable line should be built up to the Darbėnai substation and new 330 kV transmission lines Darbėnai–Mūša-Panevėžys should be installed. Further, a new unit of the Kruonis Pumped Storage Plant will address one of the main challenges, the need for flexible, real-time management of imbalances in wind power production.

In terms of investments, tendering and works in progress, Lithuania plans to upgrade 40 existing plants with a total installed capacity of 163.71 MW to preserve its current capacity until 2020. The increase in wind power plant capacities could start in 2023 if wind power plants win the auction launched in September 2019. The total installed capacity of new wind power plants is estimated to increase to 1,322 MW between 2020 and 2030.

The Current support scheme for electricity produced from RES covers the following support measures: A price premium for RES-E; Priority transmission of RES-E; An exemption from responsibility for balancing the produced electricity and/or reserving the power plant’s generating capacity during the incentive period for electricity producers operating a power plant with a capacity below 500 kW. The increase in wind power is expected to result (as the most competitive RES technology at the moment) from the competitive process of auctioning for the development of RES in electricity generation.

Luxembourg

Luxembourg plans to consistently develop wind energy as one of its three key technologies (the other two being solar and biomass) to reach the 25% share of renewable energy in the gross final energy consumption in 2030. Wind energy development consists of a small number of large wind installations, while it is acknowledged that investment may be needed for wind farms.

A large proportion of renewable energy production in Luxembourg already comes from wind power: installed capacity in 2018 was 123 MW from 69 installations. At present, around 10 wind farm projects, some of which have already undergone the strategic environmental assessment and other required impact studies, are in the development and finalisation phase for 2020 and are expected to produce electricity for around 50,000 additional households per year.

The existing feed-in payment/market premium will be continued and existing barriers will be removed where possible. The possibility for municipalities and citizens to make a financial contribution will also remain a key development factor. In the past, this has ensured a very high level of acceptance for wind power plants among the population and will continue to do so.

Malta

Malta’s NECP states that wind energy projects, both onshore and offshore, cannot be successfully implemented in Malta using mature technologies due to significant restrictions in the local context, including technical, social and environmental constraints.

Netherlands

The 2013 Dutch Energy Agreement set the ambition to increase the installed offshore wind energy capacity to 4.5 GW by 2023. The Offshore Wind Energy Road Map 2030 strives to meet this objective at a faster pace, identifying the target of 10.6 GW (49 TWh) by 2030 and between 35 GW (150 TWh) and 75 GW (320 TWh) by 2050.

The Netherland has Missions up to 2050, with specific targets to 2030. The government aims to invest 2.5% of the GDP in R&D and increase the share of private funding allocated to this end. In the domain of wind energy, there is a Multi-annual Mission-oriented Innovation Programme (MMIP) as “Renewable offshore electricity”, with international connections on Offshore Wind IWG, Demowind I and II Ocean Eranet, and Wind Technology Collaboration Programme (part of IEA).

Concerning the energy supply of the Netherlands, it is expected that imports and exports will increase in the period leading up to 2050 due to the strong growth in production capacity based on wind and solar energy. Measures in the Coalition Agreement include increasing parcels for offshore wind energy.

To guarantee the security of the supply despite the high reliance on an energy mix largely consisting of wind and solar power, a growing need for flexibility is required, which will be achieved via the market.

Despite the positive attitude towards increased sustainability within the country, some regions oppose the emergence of, for example, wind farms.

Poland

Poland plans to maintain the leading role of coal as an energy carrier. Nevertheless, to decrease its CO_2 emissions, it will pursue the diversification of energy carriers by successively increasing the share of RES – especially photovoltaics and wind power through offshore wind farms – and by including nuclear power in the energy balance starting from 2033.

Poland's NECP sets for 2030 the objective of 21-23% share of RES in gross final energy consumption (aggregate consumption in the electricity sector, heating and cooling sector, and in transport). To attain this target, RES is planned to be supported through existing and new support and promotion mechanisms. There are also plans to develop offshore wind energy.

In accordance with the projections of the National Plan, the capacity achievable by onshore wind farms is bound to increase to approximately 9.6 GW in 2030, and the volume will be maintained until 2040.

The Polish area of the Baltic Sea offers concrete potential for the offshore wind sector, which the country plans to exploit after 2025. However, to allow full exploitation of offshore wind capacity, the transmission network will need to be modernised and expanded. Moreover, the interconnection and power transmission from offshore wind farms will require the development of offshore transmission capacities. The scope of the necessary investments in transmission networks will depend on the installed capacity of offshore wind farms and the model of their connection to the national power system.

The development of renewable energy is seen positively, as it will translate into new job creation in the wind, solar, bioenergy and other sectors, with positive repercussions for the national, regional, and local labour markets.

Portugal

In 2018, the Portuguese Electricity Production System recorded a gross electricity production of 59.6 TWh. 51% of the total production came from renewable sources, which accounts for 10% over 2017. In addition, hydro and wind power, which together represented around 44% of all national electricity production in 2017, increased in 2018. In 2018, Portugal recorded 22 GW of installed capacity for electricity production, 14 GW of which, corresponding to around 64%, came from renewable technologies.

Renewables are expected to contribute to at least 80% of electricity generation by 2030, with an emphasis on wind energy (31%). In 2030, onshore wind energy capacity is projected to generate 9.0 GW while offshore 0.3 GW in 2030. Onshore wind energy capacity is projected to reach 9.0 GW and offshore wind energy 0.3 GW in 2030.

Portugal has significant untapped potential for wind power development. At the same time, gradually upgrading the existing wind farms can improve competitiveness. The point 3.1.3. of the strategy “To reinforce onshore wind energy” will include new equipment and repowering. As of today, as existing wind farms reach the end of their useful life, they are supplied with more efficient equipment. An assessment of the environmental impact has already been carried out on these sites, and grid capacity is already in place. However, it is acknowledged that it is still necessary to create favourable conditions and a regulatory framework to implement this solution, which is expected to be enacted between 2019 and 2021.

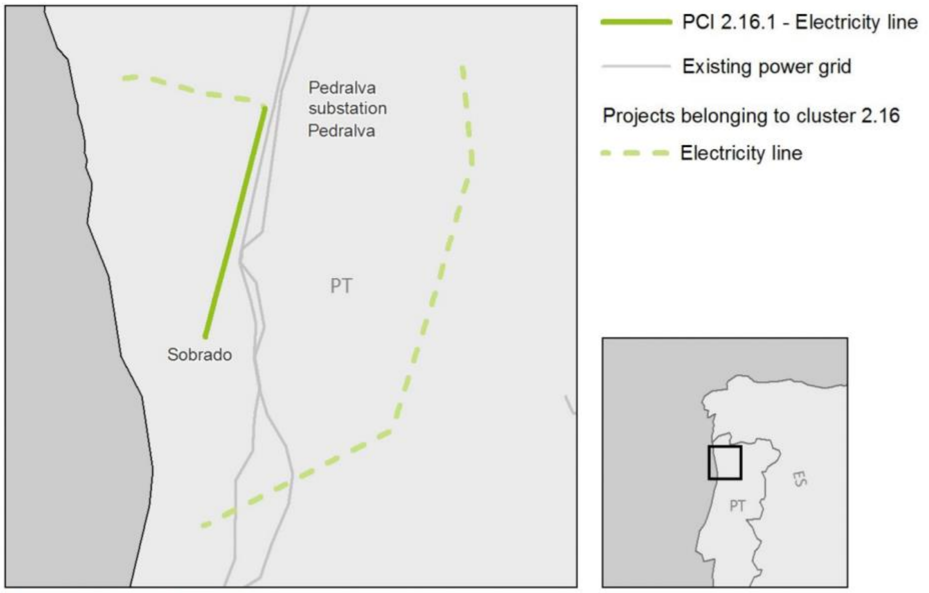
Among the national objectives for promoting offshore wind energy is the development of infrastructure near Viana do Castelo, where investments have already commenced, which is expected to deliver in the first phase 200 MW, 25 MW of which has been allocated to the Windfloat project. This investment aims to encourage national and international investors to maximise this infrastructure to promote offshore wind energy.

The promotion of hybrid systems will provide greater flexibility for the system and greater efficiency in using resources, considering the possibility of complementarity between different sources of energy (e.g. wind and solar), while simultaneously maximising the network connection capacity.

Action strategy 6.1. "To promote the production and use of RES in agriculture and forestry" includes, i.e., technological RES solutions such wind power to be adopted in agriculture and forestry facilities and equipment.

Policies and measures to achieve the targeted level of interconnectivity include implementing new projects to strengthen the network internally. Two projects, classified as Projects of Common Interest (PCI), will be implemented to strengthen the internal network: The Internal line between Pedralva and Sobrado (PCI 2.16.1) and the Internal line between Vieira do Minho, Ribeira de Pena and Feira (PCI 2.16.3). These projects seek to increase the national electricity transmission capacity from RES (mainly from hydro and wind power) in the Minho region. They are also related to the new Minho-Galicia cross-border interconnection, allowing transmission of excess production to this network.

Internal line between Pedralva and Sobrado (PT) – (PCI 2.16.1)



Source: PLATTS, GISCO, European Commission

Figure 11. Internal line between Pedralva and Sobrado (PT) – (PCI 2.16.1)

The project will develop a new 400 kV AC double circuit (OHL) Pedralva – Sobrado of about 67 km (formerly designated Alfena, initially with only one circuit installed), with a capacity of 1630/1860 MVA per circuit correspondent to summer/winter (onshore).[50]

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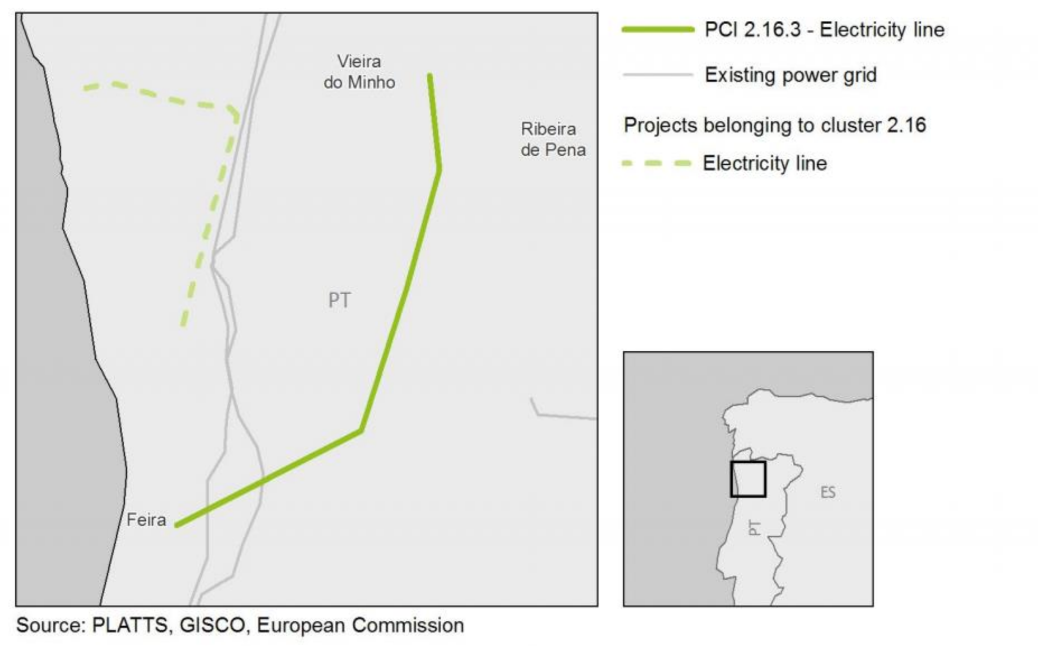
[50] The PCI fiche can be accessed here.

Internal line between Vieira do Minho, Ribeira de Pena and Feira (PT), – (PCI 2.16.3)



Source: PLATTS, GISCO, European Commission

Figure 12. Internal line between Vieira do Minho, Ribeira de Pena and Feira (PT), – (PCI 2.16.3)

The project will construct a new 400 kV AC double circuit (OHL) of about 131 km Vieira do Minho – Ribeira de Pena – Feira, along with the new substation of R. Pena. Capacity is 2x (1630/1860 MVA) (summer/winter) between Vieira do Minho and R. Pena, and 2080/2370 MVA (summer/winter) along R. Pena – Feira (onshore).[51]

Romania

Among the energy and climate policies and measures of Romania to reduce GHG emissions is the Programme for the Production of Energy from Renewable Sources, which lists wind, geothermal, solar, biomass, and hydro.

Wind power is expected to increase from 565 ktoe (2020) to 1,005 ktoe by 2030, while the gross final electricity consumption will rise from 2,228 ktoe (2020) to 3,172 ktoe (2030). Projections for 2030 reflect an increase of up to 5,255 MW in the wind capacities.

Adopting advanced technologies will be conducive to achieving the RES target by developing solar and wind power plants, increasing current storage capacities and digitalisation of the energy system. The replacement of existing conventional power generation capacities with low carbon ones will also result in the further promotion of renewable resources in the production of energy (e.g. the wind or solar).

As regards the security of supply for the energy system, according to the assessments of Transelectrica, the acceptable limits for the power produced from wind and photovoltaic sources are highly contingent on the availability of hydropower and heat regime. From the viewpoint of the flexibility of residual power, hours with high consumption in winter/summer,

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[51] The PCI fiche can be accessed here.

heat minimum/maximum hours, and extreme (minimum/maximum) hydro generation hours are essential.

Slovakia

Slovakia seeks to increase its wind power capacity by 2030 to 250-500 MW. As a land-locked country, Slovakia has only onshore potential for wind. There are currently five wind turbines in operation with a total installed capacity of 3.1 MW and an annual output of approximately 5.5 GWh of electricity. Wind power plants in Slovakia are at a disadvantage in comparison to other sources of electricity.

The installed generation capacity can react flexibly to current system requirements. However, in the Slovak power system, the increasing share of volatile RES in electricity generation may generate problems for the transmission system operator in meeting the required support service volumes in some months of the year. The installed photovoltaic and wind power plants have increased the demand for support services. Then, it will be necessary to ensure the operation of sources with adequate regulating capacities for their further development, such as planned pumped hydropower that provides an excellent balancing option for the output of wind and photovoltaic power.

The priority of R&D for the energy sector is to ensure a sustainable energy supply in the country. This includes the development of technologies for the generation of electricity and heat from RES.

Regarding household investment, after the positive experience from the currently running Green for Households II subsidy programme, it is proposed to continue providing subsidies for the purchase and installation of equipment using RES. However, this subsidy is not currently given to developing wind turbines.

The Slovakian NECP acknowledges that the current EU electricity market is affected by various subsidies and grants that have been applied to stimulate the growth of RES generation, particularly PV and wind, as well as by the use of capacity mechanisms. The Slovak Republic expects that the “Clean Energy for all Europeans” package may protect the security of electricity supply and stability of end-user electricity prices and help to reduce the consequences of transitioning away from conventional resources and provide sufficient investment for new capacities.

Slovenia

Installed wind power capacity in Slovenia is projected to grow from 10 MW in 2020 to 150 MW in 2030. The NECP claims that the required investments measures to develop wind power plants for 2021–2030 amount to 142 EUR million. The unit cost of onshore wind power is expected to decrease steadily during each coming decade up to 2050.

In terms of restrictions and obstacles to wind power, it has to be taken into account that Slovenia tops the list in Europe in terms of the area covered by Natura 2000 sites and the number of protected species and that many of these areas could be suitable for the introduction of RES – mainly hydro and wind power. The possibilities for using wind energy are consequently limited and substantially more restricted than in other EU countries, as

Slovenia does not have the option of setting up offshore wind farms. Moreover, the highly dispersed population settlement patterns further restrict the possibility of using wind power.

In addition to demanding spatial placement processes, opposition to the continued use of hydroelectric power and wind energy in Slovenia is also intensifying in some local communities, the general public and parts of the non-governmental sector.

The target set for a 27% share of RES in 2030 will not be achieved solely through the implementation of projects outside Natura 2000 areas or projects whose environmental impact is likely to be considered insignificant. Instead, to achieve this goal, it will also be necessary to develop hydroelectric and wind power plants, which are likely to significantly impact nature and, therefore, require a procedure to ascertain that public interest takes precedence over the public interest for nature conservation.

Consequently, in the wind power development scenarios analysed, Slovenia remains within the potential of 415 MW, as estimated when the Renewable Energy Sources Action Plan (AN-OVE) was revised in 2015.

As an additional measure to RES development, Slovenia takes a proactive role in identifying and locating environmentally friendly sites for hydro and wind energy and other RES. This process involves the participation of all key stakeholders, defining criteria and locally identifying areas for the more efficient deployment of RES generating facilities, including protected areas and the possibility of carrying out public benefit overriding processes.

Spain

In 2015, wind (onshore and offshore) power capacity in Spain was 22.9 GW and total installed capacity 107.2 GW. For the year 2030, the NECP foresees a total installed capacity in the electricity sector of 161 GW, 50 GW of which will be wind energy.

In terms of spatial planning, submarine electricity transmission infrastructure for planned offshore wind farm locations should be considered and planned in coordination with the Marine Strategies, Maritime Spatial Planning Plans and the applicable sectoral administrative procedures.

The Instituto para la Diversificación y Ahorro de la Energía (IDEA) will coordinate the drafting of a "Spanish Strategy for the development of offshore wind energy" the conclusions and objectives of which may be incorporated into the periodic reviews of this National Plan.

Specific measures for the adaptation of the electricity grids to integrate renewables will have to consider that the renewable technology with the highest share in the electricity system is wind energy without storage, which is a technology with low capacity for manageability. Its share of the whole electricity generated in 2017 was 18.2%. This level of integration of renewables has been possible thanks to the Special Regime Control Centre (CECRE) of the Red Eléctrica de España (REE).

In terms of maritime strategy, the current projects include wind power measures: Strategy for the North and South Atlantic Demarcation / the Strait and Alborán / Levantine/Balearic demarcation / Canary Islands demarcation. Among the measures listed is developing new facilities for generating electricity using renewables to demonstrate projects for technologies under development (offshore wind and marine energy) and future offshore wind farms.

As far as infrastructures are concerned, there are plans for the technological upgrading of existing electricity generation projects with renewable energies (including wind farms), including ad hoc mechanisms, coordination committees and calls for tenders for the allocation of a specific remuneration scheme for technological upgrading projects.

A short-term opportunity has been identified that would have the use of Spanish islands as drivers and ‘spearheads’ for the deployment of offshore wind, associated with the incorporation of storage requirements and support for the electricity system, with a greater impact on reducing GHG emissions and even avoiding current costs for the electricity system associated with the General State Budget.

Sweden

Electricity consumption in Sweden fell from 151 TWh in 2005 to 145 TWh in 2017. In 2017, 96 TWh of electricity was generated from renewable sources. The largest share, 66 TWh, came from hydropower, followed by 17.2 TWh from wind power. Sweden aims at achieving 100% renewable electricity by 2040 and net zero emissions by 2045. The installed capacity for wind power is expected to increase by 5 GW between 2017 and 2030. There is no information on the division between new capacity and repowering. Key policies and measures for achieving the 2030 climate goals regarding wind energy are expressed in the national Wind Power Initiative.

Sweden is a member of the North Seas Energy Cooperation (NSEC), a forum for regional cooperation founded in 2016. One of the objectives of NSCE is to foster cooperation among its members to produce joint strategies for cost-effective expansion of offshore wind power in the North Sea region.

The Government launched the Fossil-Free Sweden initiative in 2016 to improve dialogue between the Government and business, municipalities, other public operators and civil society.

The Swedish Energy Agency and the Swedish Environmental Protection Agency are working together to develop a Strategy for sustainable expansion of wind power. Such higher reliance on wind power will be required to achieve the target of 100% renewable electricity generation in 2040 under the Energy Agreement. The Strategy will take account of factors such as resource efficiency, human health and environmental impact. The Strategy is an initiative of the Environmental Objectives Council, which coordinates the approach of state operators to wind power and produces guidelines for balancing various interests. The Council is also drafting a wind power plan, which breaks down the national wind power requirement to regional and municipal levels. It began the work in 2018 and is due to report on it in spring 2020.

In 2015, the Government introduced a maritime spatial planning regulation (2015:400), which involves the Gulf of Bothnia, the Baltic Sea and the North Sea. These plans must ensure the sustainable use of marine resources and development of the industry while improving the marine environment. The Swedish Agency for Marine and Water Management must work with the Swedish Energy Agency to develop ways of harnessing offshore wind power and wave energy.

The Swedish Energy Agency is responsible for declaring national interest for energy generation and energy distribution, which must be of particular national relevance. Such an analysis has been very important for evaluating wind power vis-à-vis other town and country planning interests.

Electricity consumers who have their own small generation plants and who consume self-generated electricity in addition to electricity purchased from the grid, are exempt from electricity feed-in charges.

The Swedish NECP recognises that phasing out of nuclear power, with additional electricity production being primarily generated by wind and solar power, poses a challenge for the stability of the electricity system and thus increases the risk of disruption if no action is taken. This is due to the fact that system inertia decreases as a result of the phasing-out of nuclear power, while additional electricity production, primarily from wind and solar power, does not naturally contribute to system inertia.

III FRAMEWORK DEFINITION

The framework definition will be performed together with the stakeholders. The selected frameworks will be the basis for prioritization of the piloting pathways, approach planning and defining the targeted impacts of the activities. The framework definition will feed into the Deliverable 2.4 Recommendations.

IV PRIORITIZATION OF PILOTING PATHWAYS

Prioritization of piloting pathways will be performed later during the project. The piloting will be carried out with the workshops together with the EERA Joint Programmes and by receiving feedback from the stakeholders in order to assess the relevance and define possible gaps (technological, regulative, social…).

The preliminary schedule of the upcoming activities is following:

- Gap analysis and comparison between the NECPs and SET Plan Implementation Plans / Summer 2021
- Including the national Long-Term Strategy into the analysis / Autumn 2021
- Physical workshops jointly with the EERA JP workshops to continue and promote the dialogue and cooperation model between industry and energy experts and to map the pathways with industrial stakeholders and Set Plan Implementation Plans / Autumn 2021 / Autumn 2022
- Developing the facilitation framework, how to best pilot the selected key cases, i.e. to support dialogue and exchange (of best practices, challenges, gaps) between key stakeholders (academia & industry) to define recommendations on the selected pathways, with the final objective to bring technologies closer to the market / Autumn - 2021

V WAY FORWARD

This report will be complemented by the later activities within SUPEERA WP2 and the *Deliverable 2.5 Update of consolidated common and regional pathways in NECPs and stakeholders mapping* (M36, December 2022) will present them. These include the piloting of the pathways, providing coordinated input to decision-makers on systemic and cross-sectorial solutions to support the Clean Energy Transition, and finally delivering sectorial, cross/systemic recommendations on R&I priorities to support the uptake of new technologies by the industry (Deliverable 2.4, M40 April 2023).

ANNEXES

Annex 1. The analyses of the EC assessments on the NECPs.

ANNEX 1. THE ANALYSES OF THE EC ASSESSMENTS ON THE NECPS

The analyses made by SUPEERA (Tables in alphabetic order of the Member States).

European Commission's assessment of the final NECP of Austria

STRUCTURE

1. Consideration by the Commission on the implementation of the recommendation from 2019

The October 2020 assessment document includes a general overview of the implementation of the Commission recommendations from 2019 in the final NECPs.

2. Assessment of the final NECP (objectives, contributions, measures, impact, investments)

This section consists in a general summary of the planned measures, divided by areas (Decarbonisation, Renewable energy, Energy efficiency, Energy security, Internal energy market. Research innovation and competitiveness..), with an evaluation on the basis of targets, implementation and Impact. The document focuses on the trajectories outlined to achieve the described targets, however never going into too much detail technology-wise. It is and update of the 2019 Report.

3. Guidance on the implementation of the NECP linked to the recovery plans from the Covid-19 crisis

This section addresses the link between the final plan and the recovery efforts from after the Covid-19 crisis by pointing at possible priority climate and energy policy measures Austria could consider when developing its national recovery and resilience plan in the context of the Recovery and Resilience Facility.

4. Annexes:

- I: Potential funding from EU sources to Austria, 2021 – 2027

- II: Detailed assessment of how Commission recommendation have been addressed

CONTENT

2019 Recommendations and Assessment of the final NECP by the Commission

Here following a summarized table, including the 2019 Recommendation from the Commission and the evaluation of the implementation of those recommendation within the final version of the NECP together with the assessment of the final NECP.

	NECP	Related Recommendation and evaluation on its implementation	Assessment
Renewable Energy	The national contribution to the 2030 EU renewable energy target is specified in the plan and the **renewable share** is set at 46–50% in gross final consumption of energy in 2030.	On **renewables**, Austria put forward a share of renewable energy of at least 46% as contribution to the Union's renewable energy target for 2030. ➔ Fully addressed	Austria has provided the trajectories and improved renewables (RES) target.
		Austria includes an indicative trajectory in the final integrated national energy and climate plan that reaches all the reference points ➔ Fully addressed	Included

	The focus of the renewable energy dimension is on the **electricity sector**, where Austria aims to use domestic renewable energy sources to cover a large share of its electricity consumption. Excluding the electricity needed for certain activities, Austria aims to reach a target of 100% renewable electricity. It is estimated that another 27 TWh of renewable energy would be needed to achieve the goal of 100% renewable electricity.		
	For **heating and cooling**, the NECP provides information on the contribution of renewables consumed in that sector to the overall share of renewable energy. However, the plan does not specifically set out how Austria intends to increase renewable energy in heating and cooling.	Austria put forward trajectories and corresponding measures in the heating and cooling sectors to meet the indicative target ➔ Partially addressed	An indicative trajectory by sector is provided. The plan is in line with indicative 1.3 and 1 percentage points as an annual average calculated for the periods of 2021 to 2025 and 2026 to 2030 respectively, including the role of waste heat.
	For **transport**, Austria did not provide a detailed listing of the contribution of different types of biofuels pursuant to the accounting rules. The main additional contributions to achieve the minimum target of 14% renewables in **transport** in 2030 will come from increased e-mobility. Austria will maintain the use of biodiesel, increase the use of bioethanol and include a share of advanced biofuels.	Austria put forward trajectories and corresponding measures in the transport sectors to meet the indicative target ➔ Partially addressed	Specific targets for road transport electrification and use of biofuels are provided, without specifically addressing the use of gaseous transport fuels such as hydrogen and (sustainable) natural gas.
Energy efficiency	Austria aims to improve its contribution in terms of **primary energy intensity** by 25-30% compared to 2015. The NECP contains a range of measures on **energy efficiency** of transport, including support to i) multimodality, ii) rail transport and iii) road transport electrification.	Review its contributions and identify additional policies and measures that could deliver further energy savings by 2030 in view of the need to increase the level of efforts in order to reach the Union's 2030 energy efficiency target. ➔ Partially addressed	The contributions are slightly lower than in the draft plan.
	The plan provides descriptive information on **policies and measures** beyond 2020 mainly targeting the transport and building sectors. The NECP provides the amount of the required **cumulative end-use energy savings** to be achieved by	Clarify its national contribution, which is currently open to two different options, and express it in both primary and final energy consumption ➔ Not addressed	Contributions still set as a range.

	31 December 2030 – 11.878 ktoe (a slight revision upwards from the draft plan).		
	As regards **energy efficiency in buildings**, the plan specifies that a new energy saving target for 2021 to 2030 was set for federal government buildings		The information provided on the renovation of buildings is improved.
Energy Security	According to the Austrian NECP, the ongoing transformation of the energy system, with an objective of **100% renewable electricity** by 2030, is deemed as effective in reducing Austria's reliance on imported fossil fuels.	Set out concrete objectives on the diversification of oil and gas and on supply from third countries on the reduction of energy import dependency. ➔ Not addressed	Austria has not set any specific objectives. The NECP only stresses the expected benefits of the envisaged 100% RES share in electricity, and envisages investments into storage and capacity reserve but does not quantify these measures.
	The plan envisages further investment in **storage** and network infrastructure.		
	The plan mentions the **emergency plans** for gas, electricity and oil, provided for by the applicable sectorial rules.		
Internal Energy Market	Austria sets an **interconnectivity level** of 15.3% for 2030, which it already achieved in 2017 and which is above the EU-level target of 15%.	No recommendations (n/a)	

Research, Innovation and Competitiveness	Austria has ambitious national objectives and funding targets, specifically on **energy-related research and innovation** (R&I), formulated as part of its '#mission2030' and 2050 energy research and innovation strategy covering the entire field of energy transition and adjacent fields. Connections with the **SET Plan** are well explained.	Further clarify national objectives and funding targets in research, innovation and competitiveness, specifically related to the Energy Union, to be achieved between now and 2030, so that they are readily measurable and fit for purpose to support the implementation of targets in the other dimensions of the integrated national energy and climate plan. ➔ Largely addressed Underpin such objectives with specific and adequate policies and measures, including those to be developed in cooperation with other Member States, such as the European Strategic Energy Technology Plan. ➔ Partially addressed	The plan identifies relevant areas where research and innovation measures are needed. The cooperation with the Strategic Energy Technology (SET) Plan is well explained.
	The NECP expects **public spending** in energy research initiatives to leverage around EUR 2 to 2.5 billion of private investment in energy and mobility innovation in Austria by 2030.		
	The NECP notably considers **renewable hydrogen** as a key technology for sector integration and coupling. The plan sets a concrete target for renewable electricity-based hydrogen consumption of 1.1 TWh (4 PJ) in 2030.		

	As regards **competitiveness**, Austria believes it has huge potential to build on past innovation success to develop and implement innovative technologies and solutions. The policies and measures in the final plan describe the priority actions of the energy research plan, spelling out Austria's energy research and innovation strategy.		
Investments	The plan estimates the **investment needs** until 2030 by investment areas (between EUR 166.449 and 173.449 billion), mainly allocated to i) the transport sector (EUR 97.183 billion), followed by ii) the energy system (EUR 31.547–38.547 billion), iii) heating and cooling (29.728 EUR billion) and iv) innovation, research and development (EUR 6.971 billion).	Provide a general overview of the investment needed to modernise its economy by reaching its energy and climate objectives. ➔ Partially addressed Provide a general assessment of the sources of that investment, including appropriate financing at national, regional and Union level. ➔ Partially addressed	The recommendation to provide a general overview on investments needed is largely addressed, although the methodology applied is not clearly described. The recommendation on the sources of investment is partially addressed as the provided information is very general and information is lacking in detail on how to stimulate private investment and how to use financial instruments.
Regional cooperation		Continue regional cooperation, including consultations with neighbouring countries, both with a view to finalising and implementing the integrated national energy and climate plan, notably in the context of the Central and South Eastern Europe Energy Connectivity (CESEC) High-Level Group and the Pentalateral Energy Forum. ➔ Partially addressed	Information has been provided on cooperation in the Pentalateral Energy Forum in the preparation of the NECP, highlighting various areas of the Energy Union where members will cooperate. However, no further details were provided about the cooperation in the Central and South-Eastern Europe Energy Connectivity (CESEC) High-Level Group.
		Especially considering Austria's role as a regional gas hub. ➔ Partially addressed	Regional cooperation with regards to gas trade and infrastructure is not addressed, except briefly in the context of PCIs.

Guidance on the implementation of the NECP and the link to the recovery from the Covid-19 crisis

Main points:

- On **renewables**, Austria committed to achieving a share of 46%-50% renewable energy in gross energy consumption as well as a share of 100% renewable electricity.
- On **energy efficiency,** Austria would benefit from adopting and implementing additional policies and measures that would deliver additional energy savings by 2030. Following up on the NECP's recognition of the 'energy efficiency first' principle, it is necessary to ensure the principle is applied in practice.
- With regard to **energy security,** Austria is invited to set out concrete objectives on diversifying oil and gas and on supply from non-EU countries as well as on reducing energy import dependency. The intended increase in the share of renewable energy sources will require a higher degree of resilience and flexibility for the national energy system.
- Austria's plan forcefully links the **research, innovation and competitiveness** priorities both in terms of the different time periods for 2030 and 2050 and with activities at European and international level. In order to quickly and effectively fulfil those priorities concrete investment and action plans with clear timelines, budget allocations and a number of key performance indicators would nevertheless help to define the way forward.
- On **regional cooperation**, Austria has been rather proactive, notably in the context of the Pentalateral cooperation. Austria is invited to continue ongoing efforts with a view to intensifying exchanges and initiatives facilitating the implementation of its national energy and climate plan, in particular as regards relevant cross-border issues. Austria is also invited to better exploit the potential of the **multilevel climate and energy dialogues.**
- The final plan constitutes a strong basis for Austria to design climate and energy-related aspects of its national recovery and resilience plan and to deliver on broader European Green Deal objectives.

Key areas indicated by the Commission to be considered when developing the national recovery and resilience plan:

1. **Measures** to significantly **reduce greenhouse gas emissions** in view of Austria's shift to climate neutrality, including reforms of energy and transport taxation, and measures to promote sustainable mobility, including e-vehicles;
2. **Measures** to **develop renewable energy sources**, including the generation of renewable methane from biomass and renewable hydrogen, and upgrading the energy infrastructure;
3. **Measures** to **increase energy efficiency in buildings**, in particular through large-scale renovations and investments.

European Commission’s assessment of the final NECP of Belgium

Ref. docs:

https://ec.europa.eu/energy/sites/ener/files/documents/staff_working_document_assessment_necp_belgium.pdf

https://ec.europa.eu/energy/sites/ener/files/documents/summary_of_swd_assessment_necp_belgium_en.pdf

Assessment and recommendations of the final NECP by the European Commission

	NECP	Related assessment & recommendations on NECP implementation
Decarbonisation: **GHG emissions & removals**	• The final NECP includes Belgium's binding national 2030 target for GHG emissions reduction in sectors outside the EU Emission Trading System (non-ETS sectors) (-35% compared to 2005). • Operationalisation in the form of quantified annual emission allocations for 2021-2030 varies among regions. • The federal strategy is designed to support the regions in their transition to a climate-neutral society with a reduction in GHG emissions and removing carbon through natural sinks. The Flemish region intends to move towards full climate neutrality by 2050, while the Walloon and Brussels-Capital Regions aim to achieve carbon neutrality by 2050. • Concerning Belgium 2050 objective, there are references to long-term strategies at the level of each federated entity.	➔ Partially addressed • Achievements in the different regions differ (Wallonia -36.8%, Brussels Capital Region -39.4% and Flanders -32.6%) and collectively, they result in an expected shortfall of 0.6 percentage points by 2030. The Flemish contribution is lower than the -35% included in the draft NECP. • The NECP estimates that Land Use, Land Use Change and Forestry (LULUCF) will remain a net sink between 2021 and 2030. The scenario projects a slight contraction of carbon absorption rates between 2015 and 2020. Yet, over the entire period from 2015 to 2030, sink capacities are projected to increase by 3%. Belgium (along with the Flemish and Walloon regions) commits to the no-debit rule for 2021-2030, using domestic action. However, the NECP does not report any accounted LULUCF emissions as referred to in Regulation (EU) 2018/841. This means that no conclusions can be drawn about the LULUCF commitment for 2030, nor on Belgium’s intention to use the flexibility from the Land Use, Land Use Change and Forestry (LULUCF) to the effort sharing sectors. • The long-term strategies address most of the elements required under Article 15 of the Governance Regulation, though some of them only partially. • In absolute numbers, the NECP expects ESR emissions to fall from 78.6 Mt CO2 eq. in 2005 to 52.7 Mt CO2 eq. by 2030. Over the same period, ETS sector emissions are set to fall from 66.6 Mt CO2 eq. in 2005 to 59 Mt CO2 eq. by 2030. The latter value hides a significant projected increase in emissions after 2025, following the planned phase-out of nuclear production, combined with the fact that coal has already been phased out successfully in Belgium.

Decarbonisation: **Renewable energy**	• National contribution to the 2030 EU renewable energy target is specified in the plan and the renewable share is set at 17.5% of gross final consumption of energy by 2030. • In the electricity sector, Belgium aims to cover a 37.4% share of its electricity consumption from renewable energy sources by 2030. • Heating and cooling: the aggregated share of renewable energy for Belgium is set to reach 11.3%, compared to the expected share of 8% by 2020. • Transport target: contributions of all eligible fuels amount to 23.7%.	➔ Unambitious/unclear • Contribution to RE targets falls below the share of 25% by 2030 • The indicative trajectory shows that, until 2025, Belgium remains below the 2020 baseline; furthermore, by 2025 the overall renewable share will not have reached at least 43% of the total expected increase in the share of renewables for 2030. Due to the missing link to the impact and timeframe of the policies and measures, their consistency with the targets and their credibility cannot be assessed. Specifics: ➔ Electricity: not clear how target was calculated from the data provided by the federated entities. ➔ Heating and cooling: the average increase is lower than the expected 1.3 and 1 percentage point annual average increase for 2021-2025 and 2026-2030 respectively, with no detailed information of the constraints being perceived. Although the role of waste heat is mentioned in the different regions, the plan does not specify if it is included in the national heating and cooling renewable share. It is not clear how this target was calculated. ➔ Transport: the plan does not clearly show the calculation that will enable Belgium to reach 23.7% of renewables in transport by 2030. If the planned biofuels incorporation were not feasible, the plan mentions 'alternative measures' without specifying what they are. Furthermore, the amount of electricity expected to be consumed in transport and the split between the amount consumed in road and/or rail is not mentioned.
Energy efficiency	• Belgium's national contribution to energy efficiency for 2030 is 42.7 Mtoe (primary energy) and 35.2 Mtoe (final energy consumption), respectively -15% and -12% versus PRIMES2007 projections for 2030. • Belgium sets the cumulative savings target to be achieved at the level of 185 TWh (15.9 Mtoe) by 2030 or an average of 3.3 TWh (284 Ktoe) of new annual savings.	➔ Incomplete • The plan presents relevant policies and measures to achieve the targets but could be complemented with other actions removing existing barriers to renovation (e.g. skills in construction sector, building permits). • Belgium has not yet submitted its federal level long-term renovation strategy. • The plan provides descriptive information on policies and measures beyond 2020 targeting all sectors. Buildings and transport are the sectors most explored, with a full list of new measures that nonetheless lack full consistency between federal and regional levels and between regions. These policies and measures are credible, but it is not possible to assess fully whether they are sufficient to meet the target, given the lack of comprehensive and consistent data from the federal and regional governments. It is welcome that all three regional strategies seem to rely on continuing and stepping up existing measures. This should ensure that savings will materialise immediately from 2021 onwards.

		• Buildings sector: the targets envisaged (from 85 kWh/m2/year to 100 kWh/m2/year) seem realistic, but they are probably insufficient to decarbonise the building stock by 2050. Moreover, they do not fully reflect the potential of the building sector in Belgium
Energy security	• Maintaining high levels of security of supply is a priority in the ongoing transformation of the energy system, with an objective of 37.4% renewable electricity and increasing shares of domestic renewable energy of 17.5% in gross final consumption by 2030. When considering risks, the plan takes into account the plans of other connected Member States. • Diversification of sources and routes: Belgium has access to different supply sources of natural gas, both via pipelines and from LNG. However, dependency on energy imports is set to increase from 71% in 2020 to 86% by 2030, mainly as a consequence of changes in the energy mix. • Belgium has confirmed its intention to phase out nuclear energy by 2025. An increase in the country's energy dependence is expected after this phase-out. To replace 6 GW of nuclear capacity, the energy production mix is expected to make use of flexible capacity, storage and renewable energy sources. The plan anticipates policies for dismantling the nuclear power plants and for radioactive waste management.	➔ Incomplete • Policies and measures planned are not described in enough detail. • The plan lacks detailed information on further measures and investments in electricity storage, demand-response and other flexibility measures. • It does not include any consideration of cybersecurity in the energy sector. • The plan makes adequate links with the emergency plans for gas, electricity and oil, provided for by applicable sectorial rules.
Internal energy market	• Belgium set an interconnectivity level of 33% for 2030, which exceeds the target set at EU level. Currently, the electricity interconnection capacity is 24%. • The plan lists projects of common interest in the electricity field, which will help reach the declared 2030 electricity interconnection capacity objective. • Belgium reports the share of the population that experiences energy poverty. These figures give estimates for Belgium as a whole, as well as for the different regions. Several measures already exist to counter energy poverty. There is an intention to	➔ Incomplete • Given the electricity sector target of 37.4% renewable electricity by 2030, the NECP lacks a detailed overview of the development of the different sources of flexibility that are necessary to integrate the rising share of renewable energy into the electricity system. • The plan lacks specific policy objectives and measures related to the internal energy market (in particular related to the non-discriminatory participation of renewable energy, demand/response, storage, aggregation, real-time price signals, smart grids, consumer protection and competition of the retail energy market). These measures are not considered to be sufficiently detailed in relation to the achievement of the objectives. • Input on expectations on the development of market concentration has to be developed.

	continue these measures and to refine them and make them more effective.	• The plan provides an inadequate overview of current market conditions for gas and/or electricity, in particular with regards to levels of competition and liquidity of markets. • Energy poverty: policies and measures - in relation to the achievement of the target - are credible. However, no quantitative objective is provided for the reduction of energy poverty.
Research, innovation and competitiveness	• The plan identifies relevant areas where research and innovation efforts are focused. • The final plan reflects Belgium interest in deploying renewable and low-carbon hydrogen technologies. • Competitiveness: emphasis at national level is put on competitive energy prices, through the measure named ‘Energy Norm’, which ensures that energy prices are comparable to those of neighbouring countries. • Cooperation with the strategic energy technology (SET) plan is taking place through active participation in several Implementation Working Groups and partnering in ERANET projects. It is coordinated among federal and regional entities in the consultation platform BELSET.	➔ Incomplete • Areas of smart specialisation are well described and consistent with their policies and measures spelled out across the plan. • Information on public investment in R&I is provided. Efforts are considered sufficient, although their credibility is limited in relation to the achievement of the target, because R&I objectives remain at a generic level, not specific enough to be measurable. • Their impact is not always sufficiently described to assess to which extent they will contribute to the objectives set in the other dimensions of the plan. • No information can be found regarding private R&I investment (except for a rough estimate for Wallonia). • Belgium has set no quantifiable objectives on national competitiveness of specific energy technology sectors, but the regions (mainly Flanders and Wallonia) have identified priority sectors and have developed a policy on clusters to improve their competitiveness. • Information on patents is lacking and only Wallonia reports on the number of researchers.

Guidance on the implementation of the NECP and the link to the recovery from the Covid-19 crisis

Main points:

- **General recommendations:**
  - Final NECP falls short of a **fully integrated and coherent plan** that would constitute a common vision and a more useful tool to facilitate cooperation between the different authorities in achieving the climate and energy transition. Belgium is therefore encouraged to ensure more coordination and integration of the plans or the federated entities, so as to maximise synergies between policies and measures
  - To meet the contribution set out in the national energy and climate plan, it could be helpful to boost investment in renewables, ensure long-term certainty for household and institutional investors, and speed up administrative processes
- **Renewables and energy efficiency**: further develop and step up policies and measures – currently foreseen contribution is unambitious

  - **Renewables**: unclear whether and how BE intends to meet its 13% target for 2020. Recommended to explore the use of cooperation mechanisms and of the EU renewable energy financing mechanism to reach that target and maintain it beyond 2020; accelerate some of the provided policies and measures to promote renewable energy, particularly in heating and cooling, and in transport
  - **Energy efficiency:** ensure that the ‘energy efficiency first’ principle is properly implemented across all areas of the energy system, in particular when planning new gas-fired power plants, where potential for combined heat and power could be explored; improving energy efficiency in buildings, building on the momentum of the ‘renovation wave’ initiative (big potential for speeding up energy savings and contributing to the recovery of the economy after the Covid-19 pandemic) - Belgium expected to provide a robust and comprehensive long-term renovation strategy to define a roadmap for decarbonisation by 2050
- Address **energy poverty** through e.g. specific support to socially innovative solutions and social enterprises; include quantitative objectives for the reduction of energy poverty
- Support **energy security** objectives, including measures ensuring system resilience
- **Internal energy market**: set up specific measures and a clear timetable to increase flexibility
- Define clear indicators to track achievement of milestones towards research and innovation and competitiveness objectives
- **Ensure link with** activities undertaken under the SET Plan & between competitiveness objectives and policies and measures to put in place for the different sectors by 2030
- Revise current framework of estimated national **investment needs** to make it more coherent and systematic and to include the economic consequences of the Covid-19 pandemic; ensure investments are in line with national, regional or local plans for air pollution reduction; make the best possible use of the various funding sources available, combining scaled-up public financing at all levels (national and local, as well as EU funding) and leveraging and crowding in private financing
- Continue ongoing efforts on **regional cooperation** (e.g. North Sea Energy Cooperation) with a view to intensifying exchanges and initiatives
- Ensure rapid **phase-out of the fossil fuel subsidies**, through the development and implementation of specific plans with associated timelines (coupled with measures to mitigate the risk of households’ energy poverty)
- Link to the recovery from the Covid-19 crisis:
  - Mature investment projects outlined in the final NECP plan, as well as key enabling reforms that address inter alia, investment barriers, to start as soon as possible
  - Include a number of ‘flagship’ areas. In particular, the ‘Power up’, ‘Renovate’, ‘Recharge and refuel’ and the ‘Reskill and upskill’ flagships

- Belgium’s recovery and resilience plan to include a minimum of 37% expenditure related to climate. Reforms and investments should effectively address the policy challenges set out in the country-specific recommendations of the European Semester, and will have to respect the principle of ‘do no harm’
- Consider the climate and energy-related investment and reform measures on the key areas indicated below.

Key areas - indicated by the EC - to be considered for the development of the national recovery and resilience plan:

1. Measures to front-load mature public investment projects and to address regulatory barriers to investment in **clean energy production and use**;
2. Measures to ramp up the **renovation of buildings**, including reforms of energy taxes and flanking social measures, to address the current shortage of workers with the requested skills in the construction sector, and to simplify the procedure for building permits to improve renovation rates;
3. Measures supporting **sustainable mobility**, including on railways, electric and hydrogen vehicles and recharging points; review of energy taxes and of infrastructure pricing to reflect congestion and externalities; measures to gradually phase-out the favorable tax treatment of company cars.

Assessment of the final national energy and climate plan of Bulgaria

STRUCTURE

5. Consideration by the Commission on the implementation of the recommendation from 2019

The October 2020 assessment document includes a general overview of the implementation of the Commission recommendations from 2019 in the final NECPs.

6. Assessment of the final NECP (objectives, contributions, measures, impact, investments)

This section consists in a general summary of the planned measures, divided by areas (Decarbonisation, Renewable energy, Energy efficiency, Energy security, Internal energy market. Research innovation and competitiveness..), with an evaluation on the basis of targets, implementation and Impact. The document focuses on the trajectories outlined to achieve the described targets, however never going into too much detail technology-wise. It is and update of the 2019 Report.

7. Guidance on the implementation of the NECP linked to the recovery plans from the Covid-19 crisis

This section addresses the link between the final plan and the recovery efforts from after the Covid-19 crisis by pointing at possible priority climate and energy policy measures Bulgaria could consider when developing its national recovery and resilience plan in the context of the Recovery and Resilience Facility.

8. Annexes:

- I: Potential funding from EU sources to Bulgaria, 2021 – 2027
- II: Detailed assessment of how Commission recommendation have been addressed

CONTENT

2019 Recommendations and Assessment of the final NECP by the Commission

Here following a summarized table, including the 2019 Recommendation from the Commission and the evaluation of the implementation of those recommendation within the final version of the NECP together with the assessment of the final NECP.

	NECP	Related Recommendation and evaluation on its implementation	Assessment
Decarbonisation - GHG	National objective for reducing GHG emissions by 2030 as compared with 2005 for non-ETS sectors (building stock, agriculture, waste management and transport) in line with Regulation (EU) 2018/842 on binding annual greenhouse	No recommendation	

	gas emission reductions by Member States from 2021 to 2030: 0%		
Renewable energy	National target for the share of renewable energy in gross final energy consumption by 2030 is set to 27.09%. Bulgaria aims to cover a 30.33% share of its electricity consumption from renewable energy sources by 2030.	Raise the level of ambition for 2030 to a renewable share of at least 27% as Bulgaria's contribution to the Union's 2030 target for renewable energy, as indicated by the formula in Annex II of Regulation (EU) 2018/1999. ➔ Fully addressed	The share of renewable energy in gross final consumption of energy for 2030 is adequate and in line with the share that results from the formula in Annex II to the Governance Regulation. It is also an improvement compared to the 25% contribution of the draft plan.
		Put forward detailed and quantified policies and measures that are in line with the obligations laid down in Directive (EU) 2018/2001 of the European Parliament and Council and enabling a timely and cost-effective achievement of this contribution. ➔ Partially addressed	The plan includes detailed information about planned PaMs, most of which are extensions to existing PaMs, such as the preferential prices for the purchase of renewable electricity produced by plants with a total installed capacity of less than 1 MW. Additional PaMs for 2021-2030 include: support for grid integration increased use of smart grids and storage systems, review and implementation of legislative changes in administrative procedures.
	The share of renewables in heating and cooling is projected to reach 42.60% by 2030.	Increase the level of ambition in the heating and cooling sector to meet the indicative target included in Article 23 of Directive (EU) 2018/2001 ➔ Partially addressed	The plan estimates an annual increase of renewables in heating and cooling of 1.15 percentage points. This is not in line with the Directive (EU) 2018/2001 indicative requirement of 1.3 percentage points per year. The plan also refers to forthcoming assessment of the potential for renewable energy and for the recovery of waste heat and cold in the heating and cooling sector, which will be developed by 31 December 2020.
	The share of renewables in transport is set at 14.2% in 2030 in the final plan.	Put forward policies and measures to meet the transport target set out in Bulgaria's draft integrated national energy and climate plan and in line with Article 25 of Directive (EU) 2018/2001.	The target represents a marginal increase of 0.2% of the transport ambition. The plan refers to the existing blending obligation for suppliers of transport liquid fuels and the possibility of changing this approach by introducing quotas for each renewable energy supplier.

		Largely addressed	As regards advanced biofuels, the plan says that the future efforts will focus on applied research and larger-scale demonstration activities. The plan also points to the need to develop public information campaigns to increase consumer awareness.
Energy efficiency	Lowering primary energy consumption as compared with the PRIMES 2007 baseline projection: 27.89% Lowering final energy consumption as compared with the PRIMES 2007 baseline projection: 31.67% Bulgaria's national contribution to energy efficiency in 2030 is 17.5 Mtoe for primary energy consumption and 10.3 Mtoe for final energy consumption.	Increase its ambition towards reducing both primary and final energy consumption in view of the need to increase the level of efforts to reach the Union's 2030 energy efficiency target… ➔ Not addressed	The PEC contribution was only slightly reduced and remains unambitious. The contribution for FEC is much higher and represents a very low level of ambition overall.
	The policies and measures presented that go beyond 2020 mostly target energy production/distribution and building renovation (residential and non-residential). They represent mainly the adaptation or extension of existing measures.	...and support it with adequate policies and measures that would deliver additional energy savings by 2030. ➔ Partially addressed	The changes and updates are minor. Policies and measures are relevant, but their impacts and energy savings are not quantified in detail. It is not specified which measures will lead to the largest reductions.
		Underpin proposed policies and measures by an impact assessment and more detailed information on the quantification of impacts, in terms of expected energy savings, and implementation timeline. ➔ Partially addressed	Some quantified information is provided on energy savings, but this has not been done for all measures.
Energy Security	Bulgaria's security policy for the electricity sector can be summarised along two priority axes: efficient use of indigenous energy resources and increased interconnection. Bulgaria makes maximum use of the existing potential of indigenous coal in compliance with applicable environmental regulation. The coal has the potential to	Specify a robust gas diversification strategy including relevant underlying infrastructure projects and their respective contributions. Detail the strategy for the long-term supply of nuclear materials and fuel, in particular in the perspective of the foreseen enlargement of its nuclear generation capacity	The strategy for diversifying gas supplies is explained. Clearer objectives are also set in terms of diversification of sources (RES and EE promotion). The final plan also explores the possibility of using LNG from different supply routes. NECP specifies that a procedure is in progress to analyse the feasibility of diversifying the supply of fresh nuclear fuel.

	provide resources for electricity generation in the next 60 years.	➔ Largely addressed	
			The plan does not make adequate links with the emergency plans for gas, electricity and oil, provided for by the applicable sectorial rules. Specifically, no mention is made of oil.
Internal Energy Market	The plan states that Bulgaria sets an interconnectivity level of at least 15% by 2030.	Define forward-looking objectives and targets concerning market integration, in particular on measures to develop competitive wholesale and retail markets and by eliminating barriers to cross-border trade ➔ Partially addressed	The final NECP outlines the reform of the electricity market better. It also provides for the promotion of competitively determined electricity prices through a gradual deregulation of electricity prices by 2025. Furthermore, policies and measures on flexibility and non-discriminatory participation of new market participants still fall short of clear legislative and regulatory steps. Moreover, there is still no timetable for implementation. The NECP lacks a detailed plan and timetables for: the rollout of smart meters in electricity and gas markets; the non-discriminatory participation of renewable energy; the demand response and storage, including storage via aggregation.
			The final plan still lacks an assessment of the energy poverty issue (there is no estimate of the number of energy-poor households, nor is there an indicative target to reduce this number). The analysis of the social impact is not comprehensive; no forecast figures are provided in social areas, including for the residential affordable and social housing sectors. This prevents Bulgaria from making the transition to a fully liberalised market while protecting those in need.

Research, Innovation and Competitiveness		Further clarify national objectives and funding targets in research, innovation and competitiveness, specifically related to the Energy Union, to be achieved between now and 2030, so that they are readily measurable and fit for purpose to support the implementation of targets in the other dimensions of the integrated national energy and climate plan. Not addressed	The NECP provides only a general description of the research and innovation objectives, and of policies and measures up to 2030 and beyond. Its priorities seem to be energy efficiency and security.
		Underpin such objectives with specific and adequate policies and measures, including those to be developed in cooperation with other Member States, such as the European Strategic Energy Technology Plan. Partially addressed	While the NECP identifies relevant areas and specific programmes, it provides few details of timeframes, the allocation of resources or quantified targets, making the extent to which they have been implemented hard to assess. Moreover, the research and innovation efforts are not supported by concrete policies or measures beyond 2020. As regards competitiveness, no specific and measurable objectives are defined. Cooperation with the SET Plan is mentioned, but the link between European and national efforts has yet to be developed.
Regional cooperation		Intensify regional cooperation with neighbouring Member States and within established regional cooperation frameworks such as the Central and South-Eastern Europe Energy Connectivity (CESEC) High Level Group, including in the renewables, energy efficiency and research, innovation and competitiveness dimension and taking into account common challenges and shared objectives. There is significant potential to further cooperate with a view to upcoming developments in the electricity sector, including the need to accommodate higher shares of	Cooperation with neighbouring countries in the internal energy market and energy security is well developed. The NECP also provides further details in terms of the collaboration with CESEC and with neighbouring Member States as regards the electricity market and R&D/R&I, albeit at a high level. However, it is still limited as regards the development of RES and makes no reference to any potential cooperation on clean transport (and more broadly on air quality) beyond the existing CEF investment in charging infrastructure (decarbonisation dimension), despite Bulgaria's ambition to

		renewables and clean transport which could impact electricity interconnections and trading in the region ➔ Largely addressed	develop the use of electric and hybrid vehicles for both public and private use. There is no reference to the coal transition. Bulgaria has a number of borders with non-EU countries and cooperation will be important.
Investments		Provide a general overview on the investment needed to modernise the economy by reaching its energy and climate objectives. ➔ Partially addressed	The final NECP provides a general overview and a breakdown by sector of the investment needed to meet the targets set in the plan. However, information is lacking on: types of costs and methodology for estimation; breakdown of costs by dimensions; and the underlying logic of the model and assumptions.
		Provide a general assessment of the sources of investment, including appropriate financing at national, regional and Union level. ➔ Partially addressed	The NECP partially describes the available funding sources that will cover the funding needs identified. The overview of potential sources of investments is largely limited to funding opportunities at EU level. However, there is a lack of detail on the proportion of investment needs that would be covered by each source. There is no description of appropriate financing at national and/or regional level. Nor is sufficient attention given to the potential mobilisation of private investments

Guidance on the implementation of the NECP and the link to the recovery from the Covid-19 crisis

Main points:

- On **renewables**, Bulgaria committed to an overall **renewable energy target** of 27%, differentiated through sectoral projections. In the **heating and cooling** sector, specifically, Bulgaria would benefit by maximising the role of renewables and promoting the role of waste heat. In addition, the penetration of renewable electricity would be significantly enhanced by ensuring a level playing field in the electricity market.

- On **energy efficiency,** Bulgaria would benefit if it were to adopt and implement additional policies and measures designed to achieve further energy savings by 2030. Bulgaria is also invited to implement the Energy Efficiency First principle properly across all areas of the energy system, especially when planning additional investments in gas infrastructure. The improvement of energy efficiency in buildings has much potential for speeding up energy savings and contributing to the recovery of the economy after the Covid-19 pandemic. Building on the momentum of the Renovation Wave initiative, there is scope for Bulgaria to intensify efforts to improve the energy performance of the existing building stock with concrete measures, targets and actions with due attention to energy poverty.
- On **energy security,** Bulgaria would benefit if it were to combine its strategy of **obtaining access to different sources of natural gas, including decarbonised gases**, with specific measures to **integrate relevant sectors**. This would help optimise and transform the energy system as a whole, instead of decarbonising and making separate efficiency gains in each sector independently. The enhanced role for nuclear energy described in Bulgaria's energy and climate plan has the potential to help improve **energy security** only if specific measures are introduced to diversify the procurement of nuclear materials and nuclear fuels.
- As regards the functioning of the **energy market**, Bulgaria would benefit from maintaining a firm course on energy reforms and **market liberalisation**, including phasing out regulated prices and integrating the gas and electricity sectors more closely with those of its neighbours. Further efforts to improve the functional independence of the national **regulatory authority.** In retail markets, empowering **consumers w**ill help trigger genuine competition, improve quality of service and result in greater consumer satisfaction. This can be achieved through policy measures related to **storage and smart grids, system flexibility,** real-time price signals, **demand response and aggregation,** prosumers, **energy communities,** general consumer protection and non-discriminatory participation of renewable energy.
- Bulgaria would benefit by defining clear indicators to track achievement of milestones towards its **research and innovation and competitiveness** objectives. Bulgaria will need to ensure that this activity is linked with the SET plan activities already undertaken.
- As the main sources of funding identified are predominantly at EU level, the role and scope of different sources of funding in meeting the **investment needs** specified in the plan need to be clarified, as well as the amount of the investment funding required that has already been secured.
- Bulgaria is invited to continue ongoing efforts on **regional cooperation** with a view to intensifying exchanges and initiatives that will facilitate the implementation of its national energy and climate plan, in particular as regards relevant **cross-border issues.** Bulgaria is also invited to better exploit the potential of the **multilevel climate and energy dialogues** to actively engage and discuss with regional and local authorities, social partners, civil society organisations, business community, investors and other relevant stakeholders.

- **Bulgaria** faces the challenge of taking account of **just and fair transition** aspects in its efforts to shift the energy system towards low-carbon sources. In particular, the country needs to develop a more comprehensive assessment of the social, employment and skills impact of planned objectives, policies and measures. This applies particularly to coalmining regions, carbon-intensive and linked industries.
- The final plan constitutes a strong basis for Bulgaria to design climate and energy-related aspects of its **national recovery and resilience plan**, and to deliver on broader **European Green Deal objectives.**

Key areas indicated by the Commission to be considered when developing the national recovery and resilience plan:

1. Measures supporting a **coal phase-out strategy** with a clear timeframe commitment and ensuring a **just transition of coal and lignite-reliant areas**, accompanied by a clear strategy for promoting renewable energy; measures to reform the energy market;
2. Measures promoting investments in **buildings renovation**, focusing as a matter of priority on worst-performing residential buildings;
3. Measures improving sustainable transport infrastructure and boosting sustainable mobility.

Assessment of the final national energy and climate plan of Croatia

2019 Recommendations and Assessment of the final NECP by the Commission

Here following a summarized table, including the 2019 Recommendation from the Commission and the evaluation of the implementation of those recommendation within the final version of the NECP together with the assessment of the final NECP.

	NECP	Related Recommendation and evaluation on its implementation	Assessment
Renewable Energy	36.4%, Croatia's national contribution for renewable energy	Underpin the welcome level of ambition of a 36.4% renewable energy share for 2030 with detailed and quantified policies and measures ➔ Not addressed	Despite Croatia's assurances (in its presentation of its final NECP and its response to the Commission recommendations) that "more detailed policies and measures have been developed" and that "additional measures promoting renewable self-consumption and renewable energy communities have been introduced", there is little to no evidence of either in the final NECP itself
	In the **electricity sector**, Croatia aims to achieve a share of 63.8% in gross direct consumption of electricity from renewable sources by 2030.		
	The 2030 target for **heating and cooling** is 36.6%, with heat produced by cogeneration being more than 60%. This compares to an estimated share of 33.3% for 2020.	Increase the level of ambition of renewables in the heating and cooling sector ➔ Not addressed	Croatia has made it clear that it does not intend to increase its shares of renewables in heating in line with requirements of the heating and cooling indicative target. Although this target and progression are well below the 1.3% annual average increase required between 2020 and 2030, cogeneration provides 79% of heat produced for Croatia's district heating. Overall, the information provided on district heating and cooling is limited and the role of waste heat and cold is not addressed.
	For the renewables target in **transport,** the explanation for setting it at 13.2% ("in the transport sector Croatia has decided not to use the flexibility offered by the Renewable Energy Directive and the 2030 goal is higher than minimal share of RES-T, however the 14% goal is deemed not feasible"), is not clear. The final national energy and climate plan also announces the adoption of a plan setting out a policy to promote the production and use of advanced biofuels in transport. The	➔ Increase the level of ambition to meet the transport target in Article 25 of Directive (EU) 2018/2001. ➔ Partially addressed	Further information has been added, but the level of ambition has not been increased; the overall level of policy description remains generic and the actual impact of several measures is not clearly described As per the draft NECP, Croatia aims to reach a 13.2% share of renewables in the transport sector by 2030, mainly from biofuels, falling short of the 14% target for that sector. Nor does the final NECP heed the recommendation to address

	measures will include ones aimed at producing advanced biofuels from raw materials, measures on the use of advanced biofuels, R&D measures, and market strengthening and administrative measures.		the applicable multipliers and the sub-target for advanced biofuels.
	Croatia's final NECP lists the development of production capacity for **electric vehicles** among its key objectives. In the context of co-financing cleaner transport projects, the plan proposes to define special cofinancing lines for specific purposes, namely purchasing electric vehicles, as well as vehicles powered by compressed and liquefied natural gas and hydrogen.	➔	
Energy efficiency	Croatia's national contribution for energy efficiency in 2030 under the Governance Regulation is 8.23 Mtoe for primary energy and 6.85 Mtoe for final energy consumption. The only specific measure addressing industrial and service sectors relates to the promotion of energy management schemes, and the transport sector is not addressed.	Increase its ambition towards reducing both final and primary energy consumption in view of the need to increase the level of efforts to reach the Union's 2030 energy efficiency target. ➔ Not addressed	In its final plan, Croatia maintained its level of ambition, assessed as low compared to the EU level of efforts.
	The cumulative savings to be achieved under Article 7 of the Energy Efficiency Directive were recalculated by Croatia to 2953.1 ktoe. This includes the objective of renovating central government buildings, to be addressed through a set of measures s, including a financial support scheme and capacity building measures to promote Energy Service Companies and Energy Performance Contracting to target thorough renovation of public and heritage buildings.	Support the energy efficiency target with policies and measures that would deliver additional energy savings by 2030. ➔ Partially addressed	In the light of this correction of the energy saving goal, the planned policies and measures do not seem sufficient to achieve it. Further information has been added, underpinned by a scenario pathway analysis. But the overall contribution of energy efficiency to transport decarbonisation is not specified, and the status and impact of different measures is difficult to assess due to lack of detail in description. On buildings, the information in the NECP is much improved. The longterm renovation strategy has not been submitted yet.

	Energy efficiency in buildings: Croatia will adopt a long-term renovation strategy with a plan of measures and indicators for 2030, 2040 and 2050, which will be aligned with Croatia's energy development strategy. Croatia is aiming for an annual average renovation rate of 1.6%, with specific annual rates gradually increasing from 0.7% in 2021 to 3% in 2030. Three key energy renovation programmes for 2021 to 2030, for multi-dwelling buildings, family homes and public buildings. In addition to these programmes based on financial incentives, the implementation of a comprehensive promotion programme for nearly zero-energy buildings and renovation standards is also planned.	➔	The information in the final plan is much improved relative to the draft, and contains specific measures.
Energy Security	The plan gives a positive outlook for the planned energy mix by 2050		This still relies on certain assumptions with regard to the exploitation of new indigenous hydrocarbon deposits.
	When considering risks, the plan recognizes the importance of regional cooperation and envisages strong engagement with neighbouring Member States, as well as in EU-level action to combat specific risks in isolated territories such as islands.		
	The plan envisages further measures and investments in energy storage for a total of 150 MW by 2030, through various possible technologies.		The approach on the type and timeline of planned storage projects is not very detailed, but the information on gas storage development is rather robust. The plan does not include considerations on cybersecurity in the energy sector, or mitigation of risks arising from climate change.

Internal Energy Market	Croatia's electricity interconnectivity level is currently at 30%. Installed interconnection capacity exceeds the EU interconnection target. Therefore, Croatia has not presented a plan to increase electricity interconnection capacity. Given the electricity sector target of 63.8% renewable energy resources in 2030, the plan offers an overview of the development of the different sources of flexibility needed to integrate the rising share of renewable energy into the electricity system. The plan includes specific policy measures for introducing the regulatory framework for aggregation, demand response and ancillary services, by 2022. This policy measure will also increase energy security, as well as the penetration of new technologies and renewables.	➔	Croatia has clearly moved forward on certain challenges identified in the draft plan, by setting specific policy actions for regulatory measures to be put in place for the areas of system balancing and ancillary services, as well as aggregation and demand response. Although energy demand and final pricing information is present for both electricity and gas markets, Croatia's plan lacks detail on the major market conditions for competitiveness, liquidity and regulated pricing, as well as progress made on regulatory issues such as transmission system operator certification. Despite the planned deployment of **smart grids and smart meters**, no quantitative policy measures or targets are mentioned.
	The plan sets specific goals for further improving market integration by integrating Croatia's electricity trading system with that of Hungary, as done in the past with Slovenia. The goal is to increase tradable electricity at interconnection points, and the physical capacity for this already exists.	Define forward-looking objectives and measurable targets concerning market integration, in particular measures to develop liquid and competitive wholesale and retail markets, by fostering competition within the country and progressing towards fully market based prices and by eliminating barriers to cross-border trade. ➔ Partially addressed	The final plan outlines Croatia's intention for further market integration with neighbouring countries by linking to the electricity day-ahead market. The plan still lacks a qualitative and quantitative assessment of the remaining aspects and measurable targets needed both for a liquid and competitive market in electricity and gas and to address any regulatory issues.
			The NECP does not include a comprehensive analysis of the energy poverty challenge (including the share of energy poor households) nor does it indicate an objective for reducing energy poverty.

Research, Innovation and Competitiveness	general research, development and innovation objectives for 2020 (namely a spending target of 1.4% of GDP). The plan mentions the objective of reaching the EU average of 3% of GDP of investment in science and technology.	Further elaborate national objectives and funding targets in research, innovation and competitiveness, specifically related to the Energy Union, to be achieved between now and 2030. Underpin such objectives with specific and adequate policies and measures, including those to be developed in cooperation with other Member States, such as the SET Plan. ➔ Partially addressed	no specific national 2050 targets for deploying low-carbon technologies. On how to reach the national objectives and funding targets, the NECP provides a long list of most significant capacities and industries, and mentions its scientific community, but there are no linked tasks or roadmaps. Croatia aims to propose relevant data sources as well as a system for monitoring the output of indicators, but so far it remains to be put in place. The plan lacks clear policies and measures for meeting the objectives. Due to missing hard data and clear implementation plans, the extent and impact of the intentions sketched in the plan cannot be assessed.
	Enable the integration of hydrogen into its energy and transport systems. By 2040, Croatia expects a final hydrogen consumption of 0.01PJ or 2.8 GWh in the transport sector and 3.5% low-carbon vehicles by 2030. To reach these targets Croatia intends to build hydrogen-refuelling stations, provide financial incentives for energy-efficient vehicles (including hydrogen-driven) and develop technical standards to facilitate market uptake.		The NECP mentions the SET plan. It contains some alignment of the national energy research and innovation objectives with the respective priorities identified in the latter. However, the NECP does not allocate national funds or dedicated activities, and does not make any link between the energy and technology plan and the national energy and climate objectives.
			The NECP includes numerical information on patents. But information specifically on low-carbon energy technologies is missing. Likewise, on private research and innovation investment, the NECP tracks private R&D expenditures by scientific field, but the corresponding breakdown does not enable any monitoring of low-carbon or energy technologies. Finally, the plan contains no information on researchers.
			Croatia has no national 2050 targets for deploying low-carbon technologies. The NECP states that deployment of specific technologies should be driven primarily by the market.

	The NECP identifies such key areas for research and innovation as technological advances in ICT in all sectors, the development of energy storage systems, e-mobility infrastructure, batteries, autonomous systems in various sectors and robotics.		No concrete policies to raise investment in research and innovation are specified. The plan expects significant financing from EU (public) funds, and does not consider private financing.
Investments	The total estimated investment covers 12 sectors and amounts to around EUR 19 billion over the period 2021 to 2030, corresponding to an annual amount of around 3.5% of 2019 GDP. Investments are planned mainly for the building sector and electricity production installations. For 2031 to 2050, they amount to around EUR 31 billion, with nearly 40% for construction of new energy-efficient buildings in 2021 to 2050, and around 15% for electricity generation using renewable energy sources. Market risks are identified, but not further assessed	Extend its analysis of investment costs and sources, including appropriate financing at national, regional and Union level to a general overview of investment needs to modernise its economy by reaching its energy and climate objectives. ➔ Partially addressed	Market risks are identified, but not further assessed. The calculation methodology is not clearly stated. The investment needs apparently result from comparing current with projected energy needs. The national energy and climate plan does not provide a quantitative assessment of current investment, nor a budget for the planned investment. It assumes many of the measures would be co-financed by different European sources. The plan does not consider, as a funding source, possible transfers to other Member States under the Effort Sharing Regulation.
Regional cooperation		Continue regional cooperation efforts on the national energy and climate plan in the context of the Central and SouthEastern Europe Energy Connectivity (CESEC) High-Level Group (e internal energy market, assessing system adequacy, just transition, decarbonisation and renewables deployment) ➔ Largely Addressed	d Croatia mentions a willingness to further cooperate in a number of areas mentioned in this recommendation. A section on cooperation on renewables was added, compared to the draft plan, and explores in particular joint development of renewables projects, analysis of statistical transfer opportunities and cooperation in the context of the Clean Energy Initiative for EU Islands.
		Explore the cross-border potential and the macro-regional aspects of a coordinated energy and climate policy notably in the Adriatic with the	In its final plan, Croatia added a chapter on regional cooperation on decarbonisation and greenhouse emissions removal (3.1.1 ii).

		aim of reducing the region's carbon footprint and implementing an ecosystem approach. ➔ Largely addressed	During a regional workshop in 2019, Slovenia, Italy, Austria, Hungary and Croatia discussed the joint development of parts of their national climate change adaptation strategies (e.g. for the Adriatic region). Issues included waterway and soil management and carbon capture and storage.

Guidance on the implementation of the NECP and the link to the recovery from the Covid-19 crisis

Main points:

- Croatia committed to increase the share of renewables in gross final energy consumption to 36.4%. However for the transport and heating/cooling sectors, renewable energy penetration is still lower than the requirements and indicative targets in the Renewable Energy Directive. So Croatia would need to provide further analysis, update the relevant policies and implementing measures and quantify their projected impact.
- The penetration of renewable electricity would be significantly enhanced by ensuring a level playing field in the electricity market. A careful assessment of the regulatory, structural and administrative system, under this perspective, would greatly assist the removal of any barriers and burdensome procedures, streamline licensing, and promote the uptake of power purchasing agreements
- On energy efficiency Croatia would benefit from adopting and implementing additional policies and measures that would deliver additional energy savings by 2030
- Croatia could consider using the dedicated green transition funding to finance energy efficiency policy, in particular targeting renovation of buildings, services and the tourism sector.
- Improving **energy efficiency in buildings** has much potential for speeding up energy savings and contributing to the recovery of the economy after the Covid-19 pandemic. Building on the momentum of the Renovation Wave initiative21, there is scope for Croatia to intensify efforts to improve the energy performance of the building stock with concrete targets, measures, and actions with due attention to energy poverty
- As regards energy poverty, Croatia is encouraged to consult the Commission Recommendation of 14 October 2020 on energy poverty and its accompanying staff working document providing guidance on the definition and quantification of the number of households in energy poverty and on the EU-level support available to Member States' energy poverty policies and measures.
- To further strengthen energy security, Croatia would benefit from swiftly implementing the planned investment projects, taking full advantage of the available European funding, notably through projects of common interest.

- Regarding the internal energy market, Croatia would benefit from the timely implementation of its recently overhauled legislation on electricity and gas.
- Croatia would benefit from defining clear indicators to track the achievement of milestones towards its research and innovation and competitiveness objectives.
- While quantified investment needs are laid out, further detail is needed on the private and public sources of financing (at national, regional, and EU level).
- Croatia is invited to continue ongoing efforts on **regional cooperation**, to intensify exchanges and initiatives that can facilitate the implementation of its NECP, in particular as regards relevant cross-border issues, including those in the context of the CESEC High-Level Group (further explore the Clean Energy for EU Islands Initiative and the multilevel climate and energy dialogues).
- Croatia is invited to extend and update its reporting on energy subsidies and to initiate action to phase them out, in particular for fossil fuels.

Key areas indicated by the Commission to be considered when developing the national recovery and resilience plan:

1. Measures supporting investments in renewables, in particular through a stable legislative framework including a functioning and competitive electricity market;
2. Measures to support sustainable transport including through reforms to develop sustainable urban and inter-urban mobility and investments to promote a modal shift from road to rail;
3. Measures supporting investments in energy efficiency, in particular building renovation with focus on schools, hospitals and social housing, targeting households at risk of energy poverty.

European Commission’s assessment of the final NECP of the Czech Republic

STRUCTURE

9. Consideration by the Commission on the implementation of the recommendation from 2019

The October 2020 assessment document includes a general overview of the implementation of the Commission recommendations from 2019 in the final NECPs.

10. Assessment of the final NECP (objectives, contributions, measures, impact, investments)

This section consists in a general summary of the planned measures, divided by areas (Decarbonisation, Renewable energy, Energy efficiency, Energy security, Internal energy market. Research innovation and competitiveness..), with an evaluation on the basis of targets, implementation and Impact. The document focuses on the trajectories outlined to achieve the described targets, however never going into too much detail technology-wise. It is and update of the 2019 Report.

11. Guidance on the implementation of the NECP linked to the recovery plans from the Covid-19 crisis

This section addresses the link between the final plan and the recovery efforts from after the Covid-19 crisis by pointing at possible priority climate and energy policy measures Czechia could consider when developing its national recovery and resilience plan in the context of the Recovery and Resilience Facility.

12. Annexes:

- I: Potential funding from EU sources to Czech, 2021 – 2027
- II: Detailed assessment of how Commission recommendation have been addressed

CONTENT

2019 Recommendations and Assessment of the final NECP by the Commission

Here following a summarized table, including the 2019 Recommendation from the Commission and the evaluation of the implementation of those recommendation within the final version of the NECP together with the assessment of the final NECP.

	NECP	Related Recommendation and evaluation on its implementation	Assessment
Renewable Energy	The **renewable share** is set at 22% of gross final energy consumption by 2030.	Increase the level of ambition for 2030 to a renewable energy share of at least 23% as Czechia's contribution to the Union's 2030 target for renewable energy ➔ Partially addressed	Although Czechia has increased its contribution to the EU renewables target from 20.8% to 22% as a share of gross final consumption by 2030, this contribution is still below the 23% by 2030.
		Put forward detailed and quantified policies and measures that are in line with the obligations ➔ Partially addressed	The main policy announced is the revision of the renewable energy law, which is expected to be adopted in one to two years. This will delay the effect of the measures it contains.
	Czechia aims to cover 16.9% of its **electricity** consumption from renewable sources by 2030. This corresponds to a 3.3% increase over the coming decade, compared with a doubling of the renewable electricity share between 2010 and 2020, and thus represents a significant slowdown at a time when the key technologies, wind and solar energy, have reached cost parity.		
	In **heating and cooling**, Czechia plans to increase the share of energy from renewable sources by 1.0 percentage points annually, without counting waste heat. This is below the indicative 1.1 percentage points calculated as annual averages for 2021-2025 and 2026-2030 respectively.	Increase the level of ambition in the heating and cooling sector to meet the indicative target ➔ Partially addressed	The target has been increased from 0.8 to 1.0 percentage points of the annual increase in renewables in the heating and cooling sector.
	In relation to the **transport** target in the final plan, the national energy and climate plan specifies that renewables must supply 14% of energy used in transport by 2030, starting from 8.8% in 2020. It is envisaged that this increase will be achieved through renewable electricity sources, biofuels, biomethane and, to a lesser extent, hydrogen.	Put forward measures to meet the transport target ➔ Largely addressed	The measures to promote the renewable transport target are included.

Energy efficiency	The Czech national contribution to **energy efficiency** is set as a final energy consumption intensity of 0.157 MJ/CZK by 2030. It translates into 41.4 Mtoe (primary energy consumption) and 23.7 Mtoe (final energy consumption). The 2030 target means that final energy consumption must fall by 9.3% by 2030 compared to the business as usual scenario. The plan states that the energy efficiency scenario (WAM) represents the maximum potential for reducing energy consumption in each economic sector. In addition, Czechia has set a national target to cover 60% of its heat supply from combined heat and power by 2040.	Increase its ambition towards reducing primary energy consumption in view of the need to increase the level of efforts to reach the Union's 2030 energy efficiency target. ➔ Not addressed	Czechia does not plan to increase its ambition in the area of energy efficiency.
	The plan provides information on policies and measures targeting mainly buildings, industry, transport, and the public sector specifically. Grants and other financial instruments are set to contribute 44% of cumulative energy savings, voluntary agreements 32%, fiscal measures 4%, and regulatory and information/behavioural measures 20%.	Support it with policies and measures that would deliver additional energy savings by 2030. Better identify the policies and measures which are planned to be adopted in the period 2021-2030, also based on the assessment of their expected impacts. ➔ Partially addressed	
	As regards **energy efficiency in buildings**, the Czech plan provides some information on the expected increase in the rate and depth of building renovation. However, this information is provided only in relative terms (as percentages). Overall investment is given as CZK 153 billion in the residential sector and CZK 109 billion in the public and commercial sector.		The information provided on the renovation of the building stock has been improved, but remains limited.
Energy Security	Maintaining a high level of security of supply is a priority in the transformation of the energy system. With an objective of 16.9% of **renewable electricity** system and the increasing share of domestic renewable energy towards 21% by 2030, renewables will not play a decisive role in energy security.	Include projections for the future energy mix, including renewable sources of gas, and planned measures in the area of resilience of the energy system, demand side measures, cybersecurity and critical infrastructure.	The final plan includes measures to improve diversification and prevent existing levels of energy dependency from worsening. It now also describes measures to make the energy system more flexible overall.

		➔ Partially addressed	
	The 10-year development plan for the transmission system is designed to ensure security of supply (diversification of sources and transport routes of natural gas, and ensuring a robust transmission system.		
Internal Energy Market	The plan states that Czechia's **interconnectivity level** is likely to be 29.6% by 2020. This is above the EU electricity target for 2030. According to the methodology used at national level, interconnectivity will reach 44.1% by 2030.	Define forward-looking objectives and targets concerning market integration, in particular well defined new and planned measures. Set out the potential of renewable gases. ➔ Largely addressed	The final plan provides more details of the potential offered by renewable gases. It also refers to the existence of assessments of specific legislative measures designed to develop competition.
Research, Innovation and Competitiveness	Czechia has no aggregate objective with regard to research and innovation in the climate and energy field that readily lends itself to quantification.	Further clarify their national objectives and funding targets in research, innovation and competitiveness, specifically related to the Energy Union, to be achieved between now and 2030 ➔ Partially addressed	There are several national documents that include relevant areas where R&I objectives are defined. However, these objectives do not have a specific timeline or quantified targets, nor are they supported by specific policies or measures.
	The THETA programme for 2018-2025 supports research in the field of energy transformation. Apart from that, Czechia has no research and development target as regards energy or the energy transition.	Underpin such objectives with specific and adequate policies and measures, including those to be developed in cooperation with other Member States, such as the European Strategic Energy Technology Plan. ➔ Partially addressed	Cooperation with the SET plan is mentioned, but no reference is made to appropriate policies or measures to be developed in this context.
	As regards **competitiveness**, the emphasis is on affordable energy, making the economy less energy-intensive, and manageing exposure to energy imports.		

Investments	Information is provided on **investment needs** and on mechanisms and funding sources to leverage investment to promote renewables, energy efficiency, infrastructure, and the transmission system. The sources of financing referred to are EU programmes, proceeds from the sale of emission allowances, and the state budget.	Extend its analysis of investment needs and sources, including appropriate financing at national, regional and Union level, which is currently provided for specific policies, to a general overview of investment needs to reach its energy and climate objectives. ➔ Partially addressed	The areas considered are renewables, energy efficiency, infrastructure, and the transmission system, but there is no general overview of investment needs and funding. Issues such as transport are not covered.
Regional cooperation		Continue the already excellent approach to regional cooperation in the framework of the Visegrad Group involving Czechia, Hungary, Poland and Slovakia, as well as bilateral dialogues with other Member States. Such cooperation could include topics such as further integration in the internal energy market, measures related to assessing system adequacy in light of the planned continuation of a capacity market, just transition, decarbonisation and further renewables deployment, including resulting impacts on the energy system and cross-border electricity trade. ➔ Partially addressed	Czechia has consulted neighbouring Member States (bilaterally or as part of cooperation within the Visegrad group) in the course of drafting the NECP.

Guidance on the implementation of the NECP and the link to the recovery from the Covid-19 crisis

Main points:

- Czechia has committed to increasing the share of **renewables** in gross final energy consumption to 22% by 2030.
- On **energy efficiency,** achieving the ambitious contribution could be supported by.. **Improving energy efficiency in buildings** has much potential for speeding up energy savings and contributing to the recovery of the economy after the Covid-19 pandemic. Building on the .. YYY initiative, there is scope for XX to intensify efforts to improve the energy performance of the existing building stock with specific measures, targets and actions.

- On **energy security,** Czechia would benefit from adopting and implementing additional policies and measures to achieve additional energy savings by 2030. New energy-saving measures would need to be implemented as soon as possible to avoid any delay in achieving such savings.
- As regards **energy security**, Czechia would benefit by further developing measures to support the energy security objectives, including measures ensuring system resilience and flexibility.
- Czechia would benefit from defining clear indicators to track achievement of milestones towards its **research and innovation and competitiveness** objectives. Over time, the gathering of granular research, innovation and competitiveness data will be useful to strengthen this process. Czechia would need to ensure the link with the SET plan activities undertaken.
- Czechia is invited to continue ongoing efforts on **regional cooperation** with a view to intensifying exchanges and initiatives that will facilitate the implementation of its national energy and climate plan, in particular as regards relevant cross-border issues, including those in the context of the CESEC High-Level Group. Czechia is also invited to better exploit the potential of the **multilevel climate and energy dialogues**.
- The final plan constitutes a strong basis for Czechia to design climate and energy-related aspects of its national recovery and resilience plan and to deliver on broader European Green Deal objectives.

Key areas indicated by the Commission to be considered when developing the national recovery and resilience plan:

1. **Measures to promote renewables and energy efficiency** to reduce dependency on coal and improve the flexibility of the grid, including by reducing administrative burdens to speed up building renovation;
2. **Measures** increasing the **roll-out of electric and hydrogen vehicles** by developing charging infrastructure and alternative fuels, and tax reforms;
3. **Measures** to promote **sustainable transport infrastructure**, in particular by investing into the backbone railway infrastructure and improving suburban transport networks.

European Commission’s assessment of the final NECP of Denmark

Ref. docs:

https://ec.europa.eu/energy/sites/ener/files/documents/staff_working_document_assessment_necp_denmark.pdf

https://ec.europa.eu/energy/sites/ener/files/documents/summary_of_swd_assessment_necp_denmark_en.pdf

Assessment and recommendations of the final NECP by the European Commission

	NECP	Related assessment & recommendations on NECP implementation
Decarbonisation: **GHG emissions & removals**	• In addition to the binding target for non-ETS emissions of a 39% reduction by 2030 compared to 2005 set in the Effort Sharing Regulation, Denmark has set the objective of achieving climate neutrality by 2050. • The government has reached a cross-party agreement on a new Climate Act that was adopted by the parliament in June 2020. The Act includes a legally binding target to: (i) reduce total domestic GHG emissions by 70% by 2030 compared to 1990 levels; (ii) reach net-zero emissions by 2050 at the latest; and (iii) set milestone targets based on a five-year cycle. The country’s long-term strategy is also based on these targets. This likely implies that the binding target for non-ETS emissions of a 39% reduction is also reached domestically. • The Commission estimates that Denmark would miss its 2030 non-ETS target by 13 percentage points and have a deficit of 28.3 Mt CO2eq over the period 2021-2030. This scenario uses policies that were adopted by May 2019. Denmark did not provide any scenario with planned additional measures.	➔ Not addressed • It is recommended to (i) clarify how it intends to reach its 2030 target for GHG emissions not covered by the EU ETS of a 39% reduction compared to 2005; (ii) put in place further cost-efficient policies; (iii) specify Denmark’s intended use of the flexibilities between: the effort sharing sectors; the land use, land use change and forestry (LULUCF) sector; and the ETS sector. The final plan includes less, rather than more, information on how Denmark plans to meet its 2030 non-ETS target. • The long-term strategy in the Climate Act misses some aspects required by Article 15 of the Governance Regulation, such as a report on public consultation or an assessment of socioeconomic impacts. • Denmark estimates that over the period 2021-2030, it will generate more than 14.6 million LULUCF credits, which is the amount the country may use to comply with its commitments in the ESR. The NECP does not explain in detail how these credits will be generated, nor does it confirm whether Denmark intends to use such flexibility. • For LULUCF, the government considers establishing a biodiversity package, a forest fund and subsidies for the conversion of arable land on organic soils to nature. • Planned sectoral strategies for agriculture, transport, energy, construction and industry will be included in the climate action plan to be adopted in 2020. As a result, the NECP does not specify Denmark’s strategy for reaching its 2030 non-ETS target, but it makes reference to certain objectives and planned initiatives. The NECP does not discuss the expected impacts of these initiatives.

Decarbonisation: **Renewable energy**	• 55% share of renewable energy in gross final consumption of energy by 2030 as its contribution to the EU's renewable-energy target for 2030. This is considered as sufficiently ambitious when compared to the 46% share resulting from the formula in Annex II of the Governance Regulation. • Modelling based on Denmark's existing policies and measures indicate it will reach a share of 54% of renewable energy by 2030, thus indicating that additional policies and measures will be needed to reach the 55% share	➔ Partially addressed • Denmark's NECP set out an indicative trajectory well above the reference points provided for in the Governance Regulation, with a surplus of 11% above the 2020 target being factored in as an early effort towards the 2030 target. • According to the modelling for 2030, the share of renewable energy in transport will reach 1% in 2030; the share of renewable electricity consumption will exceed 100% by 2030; and the share of renewable energy in heating and cooling will reach 60% by 2030, of which there will be 80% renewable energy in the district heating sector. The 80% target represents an average increase of 0.88 percentage points in renewable energy in the district heating sector per year between now and 2030. • Denmark will increasingly depend on relatively large imports of biomass used for heating and electricity, as approximately 50% of its biomass needs will be covered by imports. The sustainability issues this situation raises are currently addressed in a voluntary agreement in the energy sector, but an analysis has been initiated that will serve as input to the forthcoming climate action plan.
Energy efficiency	• Denmark's national contribution for energy efficiency in 2030 is 18.3 Mtoe for primary energy and 15.8 Mtoe for final energy consumption, illustrating a very low ambition in this area. • The plan also presents the cumulative savings to be achieved under Article 7 of the Energy Efficiency Directive as 6.414 Mtoe	➔ Partially addressed • The plan provides descriptive information on policies and measures beyond 2020, which are considered sufficient in relation to the achievement of the target, simply because the target was set as the expected consumption level in a projection, including only already known and adopted policies and measures. • Progress has been made with the adoption or implementation of certain measures that were under preparation at the time of the draft NECP submission. Many of these measures were related to transport. • The recommendation to substantially increase the level of ambition for energy efficiency was not addressed: the contribution in primary energy consumption was only slightly reduced, while it remained the same for final energy consumption. • For cumulative savings four measures to achieve this target have so far been identified: (i) a subsidy scheme for private enterprises; (ii) a subsidy scheme for buildings; (iii) improving the efficiency of existing buildings by other measures; and (iv) a subsidy scheme to replace oil burners with heat pumps in buildings outside district heating areas and gas grids. • On buildings, the information in the NECP is improved but remains limited; the NECP presents an insufficient level of ambition. Denmark submitted its long-term renovation strategy

Energy security	• Maintaining a high level of security of supply is a priority in the ongoing transformation of Denmark’s energy system. The country has an ambitious objective of 55% renewable energy in gross final consumption in 2030, and for production of renewable electricity to be above 100% of consumption. When considering the risks to energy security, Denmark’s’ plan refers to its intention to expand wind-power generation and the importance of electricity interconnections for imports. • The plan outlines the increasing contribution that will be made by biogas production to security of supply. Biogas will account for an expected 15% of gas consumption in 2020 and 30% in 2025. • The plan envisages an increased role for energy storage and making use of surplus wind energy.	➔ ???? • Denmark relies on electricity imports in times of low wind, and the plan points to varied electricity-generation profiles across Europe, partly due to different weather patterns for wind-power generation. Given this reliance on imports and Denmark’s renewable-energy goals, the plan should better take into account the plans of the other connected Member States. The plan states that regional developments will be monitored but does not spell out specific measures. • Despite Denmark’s goal of reducing GHG emissions by 70% by 2030 and the aim to achieve net-zero emissions by 2050 at the latest, natural gas and oil will continue to play a role in the years to come. Denmark therefore continues to support investments in oil and gas extraction in the North Sea. • Specific policies and measures to ensure that storage will be able to play this key role would provide clarity and certainty as to how the electricity system will cope with the increase of renewable energy in electricity generation. Although the plan presents policies and measures to increase interconnectivity and draw up a smart-energy plan, it is vague on details to address the implications of electricity being increasingly based on variable generation.
Internal energy market	• Denmark’s current interconnectivity level is 50.6%, well above the EU target of 15% for 2030. However, it does not contain any specific target for the level of electricity interconnection by 2030. • The share of renewable energy in electricity is projected to be more than 100% in 2030.	➔ Partially addressed • Given Denmark’s objective of having the most integrated, market-based and flexible energy system in Europe, its plan lacked detail on competition, liquidity and forward-looking objectives, in particular for gas. Forward-looking and measurable objectives would be a useful addition to the NECP. • The plan also refers to the market-based procurement of energy and non-energy services by transmission-system operators to improve price signals. However, it does not contain policies and measures on other aspects of market integration • The plan would still benefit from a selected number of clear and detailed objectives for: system flexibility; smart grids; demand response and aggregation; storage; distributed generation; consumer protection; and competitiveness in the retail sector. • Denmark provided a rudimentary description of the current situation on energy poverty. However, Denmark’s general intention to consider vulnerable consumers further under the Electricity Market Design Directive could be strengthened by a target of reducing energy poverty, or by maintaining already low levels of energy poverty through the energy transition.

Research, innovation and competitiveness	• In the 2018 Energy Agreement, Denmark committed to spend DKK 50 million (EUR 6.7 million) in 2020 on research, development and demonstration of new energy technology. With the research reserve agreement in 2020, spending on green research, development and demonstration will be increased by DKK 1 billion (EUR 134 million) in 2020 in addition to the existing spending targets. • Denmark's strategy is to invest in areas in which there is a particularly good match between global demand for new energy technology on the one hand, and 'Danish strongholds' (i.e. areas where Danish businesses are already strong, such as wind power, district heating, energy efficiency, bioenergy, smart grids and system integration) and business potential on the other. • On competitiveness, the main elements are the 'green entrepreneurialism' priority of delivering green solutions to the fast-growing global market support green diplomacy. Instruments in Denmark's export scheme (totalling DKK 174 million, approximately EUR 23.3 million, from 2019 to the end of 2024) include funding for export-promotion activities allocated through tenders and subsidies.	➔ Partially addressed • NECP does not describe a quantitative funding target at this stage. • Denmark declared that its SET plan is being implemented through the Horizon 2020 and ERA-Nets programmes for funding research. The plan NECP did not provide details on the funds allocated to each implementation plan. • The NECP says that the Danish energy-technology development and demonstration programme is in line with the objectives of the SET plan. However, the plan does not explain how this contributes to reaching Denmark's national energy-and-climate objectives. • Denmark does not have any funding target for private R&I in the energy union. • With an excess production of renewable electricity planned in the course of the next decade, and a need to decarbonise all sectors of its economy, Denmark is promoting research and development in energy-storage technologies. As a specific action, the country set up a fund of EUR 17 million to support demonstration projects in energy storage. Danish pension funds announced they would invest EUR 47 billion to support the green transition by 2030, which is more than the investment needs identified by Denmark. This implies that Denmark has sufficient financing to deploy low-carbon technologies.

Guidance on the implementation of the NECP and the link to the recovery from the Covid-19 crisis

Main points:

- In its plan, Denmark confirms an economy-wide target for non-ETS GHG-emissions reduction by 2030, compared to 2005, of 39%, in line with the ESR. The plan presents only a scenario with existing measures, in which the target would be missed (by 13 percentage points). Planned policies and measures are not described and the plan does not clarify whether Denmark intends to make use of the ETS and LULUCF flexibilities.
- Denmark's plan leaves still scope to further develop and reinforce policies and measures on both renewables and energy efficiency as to contribute more to the EU climate and energy targets and strengthen the green transition.

Renewables

- Denmark committed to increase the share of renewables in gross final energy consumption to 55% in 2030. However more detailed policies are needed, notably for electricity. This includes building up supply chains and provide certainty for investors for offshore wind, advanced transport fuels and bio-energy. The sustainable use of biomass would require continued vigilance due to the high share of biomass in the energy sector.

Energy efficiency

- Denmark would benefit from adopting and implementing additional policies and measures that would deliver additional energy savings by 2030 and allow increasing the level of ambition. The commitment in the NECP to increase Denmark's contribution to the EU's 2030 energy efficiency target beyond what has been notified so far is welcome, as there is room for Denmark to contribute more. The continuing growth in energy consumption in Denmark (2015-2018) indicates that here is potential for further measures and improvement of energy efficiency in several sectors.
- Although additional measures regarding more efficient transport and vehicles have been identified, more can be defined, decided and fully implemented.
- Denmark can also take further advantage of the energy efficiency first principle and strive towards better integration of policies relating to energy efficiency. It could be useful to establish additional funding mechanisms to scale up investments in energy efficiency and consider the opportunities provided in existing and new relevant EU initiatives. Improving and increasing the role of energy efficiency could be an important tool in Denmark's efforts to reach its legally binding target of reducing GHG emissions by 70% by 2030.
- The improvement of energy efficiency in buildings has much potential for speeding up energy savings and contributing to the recovery of the economy after the Covid-19 pandemic. Building on the momentum of the Renovation Wave initiative, there is scope for Denmark to intensify efforts to improve the energy performance of the existing building stock with concrete measures, targets and actions. Denmark would need to underpin the substantial energy saving potential of the existing building stock by implementing the long-term renovation strategy.

Security of supply

- Denmark would benefit from a strengthened cooperation with the other connected Member States. Since the plan puts forward a more important role for storage, having more concrete policies and measures would provide clarity and certainty as to how the electricity system will cope with the increase of renewable energy in electricity generation. The plan provides reference to the emergency plans for gas, but it would be beneficial for Denmark to have such plans available also for electricity and oil.

Internal energy market

- Denmark has set the objective of having the most integrated, market-based and flexible energy system in Europe. Setting-up concrete measures, milestones and a clear timeline as regards system flexibility, smart grids, demand response, aggregation, storage, distributed generation, consumer protection and competitiveness in the retail sector would further support this objective. A deeper analysis of key issues such as market barriers for new participants would be beneficial in this regard.

Research, innovation and competitiveness

- The recently adopted Climate Law will require further support to Denmark's research and innovation base in order to reach the target's ambition. The strategy to invest in areas where demand can match "Danish Strongholds" can prove supportive to competitiveness. However, the link between these research, innovation and competitiveness measures with the undertaken SET plan activities would need to be ensured.

Investments

- Investments are needed for installation of new renewable energy capacity, while significant investment needs are also identified in households (energy efficiency and conversion of heat supply), industry as well as biogas and district heating. Private capital is expected to constitute a substantial proportion of the funding.

For all investments implementing the national energy and climate plan, Denmark is invited to ensure these are in line with national, regional or local.

European Commission's assessment of the final NECP of Estonia

STRUCTURE

13. Consideration by the Commission on the implementation of the recommendation from 2019

The October 2020 assessment document includes a general overview of the implementation of the Commission recommendations from 2019 in the final NECPs.

14. Assessment of the final NECP (objectives, contributions, measures, impact, investments)

This section consists in a general summary of the planned measures, divided by areas (Decarbonisation, Renewable energy, Energy efficiency, Energy security, Internal energy market. Research innovation and competitiveness.), with an evaluation on the basis of targets, implementation and Impact. The document focuses on the trajectories outlined to achieve the described targets, however never going into too much detail technology-wise. It is and update of the 2019 Report.

15. Guidance on the implementation of the NECP linked to the recovery plans from the Covid-19 crisis

This section addresses the link between the final plan and the recovery efforts from after the COVID-19 crisis by pointing at possible priority climate and energy policy measures Italy could consider when developing its national recovery and resilience plan in the context of the Recovery and Resilience Facility.

16. Annexes:

- I: Potential funding from EU sources to Estonia 2021 – 2027
- II: Detailed assessment of how Commission recommendation have been addressed

CONTENT

2019 Recommendations and Assessment of the final NECP by the Commission

Here following a summarized table, including the 2019 Recommendation from the Commission and the evaluation of the implementation of those recommendation within the final version of the NECP together with the assessment of the final NECP.

	NECP	Related Recommendation and evaluation on its implementation	Assessment
Renewable Energy	The **renewable energy** contribution to the 2030 EU level target is 42% of gross final energy consumption in 2030.	Underpin the welcomed level of ambition of a 42% renewable energy share for 2030 as Estonia's contribution to the Union's 2030 target for renewable energy by detailed and qualified policies. ➔ Partially addressed	**Sufficiently ambitious** as it is above the 37% resulting from the formula in Annex II of the Governance Regulation. The indicative trajectory reaches all reference points as required by the Governance Regulation The measure aimed at increasing the uptake of alternative fuels in transport, aims among other things at achieving the renewable energy target for the transport sector. However, it mentions no other targets for 2030 but a 10% share of methane fuels in the energy consumption of road vehicles, which seems not to be an especially renewable target.
		Provide measures on the enabling frameworks for renewable self-consumption and renewable energy communities. ➔ Partially addressed	In its final NECP, Estonia explains that it allows for convenient and easy creation of renewable energy communities and the production of renewable energy for self-consumption. This recommendation has not been fully addressed, since the NECP does not deliver detailed and quantified policies and measures.
	Electricity sector: desynchronisation from the BRELL (Belarus, Russia, Estonia, Latvia and Lithuania) system and synchronisation with the Continental Europe synchronous area. The sector has a target of 40% renewable electricity in 2030.		Estonia provides little additional information in its final NECP compared to the draft plan that could demonstrate that the Commission's recommendations have been addressed. The limited information on policies and measures makes it difficult to assess whether the overall or specific shares of renewables will be reached.
	Heating and cooling: Estonia expects that renewable energy in 2030 will represent 63% of the gross final consumption of heat when compared to the 55.3% projected for 2020	Provide additional details on measures to meet the indicative target in the heating and cooling sector pursuant to Article 23 of Directive (EU) 2018/2001.	The key policies and measures in the heating and cooling sector are economic and policy support for renewable energy production and the utilisation of the potential of cogeneration, support to transition from oil to renewables,

		➔ Partially addressed	the renovation of district heating networks and boilers and promotion of the use of local renewables. The final NECP **does not provide** any further information regarding measures to meet the renewable heating target by 2030 and the role of waste heat and cold.
	Transport: Estonia aims to meet the 14% target by 35% 'second generation' biofuels and 65% electricity with the applicable multipliers in line with the Renewable Energy Directive, however without a clear split between the multipliers and caps.	Ensure that adequate measures are in place for the increase of renewables to meet the transport target set out in the draft plan and in line with Article 25 of Directive (EU) 2018/2001. ➔ Partially addressed	Estonia does not provide clarifications on what is understood by first- and second-generation biofuels, as these terms are not used in the Directive. The key policies and measures to achieve this are listed under additional possible measures, and they are **considered insufficiently detailed** to be able to assess their impact on the achievement of the target.
Energy efficiency	Estonia's national contribution for energy efficiency in 2030 is 5.4 Mtoe for primary energy and 2.9 Mtoe for final energy consumption. Estonia has the second highest energy intensity of economy (after Finland) in the EU.	Increase the level of ambition towards decreasing both final and primary energy consumption in 2030 in view of the need to increase the level of efforts necessary to reach the Union's 2030 energy efficiency target. ➔ Partially addressed	The plan provides descriptive information on policies and measures beyond 2020 targeting transport, buildings, "thermal transmission "(district heating), "public sector" and "other" sectors. The energy savings contribution of these measures towards the 2030 target is not reported and it is not possible to assess which policies and measures are expected to have the largest impact or to asses if they are sufficient to reach the contribution.
	Estonia presents the cumulative savings to be achieved under Article 7 of Energy Efficiency Directive with a cumulative amount of 1.26 Mtoe and (52.8 TJ). This will be achieved by alternative measures targeting reconstruction of private residences, apartment buildings, public sector, and business buildings, increasing the fuel efficiency of the transport sector, and more.	Support it with policies and measures that would deliver additional energy savings by 2030. In the final plan include all the policies and measures planned to achieve the cumulative savings goal with a realistic schedule of implementation and a clear assessment of their investment needs. ➔ Partially addressed	Estonia's contribution for primary energy consumption is the same as in the draft plan and for final energy consumption is of rather modest ambition. As a result, both contributions are assessed as of modest ambition compared to the EU efforts needed to achieve the target.
	Regarding energy **efficiency in buildings** Estonia sets a clear objective to renovate 3%/year of the floor area of public buildings owned by the national government. This represents 170,000 m2 by 2030.	➔ Partially addressed	With regards to buildings, the plan provides useful elements, while more information has been provided on the renovation of the building in long-term renovation strategy that Estonia submitted on 13/07/2020.

Energy Security	The plan indicates that the main instrument to achieve energy security in gas is the Balticconnector pipeline which has been commissioned at the end of 2019. Additionally, Estonia indicates that it has set the target to increase the biomethane production volumes.	Specify measures to ensure the electricity generation adequacy in light of the ambitious renewables target, including measures on demand response and storage ➔ Partially addressed	The final plan specifies that the National Regulatory Authority may impose an obligation on the system operator to invite tenders for the creation of new production capacities, without detailing it further. The plan could benefit from further elaboration on the potential evolution of the Estonian generation mix and ensuring the electricity system adequacy related to it. The plan includes general considerations on cybersecurity; however, it does not go into specifics of the energy sector
	The plan acknowledges that the key objective for Estonia in the **electricity sector** is desynchronisation from the BRELL (Belarus, Russia, Estonia, Latvia, and Lithuania) system and synchronisation with the Continental Europe synchronous area	➔ Partially addressed	The plan highlights that the successful completion of this project will contribute to individual targets related to energy security and enable further market integration. The planned policies and measures are considered credible in relation to the achievement of the objectives.
Internal Energy Market	The plan states that Estonia's current interconnectivity level is 63%, which is above the target set at EU level. The plan mentions the Baltic interconnection project, which will strengthen the interconnections between the Baltic States.	Define forward-looking objectives and targets concerning market integration, in particular measures to develop more competitive retail markets and to increase the level of consumer engagement in the retail market. ➔ Partially addressed	The plan provides a **sufficient overview** of current **market conditions** for electricity, regarding market concentration and liquidity as well as high level of wholesale price convergence with neighbouring countries. The final plan refers to a single gas market in the Baltic States established in 2017 through a regional cooperation of transmission system operators. The final plan **does not include** further policy objectives and measures related to the **competitiveness** and **flexibility** of retail markets or to **consumer engagement** and **protection.**
Research, Innovation and Competitiveness	The plan presents general objectives for research and innovation for the 2014-2020 period, such as reaching a level of R&D corresponding to at least 3% of the GDP, and private sector R&D expenditure amounting to 2% of the GDP.	Further clarify the national objectives and funding targets in research, innovation and competitiveness, specifically related to the Energy Union, to be achieved between now and 2030, so that they are readily measurable and fit	The development plan for Estonian research, development, innovation, and entrepreneurship 2021-2035 is currently being developed but no targets are indicated, therefore efforts are **still insufficient**

		for purpose to support the implementation of targets in the other dimensions of the integrated national energy and climate plan. ➔ Partially addressed	
	When it comes to the **low-carbon technologies sector**, a “Green Technology Investment Programme” is planned to boost start-ups and scale-ups who develop and bring to market new products, services and technologies that reduce greenhouse gas emissions. The aim is to mobilise additional private capital through public equity investments.		In regards to competitiveness, the emphasis is put on a set of quantified objectives by 2030, aimed at ensuring affordable energy supply and contributing to improving Estonia's overall macroeconomic competitiveness. The low-carbon technologies sector is developed especially in energy storage technologies, and measurable objectives are provided until 2030.
		Underpin such objectives with specific and adequate policies and measures, including those to be developed in cooperation with other Member States, such as the Strategic Energy Technology Plan ➔ Partially addressed	The NECP does not mention the Strategic Energy Technology (SET) Plan, even though Estonia is actively participating in three implementation working groups on photovoltaics, offshore wind and carbon capture utilisation and storage.
Investments	Estonia estimates average expenses of EUR 226 million per year between 2021 and 2030. Just shy of half of these investments concern the renovation of buildings, while 26% would fall to transport, 15% to the energy system, and 12% to agriculture.	Provide a general overview on the investment needed to modernise its economy by reaching its energy and climate objectives, and a general assessment of the sources of that investment, including appropriate financing at national, regional, and Union level. ➔ Partially addressed	The plan does not provide a full picture concerning the overall investment needs to modernise Estonia’s economy by reaching its energy and climate objectives. Estonia would benefit from further clarifying the full investment needs of decarbonising its power and transport sectors, including investments needed for the electricity grid, for energy storage, and for transport infrastructure.
Regional cooperation	In the final NECP, Estonia indicates that in the regional consultations with the other Baltic state's opportunities have been identified for regional co-operation in renewable energy and related technologies.	Intensify the already good regional cooperation arrangements between Baltic countries (Estonia, Latvia, and Lithuania); extend them to new areas and broaden the geographic reach to include the	Regional cooperation with the Baltic partners is also already happening in areas of GHG emissions projections reporting, LULUCF, agriculture and land use sectors. Estonia is also participating in the Baltic-Nordic energy research cooperation program:

		Nordic countries (Denmark, Finland, Iceland, Norway, and Sweden). ➔ Fully addressed	
		The focus of the regional exchanges should be on internal energy market and energy security areas, in view to the changes in the electricity systems accommodating higher shares of renewable electricity, which will increase electricity import/export and enhance the need for system flexibility, as well as on the decarbonisation of the transport sector and research. ➔ Largely addressed	Estonia recognises the potential for further cooperation in areas highlighted in the Commission recommendation and points out that cooperation with Baltic countries concerns such areas as the gas market, the synchronisation of the power systems and cross-border electricity and gas projects

Guidance on the implementation of the NECP and the link to the recovery from the Covid-19 crisis

Main points:

- **On renewables**, Estonia committed to achieve 42% share of renewable energy in final energy consumption in 2030. The additional measures shall be based on a more specific and detailed planning of the renewable energy generation sources. Furthermore, Estonia could implement initiatives to overcome administrative burden. Focus on implementing the planned measures in transport would especially be beneficial for Estonia to fill the gap between the current situation and the national and EU objectives in this sector.
- **On energy efficiency,** Estonia would benefit from adopting and implementing additional policies and measures that would deliver additional energy savings by 2030. To ensure effectiveness of those policies it is important to underpin them with a detailed assessment of impacts and investment needs. Estonia should underpin the substantial energy saving potential of the existing building stock by **implementing the long-term renovation strategy**, in accordance with Article 2a of the Energy Performance of Buildings Directive.
- **Regarding energy security**, Estonia is expected to concentrate on the swift implementation of all investments and measures required for the synchronization, together with Lithuania and Latvia, with the European continental grid.

- Concerning the **internal energy market,** Estonia could reinforce the monitoring and analysis of retail market competitiveness aspects, notably by introducing concrete objectives as well as corresponding implementation targets/timelines and indicators to assess related progress on retail market competition, demand-side flexibility and consumer empowerment.
- **On research, innovation and competitiveness**, Estonia would benefit from further developing national energy-specific policies and measures, specifically supporting the achievement of national objectives and targets in the other Energy Union dimensions and those of the European Green Deal.

Key areas indicated by the Commission to be considered when developing the national recovery and resilience plan:

1. **Measures for reforms** and investment into the expansion of **renewable sources of energy** in view of supporting the **phase-out of oil shale** from electricity production, including accompanying investments into the electricity grid and into storage solutions.
2. **Measures supporting** the **renovation of buildings**, including integration of renewables, and continue the phase-out of carbon-intensive heating technologies.
3. Measures for reforms and investment into sustainable transport modes, including the completion of Rail Baltica and increased rail electrification.
    - plans for air pollution reduction, such as the National Air Pollution Control Programme (NAPCP), and relevant air quality management plans.
    - In implementing its plan, Denmark is invited to make the best possible use of the various funding sources available, combining scaled-up public financing at all levels (national and local, as well as EU funding) and leveraging and crowding in private financing

Regional cooperation

- Denmark has continued to work together with the other North Seas Energy Cooperation countries, notably exploring the possibilities for concrete joint offshore wind projects that would be connected to and supported by several Member States. Denmark is invited to continue ongoing efforts on regional cooperation in view of intensifying exchanges and initiatives facilitating the implementation of its national energy and climate plan, in particular as regards relevant cross-border issues. Denmark is also invited to better exploit the potential of the multilevel climate and energy dialogues to actively engage and discuss with regional and local authorities, social partners, civil society organisations, business community, investors and other relevant stakeholders the different scenarios envisaged for its energy and climate policies.

Energy poverty

- A target of reducing energy poverty, or maintaining already low levels of energy poverty as part of the energy transition, would support Denmark's general intention to consider vulnerable consumers through specific and measurable objectives. Denmark is encouraged to consult the Commission Recommendation of 14 October 2020 on energy poverty and its accompanying staff working document providing guidance on the definition and quantification of the number of households in energy poverty and on the EU-level support available to Member States' energy poverty policies and measures.

Energy subsidies

- Denmark is invited to continue and update the identification and reporting on energy subsidies and continue actions to phase out subsidies, in particular for fossil fuels. The green transition in Denmark would receive a further boost from rapid phase-out of the fossil-fuel subsidies identified in the NECP and recent Commission analyses. This would involve the further development and implementation of specific plans with associated timelines, coupled with measures to mitigate the risk of households' energy poverty

Key areas - indicated by the EC - to be considered for the development of the national recovery and resilience plan:

1. Measures to promote a **green tax reform** while ensuring a just transition for the most affected households and companies;
2. Measures to promote **sustainable energy production**, including clean hydrogen;
3. Measures to promote **increased energy efficiency through building renovation**, notably in the residential sector and primarily in social housing, as well as renovating heating and cooling technical building systems

European Commission's assessment of the final NECP of Finland

STRUCTURE

17. Consideration by the Commission on the implementation of the recommendation from 2019

The October 2020 assessment document includes a general overview of the implementation of the Commission recommendations from 2019 in the final NECPs.

18. Assessment of the final NECP (objectives, contributions, measures, impact, investments)

This section consists in a general summary of the planned measures, divided by areas (Decarbonisation, Renewable energy, Energy efficiency, Energy security, Internal energy market. Research innovation and competitiveness..), with an evaluation on the basis of targets, implementation and Impact. The document focuses on the trajectories outlined to achieve the described targets, however never going into too much detail technology-wise. It is and update of the 2019 Report.

19. Guidance on the implementation of the NECP linked to the recovery plans from the Covid-19 crisis

This section addresses the link between the final plan and the recovery efforts from after the COVID-19 crisis by pointing at possible priority climate and energy policy measures Finland could consider when developing its national recovery and resilience plan in the context of the Recovery and Resilience Facility.

20. Annexes:

- I: Potential funding from EU sources to Finland, 2021 – 2027
- II: Detailed assessment of how Commission recommendation have been addressed

CONTENT

2019 Recommendations and Assessment of the final NECP by the Commission

Here following a summarized table, including the 2019 Recommendation from the Commission and the evaluation of the implementation of those recommendation within the final version of the NECP together with the assessment of the final NECP.

	NECP	Related Recommendation and evaluation on its implementation	Assessment
Renewable Energy	The national contribution to the 2030 EU **renewable energy** target is specified in the plan at a level of 51% in gross final consumption of energy in 2030 (compared to 41.2% in 2018).	Increase the level of ambition for 2030 to a renewable energy share of at least 51% as Finland's contribution to the EU's 2030 target for renewable energy ➔ Fully addressed	Finland has set a 51% share as Finland's national contribution to the EU's binding target of at least 32% of renewable energy in compliance with the Renewable Energy Directive, which is in line with the formula.
	Finland has not set a specific target for renewables in **electricity**. However, the scenario with additional measures projects a share of renewables in electricity of 53% (52% in the scenario with existing measures (WEM), vs 38.8% in 2018).		
	A number of measures target the use of renewables in **heating and cooling**, including a quota obligations for biofuels in heating and the phasing out of oil heating. However, no specific target is provided.	Put forward detailed and quantified policies and measures that are in line with the obligations ➔ Partially addressed	For electricity and heating and cooling, the plan lacks detail on the quantified impact of policies and measures.
	The proposed renewable energy share in the **transport** sector is 45%16, a significant increase compared to the current level (14.9% in 2018).	Put forward detailed and quantified policies and measures that are in line with the obligations ➔ Partially addressed	On transport, the plan mentions specific measures to limit CO2 emissions and provides quantifications of the impact. Finland aims to increase the share of renewable energy to 30% of the final energy use in road transport. The plan contains objectives for the share of transport biofuels to be increased to 30% and to have 250,000 electric and 50,000 gas-powered vehicles on the roads.

Energy efficiency	Finland's national contribution for **energy efficiency** in 2030 is set at 25 Mtoe of final energy, translating into 34.8 Mtoe of primary energy consumption.	As regards energy efficiency, substantially increase the ambition towards reducing both final and primary energy consumption in 2030 in view of the need to increase the level of efforts to reach the EU's 2030 energy efficiency target. ➔ Partially addressed	The ambition was increased but the level for both primary energy consumption and final energy consumption is low compared to efforts at EU level.
	The plan describes **policies and measures** beyond 2020, targeting all sectors. Finland has included new measures for the transport sector (transport fuel taxation, promoting modal shifts, rail infrastructure investments), agriculture and waste heat. Finland presents the **cumulative savings** to be achieved at a level of 105 TWh (9.03 Mtoe).	Support the increased ambition with policies and measures that would deliver additional energy savings by 2030. ➔ Partially addressed Assess the reasons behind the expected increase of the gross domestic product (GDP) being accompanied by an increase of energy consumption, and identify specific measures to mitigate such effect. ➔ Partially addressed	Finland has included new measures for the transportation sector, agriculture and waste heat. However, some of these measures do not have energy efficiency as a main priority and some have already been implemented. An explanation is provided, based on the projected GDP growth in heavy industries with high energy intensity (such as pulp production, biorefineries and data centres). However, the plan does not specify which policies and measures would mitigate this effect.
	Regarding **buildings**, the plan presents the initial target levels for heating energy use by buildings (excluding saunas) at 54 TWh in 2030, 45 TWh in 2040 and 37 TWh in 2050, including the energy harvested by heat pumps. This corresponds to energy savings of 16% in 2030, 30% in 2040 and 42% in 2050, when compared to the baseline of 2020.	Look at the energy savings potential in the residential and industrial sectors and identify the most appropriate measures to address it. ➔ Partially addressed	The energy savings potential in the individual sectors is not described. The policies and measures target these sectors but it is unclear what specific sectors are targeted by a particular policy or measure. The information provided on the renovation of the building stock has been improved.
Energy Security	Maintaining a high level of **security of supply** is crucial to transforming the energy system, with an objective of 51% of renewable energy in Finland by 2030.	Specify the measures supporting the energy security objectives on diversification and reduction of energy dependency, including measures ensuring flexibility. ➔ Largely addressed	The main security measure emphasised by Finland is a well-functioning domestic and regional electricity market that provides the right signals for any needed investments.

	Reference is made to **cyber security** exercises that have been carried out, although the plan provides no overall assessment of how resilient the energy sector is. In relation to critical infrastructure, the NECP sets out investment plans and states that networks are resilient to extreme weather conditions.		
	The plan envisages further measures to encourage **flexibility** through storage and demand side response and through investments in network infrastructure.		
Internal Energy Market	The plan states that Finland's **electricity interconnection** target for 2030 is to keep the level of interconnectivity above 15%, which is above the target set at EU level, despite some changes in installed capacity for both generation and interconnection.	No recommendations (n/a)	
Research, Innovation and Competitiveness	In terms of **research and innovation**, the NECP describes some seemingly well-functioning support programmes, the country's overall good track record in clean energy technologies and strong export capability. The plan identifies a goal for investment to reach 4% of total GDP.	Further clarify national objectives and funding targets in research, innovation and competitiveness, specifically related to the Energy Union, to be achieved between now and 2030 ➔ Partially addressed	The goal of the new government to raise RDI investment to 4% of GDP is welcome and the plan also identifies research and innovation efforts in relevant areas.
	As regards **competitiveness**, the emphasis is on turning Finland, already among the top clean-tech players in the EU, into the world's best environment for innovation and experiments by 2030..		

	The NECP stresses that additional **investments** in research and innovation will be needed for low-carbon technologies, especially bioeconomy, the circular economy, clean energy solutions, energy efficiency, emissions-free forms of energy production, energy storage solutions, carbon recovery and energy utilisation.		
Investments	Finland is active within the **Strategic Energy Technology (SET) Plan**, leading two actions: (1) energy efficiency in industry; and (2) renewable fuels and bioenergy. However, the NECP does not detail **investments** for each SET Plan action or provide further explanations as to how the SET Plan can contribute to reaching the national energy and climate objectives.	No recommendations (n/a)	
Regional cooperation		Intensify the already good regional cooperation arrangements between Nordic countries (Denmark, Finland, Iceland, Norway and Sweden), extending them to new areas and broadening the geographic reach to include the Baltic States (Estonia, Latvia and Lithuania). ➔ Fully addressed	The final plan states that NECPs will give a solid basis for future cooperation on energy and climate policy with Nordic and Baltic states.

Guidance on the implementation of the NECP and the link to the recovery from the Covid-19 crisis

Main points:

- On **renewables**, more detailed policies for electricity would be beneficial to build up supply chains and provide certainty for investors

- On **energy efficiency,** the ambition has increased compared to the draft NECP, but there is still room for Finland to further reduce final and primary energy consumption in 2030, also in view of Finland's ambition to be carbon neutral by 2035. Finland can take further advantage of the energy efficiency first principle and streamline energy efficiency measures with other efforts to shape a smart, efficient and integrated energy system.
- Finland would benefit from further developing measures to support the **energy security** and internal market objectives, including measures to ensure system resilience. This includes, in particular, specific measures to preserve and strengthen cybersecurity in the energy sector.
- Finland would benefit from defining clear indicators to track progress towards its **research and innovation and competitiveness** objectives. Over time, the gathering of granular research, innovation and competitiveness data will be useful to help strengthen this process. Finland would also need to ensure the link with the SET Plan activities.
- Finland has been rather proactive in terms of **regional cooperation**, notably in the context of the Baltic Energy Market Interconnection Plan (BEMIP) High Level Group and in the context of the regional cooperation between the Nordic countries. Finland is invited to continue ongoing efforts to intensify exchanges and initiatives facilitating the implementation of its NECP, particularly as regards relevant cross-border issues. Finland is also invited to better exploit the potential of the **multilevel climate and energy dialogues** to actively engage with regional and local authorities, social partners, civil society organisations, the business community, investors and other relevant stakeholders, and to discuss with them the different scenarios envisaged for its energy and climate policies**.**
- The final plan constitutes a strong basis for Finland to design climate and energy-related aspects of its national recovery and resilience plan and to deliver on broader European Green Deal objectives.

Key areas indicated by the Commission to be considered when developing the national recovery and resilience plan:

1. **Measures** to **promote a carbon neutral economy** and ensure **more consistent price signals** to foster energy sector integration, energy efficiency and renewable energy;
2. **Measures and investments** to **promote energy efficiency in buildings**, including automation and digitalisation, as well as the decarbonisation of heating systems;
3. Measures and investments to promote the electrification and capacity of railways.

European Commission’s assessment of the final NECP of France

STRUCTURE

21. Consideration by the Commission on the implementation of the recommendation from 2019

The October 2020 assessment document includes a general overview of the implementation of the Commission recommendations from 2019 in the final NECPs.

22. Assessment of the final NECP (objectives, contributions, measures, impact, investments)

This section consists in a general summary of the planned measures, divided by areas (Decarbonisation, Renewable energy, Energy efficiency, Energy security, Internal energy market. Research innovation and competitiveness), with an evaluation on the basis of targets, implementation and Impact. The document focuses on the trajectories outlined to achieve the described targets, however never going into too much detail technology-wise. It is and update of the 2019 Report.

23. Guidance on the implementation of the NECP linked to the recovery plans from the Covid-19 crisis

This section addresses the link between the final plan and the recovery efforts from after the COVID-19 crisis by pointing at possible priority climate and energy policy measures France could consider when developing its national recovery and resilience plan in the context of the Recovery and Resilience Facility.

24. Annexes:

- I: Potential funding from EU sources to France 2021 – 2027
- II: Detailed assessment of how Commission recommendation have been addressed

CONTENT

2019 Recommendations and Assessment of the final NECP by the Commission

Here following a summarized table, including the 2019 Recommendation from the Commission and the evaluation of the implementation of those recommendation within the final version of the NECP together with the assessment of the final NECP.

	NECP	Related Recommendation and evaluation on its implementation	Assessment
Renewable Energy	The **renewables share** is set at 33% in gross final consumption of energy in 2030	Increase the level of ambition for 2030 to a renewable share of at least 33% as France's contribution to the Union's 2030 target for renewable energy, as indicated by the formula in Annex II of Regulation (EU) 2018/1999. ➔ Fully addressed	This is **considered sufficient** as it is line with the formula set out in Annex II of the Governance Regulation. However, the final plan does not mention which sector is contributing to achieve the 1% improvement compared to the draft NECP since sectoral shares are the same as the draft. The indicative trajectory for all reference points is not properly reflected.
		Include an indicative trajectory in the final integrated national energy and climate plan that reaches all the reference points pursuant to Article 4(a)(2) of Regulation (EU) 2018/1999 in accordance with that share, in view of the need to increase the level of efforts for reaching this target collectively. ➔ Not addressed	The reference year 2022, 2025 and 2027 are not presented in the final NECP; only years 2023 and 2028 are covered.
		Put forward detailed and quantified policies and measures that are in line with the obligations laid down in Directive (EU) 2018/2001 of the European Parliament and Council (8), to enable	Many policies and measures **are quite detailed** for the three sectors ((i) electricity, (ii) heating and (iii) cooling and transport) but are **not fully quantified**. On cost-effective achievements in the electricity sector, a whole section has

		a timely and cost-effective achievement of this contribution. ➔ Largely addressed	been added in which the cost of renewables support is assessed up to the horizon of 2028, per technology.
		Ensure that the renewable energy target for 2020 set in Annex I of Directive 2009/28/EC of the European Parliament and of the Council (9) is fully met and maintained as a baseline from 2021 onwards and explain how it intends to meet and maintain such baseline share. ➔ Not addressed	The plan does **not include data on the achievement of the 2020 target or projections**. (Only 2023 projected renewables level is higher than 2020 target level.)
	Electricity sector: France aims to cover a 40% share of its electricity consumption from renewable energy sources by 2030. This will be achieved by doubling the installed capacity of electric renewable energies in 2028 compared to 2017 with an installed capacity of 101 to 113 GW in 2028 and 36% of renewable energy in electricity production in 2028. Installed renewable energy capacity will be increased by 50% by 2023.		
	Heating and cooling: a share of 38% of renewables is set for 2030.	Reconcile the objectives put forward in its draft integrated national energy and climate plan for the share of renewable energy in the heating and cooling sector and in the transport sector with the indicative target included in Article 23 of Directive (EU) 2018/2001 and the transport target in Article 25 of Directive (EU) 2018/2001, respectively. ➔ Partially addressed	This corresponds to 1.2 percentage points of the annual average and **is in line with indicative 1.1 percentage points** as an annual average calculated for the periods 2021 to 2025 and 2026 to 2030 as provided under Article 23 of Directive 2018/200117, provided that waste heat is not included in this target. The final NECP includes an average increase of 1.2 pp., but it is **not clear whether waste heat is included in this objective**. The objectives are reconciled for 2030 transport target; however it is not fully clear if the calculation follows the methodology of Directive 2018/2001.

	Transport: France provides a target of 15% of final fuel consumption supplied by renewables. The key policies and measures to achieve this are improving the energy efficiency of new road transport vehicles by imposing emission standards on car manufacturers; encouraging the development of low-emission vehicles; addressing obstacles to the development of electric vehicles; promoting the development of biofuels and other alternative fuels; supporting modal shift. France also aims to increase biomethane consumption to 7% of consumption of gas in 2030. France has also set itself an objective of 10 to 100 MW of electrolyser capacity and a share of decarbonised hydrogen in industrial hydrogen consumption of 20% to 40% by 2028.		The target is **above the 14% target** laid down in Article 25 of Directive 2018/2001[18].
Energy efficiency	France's national contribution for **energy efficiency** in 2030 is 202.2 Mtoe for primary energy, as a projection and **120.9 Mtoe for final energy**, translating the target of 20% reduction in final energy consumption compared to 2012.	Review the efforts on reducing primary energy consumption to contribute to reaching the collective Union's 2030 energy efficient target. France's contribution is of sufficient ambition for final energy consumption. ➔ Partially addressed	This target needs to be scaled up to achieve a 50% reduction in energy consumption in 2050 compared with 2012. On primary energy consumption, the contribution remains broadly the same. The ambition level was slightly increased for final energy consumption.
		Include details on the expected impacts of the planned policies and measures in the final integrated national energy and climate plan, to make sure that their scale of implementation would be sufficient to deliver the necessary reductions of energy consumption. ➔ Largely addressed	The plan **provides detailed and comprehensive information** on the policies and measures planned beyond 2020. Overall, the measures are considered sufficient in relation to the achievement of the target, although only the impacts of the energy efficiency obligation scheme (EEOS) are clearly assessed. France presents the cumulative savings to be achieved under Article 7 of Energy Efficiency Directive[19] with a cumulative amount of 65.2 Mtoe.[20] To achieve this goal, France relies entirely on a single and cross-cutting measure, which is the well established EEOS. Such a strategy is considered reliable as the EEOS has been extended to cover all end-use sectors (e.g. including agriculture), its monitoring and checking processes have

			been strenghtened and overall, in the last years, it has always achieved its expected results. More information was provided on the national measures, but their expected impacts are not fully quantified. The information provided on the renovation of the building is improved.
	On transport, the plan mentions several actions contributing towards a more efficient organisation of the mobility system and therefore towards improved energy efficiency and emissions reductions. For example, demand management, incentivising multimodality and modal shift, supporting active modes and developing low-emission zones, increasing investments in rail and waterborne transport infrastructure, digitalisation and automation.		
	Energy efficiency in buildings: the NECP includes a number of specific actions on buildings, with a quantitative objective to renovate 370,000 residential buildings per year by 2030. The plan presents measures addressing ‘passoires énergétiques’ (buildings with energy performance certificates F or G), public buildings and more generally a broad list of energy efficiency measures.		Financing mechanisms for building renovation are outlined; however they **lack specific information and figures** (e.g. m2 of buildings, energy savings, energy savings/m2, investments). Such information would allow a comprehensive evaluation of the ambition, effectiveness and feasibility of the measures, and how they link to the milestones and measurable progress indicators for the decarbonisation of the national building stock.
Energy Security	France faces the challenge of **simultaneously decreasing the share of nuclear energy and phasing out coal power plants**. France’s approach to ensure security of supply is to i) manage energy demand, ii) generate energy locally, mainly with renewables, and iii) diversify supplies. Policies and measures include reducing electricity peak demand and secure biomass supply.	Specify the measures supporting the energy security objectives on diversification and reduction of energy dependency, including measures ensuring flexibility, as well as information on planned nuclear generation capacity. ➔ Not addressed	No new elements added compared to the draft NECP. The plan assesses the **reduction of energy dependency and security** of supply by maintaining a **high quota of nuclear energy** in their mix. Increased diversification by renewable sources to cope with future crisis or technical issues. Several scenarios envisaged for 2030 and 2050, depending on variable outcomes. Security of energy supply is based on the **diversification of import sources, reducing import dependency by**

			increasing renewable energy. A clear strategy to guarantee the security of uranium supply is established combining geographical and commercial diversification, long-term contractual security and stock management.
	Maintaining a **high level of security of supply is a priority** in the ongoing transformation of the energy system, with an objective of 40% renewable electricity system and increasing share of domestic renewable energy to 33% by 2030. On security of supply for gas, France bases its strategy on maintaining the current gas stock capacities, with possible reductions in the future, and the development of flexible demand (at least 200 GWh/d of interruptible capacities by 2023).		
	The final plan assesses the **reduction of energy dependency and security of supply** by maintaining a high share of nuclear energy in the national energy mix. France aims at increasing diversification through renewable sources to cope with future crisis or technical issues. Several scenarios for 2030 and 2050 are envisaged. A clear strategy to guarantee the security of uranium supply is established combining geographical and commercial diversification, long-term contractual security and stock management.		
Internal Energy Market	France sets the objective of an **additional 10 GW of interconnections by 2030**, for a total capacity of 26 GW, corresponding to an interconnectivity level of approximately 16.5% for 2030. The plan lists **current projects of common interest**, which will increase interconnectivity. This includes the Celtic Interconnector, which will directly connect Ireland to the EU's Internal Energy Market following the UK's withdrawal from the European Union.	Define forward-looking objectives and targets concerning market integration, in particular measures to develop more competitive wholesale markets, including progressing towards fully market-based prices. ➔ Partially addressed	The target is above the target set at EU level. France reports on the phasing-out of regulated retail prices for the supply of gas and on the reduction of the scope of the beneficiaries of the regulated prices for the supply of electricity as per the recast Electricity Directive. However, the NECP fails to report on measures to develop more competitive wholesale markets, in particular on electricity.

	The plan provides for the **development of interconnections** with Spain, Italy, the UK and Ireland and studies for reinforcing interconnections with Germany, Switzerland and Belgium. France also plans to accompany decentralisation of generation, increase flexibility and smartness of networks, and prepare for smart sector integration, notably between electricity, gas and heat sectors.		
	The final plan **includes further policy objectives and measures related to the internal energy market** such as measures to ensure the non-discriminatory participation of new market entrants and the different flexibility sources in all energy markets. For example, measures are listed in support of demand response, storage and fostering the role of consumers and energy communities. On the recommendation to set objectives and move towards market-based prices, France reports on the Energy law passed in September 2019 where gas retail price regulation will be removed by 2023 and the scope of electricity price regulation will be limited to households and microenterprises, in line with the Electricity Directive. The role of aggregator and demand response is slightly expanded. The target for 'photovoltaic sites for self-consumption' is doubled for 2023 compared with the draft NECP.		
Research, Innovation and Competitiveness	The plan identifies **relevant areas where research and innovation** efforts lie. France included a number of policies, plans and roadmaps which include an R&I aspect – such as the climate plan, the national energy research strategy integrating the 2050 and 2028 roadmaps with sections on innovation, and the hydrogen deployment plan. On funding targets, France refers to its 2018 R&D expenditures and recalls that the trend over recent years	Underpin such objectives with specific and adequate policies and measures, including those to be developed in cooperation with other Member States, such as the European strategic energy technology plan. ➔ Partially addressed	Many policies and measures have been proposed, however there is a **lack of quantified objectives and targets**. The **cooperation with the strategic energy technology (SET) plan is clearly and extensively addressed** within the various Implementation Plans as well as its level of ambition of national objectives regarding competitiveness; its priorities interlinked with national priorities, but it is not clear how these will be implemented.

	has been to increase the funding of public research in new energy technologies.		Overall, France showed efforts to propose policies and measures in the fifth dimension of the Energy Union. However, there is **still a lack of quantified national objectives and quantified targets**, which make the adequacy assessment of their policies and measures impossible. Quantified objectives which are missing should be linked to specific and adequate policies and measures which are mentioned.
	As for the ongoing funding in this field, the investments for the future programme currently has an allocated total budget of around EUR 450 million within eight renewable energies. Among other initiatives, an Innovation Fund worth EUR 10 billion was created by the French government, generating EUR 250 million per year which are used to promote the emergence of breakthrough innovations and their mass production in France.	Further quantify the national objectives and funding targets in research, innovation and competitiveness, specifically related to the Energy Union, to be achieved between now and 2030, so that they are readily measurable and fit for purpose to support the implementation of targets in the other dimensions of the final integrated national energy and climate. ➔ Partially addressed	Due to a lack of quantified national objectives and quantified targets, the **plans assessment of these policies and measures is impossible to evaluate**. The NECP **identifies objectives and broad areas of R&I actions** (in energy, climate and mobility) but **without specific timeline nor quantified targets**. For some of the objectives support policies or measures beyond 2020 are presented, but for most of them neither timeline nor dedicated funding mechanisms are presented for the period beyond 2020. As regards competitiveness, there are no specific and measurable objectives.
	France aims to **promote and improve research and innovation in the energy sector**, particularly in geothermal energy, fission and fusion, hydrogen, batteries, offshore wind and second-generation solar PVs, which would also improve French competitiveness.		
	According to its final energy and climate plan, France considers this decade as a preparation period for a **massive deployment of the clean hydrogen as of 2030**. France will first focus on decarbonising existing industrial uses of hydrogen, like in the refinery, iron and steel, ammonia, plastics and glass sectors. The plan confirms the intention to develop research and demonstration		This **is in line with the gradual development of the EU hydrogen** economy foreseen by the Commission in its Hydrogen Strategy adopted in July 2020

	project on hydrogen and underlines France's commitment to fuel cell vehicles as well as refuelling stations by 2028.		
	The French government aims to **continue and step up support for R&D and innovation for the energy transition**, including confirming its commitments under 'mission innovation,' strengthen French participation in major international research programmes, and develop new training courses for jobs in the energy transition. The law on multiannual research planning was being debated within the French parliament at the time that the final plan was being drafted. Following adoption, the law should enter into force in 2020. The law addresses one of the three main challenges for R&I that is to say increasing the funding capacity for research projects, programmes and laboratories.		French national policies are **consistent with the goals of promoting innovation and financing in R&D and addressing needs** beyond the strict energy sector for the economy at large. However, specific and measurable objectives and targets on competitiveness are still missing. Regarding specific data, no reference is made to private R&I spending. However, information on patents is included under Section 2.5, but not at the level of low-carbon energy technologies and qualitative information on researchers is included.
Investments	**Investment needs**: The final plan includes a general overview of the investments needed to reach 2030 and 2050 targets in the energy, transport, buildings as well as agriculture sectors. The plan also includes information on the investments needed by sector and technology type.		There is a **need to clarify in the final plan that the investments needs** reported are additional to a business as usual scenario that does not achieve the climate and energy objectives as introduced in the plan. The source of funding is not systematically indicated with the corresponding amounts and is mostly focused on the national support (EU or private funds are not detailed). Potential mobilisation of private investments could be further addressed, particularly in research, innovation and competitiveness. There is no mention of using financial instruments in energy efficiency. On cohesion policy, the plan includes no information on how cohesion policy funds are or could be used. Overseas investments are not described. The energy and climate plan only presents a

			national approach and does not go into regional considerations such as local disparities, regional statistical data in on greenhouse gas emissions, energy efficiency, renewable energy, fossil fuels consumption and links between existing regional plans.
Regional cooperation		Intensify the existing good regional cooperation with Spain, Portugal and the Pentalateral countries (10). The focus of the regional exchanges should be on internal energy market and energy security areas. ➔ Fully addressed	The following specific prospective works are described: hydrogen cooperation; security of supply, decarbonised electricity system in 2050, cross-border cooperation on renewable electricity, mobility services without regional restrictions, the clean energy package working on specific regional measures for crisis situations.
		Continue the cooperation with Portugal and Spain, in particular on cross-border and cross regional energy interconnections. ➔ Not addressed	France does not add more relevant information on the cooperation with Portugal and Spain. Ongoing interconnection projects are well reflected.
		Consider strengthening measures related to regional cooperation in the area of renewable energy. ➔ Fully addressed	The final plan focuses on renewable electricity initiatives as follows: (i) with Penta-countries: cross-borders tenders, joint projects and statistical transfers ('cluster menu'), (ii) with NSEC countries: framework for supporting and financing offshore wind projects, analysis and development of options to mobilise more capital for joint projects, for example through European funds such as the European Fund for Strategic Investments (EFSI) and Connecting Europe Facility.
		Consider also intensifying regional cooperation arrangements to new areas such as regional generation capacity assessment and research and innovation on technologies of common interest with other Member States. ➔ Fully addressed	Regional cooperation arrangements are addressed as follows : (i) with Penta-countries: study of carbon pricing options and their cross-border impact on electricity prices, development of financing tools for the energy transition with the EIB, (ii) with NSEC countries: creation of four support groups working on Maritime spatial planning and environmental impact assessment / Development and

			regulation of offshore networks and other offshore infrastructure / Mechanisms for supporting and financing offshore wind projects / Technical standards and rules in the offshore wind sector.

Guidance on the implementation of the NECP and the link to the recovery from the Covid-19 crisis

Main points:

- **On renewables**, France committed to increase the share of renewables in gross final energy consumption to **33% in 2030**. France is **invited to clarify whether and how it intends to meet its 23% target for 2020**, and to explore the use of **cooperation mechanisms** and of the **Union renewable energy financing mechanism** to reach that target and maintain it beyond 2020. France is also invited to intensify its efforts to **facilitate administrative procedures** for new renewable projects and for repowering, as well as to increase the **local acceptance** of renewable energy projects, including through **renewable energy communities** and other participatory financing schemes.
- **On energy efficiency**, a swift implementation of the main instruments and policy measures identified would help avoid delays that could put at risk the estimated energy savings and the achievement of the overall objectives. France is also invited to ensure that the **energy efficiency first principle** is applied in a structured manner in the implementation of the national energy strategy. In particular, measures to moderate energy demand could be viable alternatives to possible increase in generation and interconnection capacities in the context of the phase out of households use of coal and oil. Building on the momentum of the **Renovation Wave initiative**, there is scope for France to intensify efforts to improve the energy performance of the existing building stock with specific measures, targets and actions, while giving due attention to energy poverty.
- On **energy security**, France is encouraged to leverage well-established strategies in terms of diversification of energy suppliers and energy sources as well as reducing and flexibilisation of energy demand.
- On **the internal energy market**, France's progression towards market-based prices and a competitive retail market still require more effort. In particular, both the electricity retail and wholesale markets still show low levels of competition. France is strongly encouraged to undertake the proper actions and reforms to decrease market concentration.

- On **research and innovation**, an effective implementation of the plan will enable France to swiftly move forward in improving its research and innovation base and competitiveness. Quantitative information to underpin the respective objectives and investment targets as well as specific timelines and dedicated funding mechanisms would allow France to reach its level of ambition in research and innovation.
- On **regional cooperation**, France has been rather **pro-active**, notably through the Pentalateral cooperation and the High-Level Groups for South West Europe and North Seas Energy Cooperation. France is invited to continue ongoing efforts to facilitate the implementation of its plan, in particular on relevant cross-border issues. Participating in High-Level Groups for TEN-E such as for South West Europe and North Seas Energy Cooperation would enable France to continue developing interconnections in the future, as well as deploying offshore wind projects.
- The final plan constitutes a strong basis for France to design climate and energy-related aspects of its national recovery and resilience plan, and to deliver on broader European Green Deal objectives.

Key areas indicated by the Commission to be considered when developing the national recovery and resilience plan:

4. Measures, including **reforms**, to increase the **energy efficiency of buildings** (including social housing);
5. Measures to promote renewable energy, in particular by simplifying administrative procedures to support investment; measures aimed at strengthening and expanding the transmission and distribution lines, including electricity interconnections with neighbouring countries; a review of economic incentives to support the energy transition;
6. Measures to promote sustainable mobility by accelerating the electrification of transport and the use of alternative fuels including hydrogen ; measures to invest in green mobility infrastructures.

European Commission’s assessment of the final NECP of Germany

Ref. docs:

https://ec.europa.eu/energy/sites/ener/files/documents/staff_working_document_assessment_necp_germany.pdf

https://ec.europa.eu/energy/sites/ener/files/documents/summary_of_swd_assessment_necp_germany_en.pdf

Assessment and recommendations of the final NECP by the European Commission

	NECP	Related assessment & recommendations on NECP implementation
Decarbonisation: **GHG emissions & removals**	• Germany's final integrated national energy and climate plan sets the target to reduce greenhouse gas (GHG) emissions for sectors not covered by the EU Emissions Trading System (non-ETS) by 38% by 2030 compared to 2005. Germany has a separate national target to achieve a 55% total GHG emission reduction in 2030 compared to 1990. This is consistent with Germany's national 2050 objective of climate neutrality. • Germany has adopted a national law introducing carbon pricing for CO2 emissions from fossil fuel combustion outside the ETS, with industrial and building heating and transport the key emitting sectors covered. The system starts with a fixed price in 2021, increasing up to 2025 (from EUR 25 to EUR 55/t CO2, respectively). • In the transport sector Germany has a trajectory for emission reductions (125 Mt CO2eq by 2030 compared to 161 Mt CO2eq by 2021). The final plan identifies a broad range of measures in this sector, e.g. regulatory, fiscal and financial support measures, to stimulate demand for alternative fuel vehicles and infrastructure in road transport, transport efficiency and digitalisation, massive investment in the rail network and measures such as aviation taxation. • In the building sector Germany's target is further emission reductions (from 118 Mt CO2eq in 2020 to 70 Mt CO2eq in 2030) via energy efficiency measures, including renovation of existing building stock and standards for new buildings, to renewable energy, including district heating.	➔ Fully addressed • Germany is recommended to specify cost-efficient additional policies and measures, notably in the building, transport and agriculture sectors, to address the significant projected target gap for nonETS sectors. In particular, the final plan provides a comprehensive list of additional policies and measures, with a scenario including additional measures (WAM) that almost achieves the 2030 target for effort sharing. Moreover, further measures are being announced. • Germany does not indicate whether it intends to generate credits from the land use, land use change and forestry (LULUCF) sector that can be used for compliance with the effort sharing target (potentially up to 22.3 Mt over 10 years). It also projects that the LULUCF sector, which was a net carbon sink until 2018, will become a net source of emissions over the whole decade. • Germany notified its long-term strategy to the Commission on 2 January 2020. Germany now refers to climate-neutrality in its Climate Law. However, the long-term strategy lacks many elements required under Article 15 of the Governance Regulation.
Decarbonisation: **Renewable energy**	• Germany's contribution to the EU's renewable energy target for 2030 is 30% of gross final energy consumption in 2030. • For heating and cooling, Germany aims to achieve a 27% share of renewables in 2030, which is in line with the indicative target of 1.3 percentage points for the overall share and 1 percentage point (up	➔ Partly addressed • In the electricity sector, Germany aims to cover a 65% share of its electricity consumption from renewable energy sources by 2030, which will require having an installed renewable energy capacity of approximately 200 GW. To achieve this target, it is essential to speed up the expansion of the grid and to accelerate planning and approval procedures for onshore

	to 30% in 2030) for district heating as an annual average calculated for 2021-2025 and 2026-2030 respectively. • Germany aims to achieve a national level of 27% (including multipliers set out by the recast Renewable Energy Directive) when it comes to renewable energy in transport. Furthermore first generation biofuels are set to rise to 5.3% and advanced biofuels to 3.5% in 2030. In addition, Germany is putting in place financial incentives (purchase subsidies, tax incentives) to boost the market uptake of electric, gas, plug-in hybrid and battery fuel cell vehicles.	wind energy. The increased capacity will be achieved mainly by auctions for larger PV, onshore and offshore wind and for biopower to a smaller degree. • Germany expect increases in the use of heat pumps, geothermal and solarthermal, although biomass remains the main source of renewable energy. However, the policies and measures set out in the plan appear, at this stage, not enough to achieve the target, because there is too little detail on the effects of each measure. It also lacks an assessment of the impact of forest biomass on the LULUCF sink.
Energy efficiency	• Germany's contribution to the EU target is sufficiently ambitious in terms of primary energy consumption, amounting to 216 million tonnes of oil equivalent (Mtoe). • On buildings, the German NECP already includes a wide range of policies to foster energy efficiency. It gives an indicative milestone for energy performance (non-renewable primary energy consumption) to fall from 4400 PJ in 2008 (base year) to 2,000 PJ in 2030. The plan also presents measures to tackle a wide range of issues, including information and advice on energy efficiency for residential, non-residential buildings and SMEs; several support programmes to promote energy efficiency and renewables in heating systems; tax incentives for energy renovation of buildings; innovation programmes for the future of construction; energy efficient procurement for public buildings and buildings from municipalities; energy audits, labels and management systems	➔ Largely addressed • The NECP plan provides descriptive information on policies and measures beyond 2020, targeting all the main sectors (buildings and urban planning, public sector, industry, transport and agriculture). These are supported by cross-cutting measures related to consumer protection, financing, awareness raising and dialogue. These policies and measures do not appear sufficient to achieve the target, because Germany's primary energy consumption target is below the level projected under the WAM scenario (227 Mtoe in 2030). •
Energy security	• Energy security along affordability and environmental compatibility is the three main objectives of Germany's energy transition.	➔ Partially addressed • The German NECP does not describe measurable targets, including targets for system flexibility, e.g. via demand response and energy storage, diversifying the oil or gas supply, reducing import dependency or the reliability of the electricity supply. It is therefore difficult to make an assessment of it. • The impacts of climate change are not mentioned as a risk to energy security, despite the fact that Germany's national adaptation plan includes such measures for the energy sector. The plan lacks information on how climate change risks may affect energy supply (e.g.

		wildfires and storms destroying biomass resources and power networks, availability of hydro power) in line with impact and vulnerability assessments
Internal energy market	• Germany sets no target interconnectivity level for 2030 • The plan includes precise measures to improve the flexibility of combined heat and power generation. It also indicates that barriers to flexible service provision in the tariff system are under review. • The plan argues that a large bidding zone reduces the need for storage	➔ Partially addressed • The NECP does not provide quantitative information on core market indicators (such as market concentration, liquidity or the share of market-based investments). • The NECP: - refers to recent decisions on the closure of coal-fired electricity generation and describes the action plan to reduce structual congestion in the electricity network. - refers to ongoing regional and European processes to improve market functioning (e.g. flow-based market coupling), without detailing national contributions to these processes. - gives an overview of the development of different sources of flexibility needed to integrate the rising share of renewable energy into the electricity system. However, the NECP does not cover aspects related to system flexibility comprehensively. It contains only limited information on the potential and the sources for increasing system flexibility. It lacks a comprehensive analysis of the barriers to new market participants (e.g. aggregators) and of the expected uptake of different sources of flexibility (demand response, energy storage, and distributed generation). - includes only very limited policies and measures to promote flexibility. To unlock the full potential for system flexibility, tariff-based schemes are not sufficient and it is important to ensure all providers, including consumers, can access all electricity markets. - contains only limited quantitative parameters on the functioning of national retail markets. It does not detail policy objectives related to retail markets or the policies and measures planned to reach those objectives. The plan also lacks specific objectives for market integration or for improving the impact of market components in electricity prices.
Research, innovation and competitiveness	• The German federal government aims to step up energy research between 2020 and 2030, to support application-oriented research in view of reaching the country's 2050 targets. • Five main areas for energy research: (i) energy transition (buildings and districts, industry, businesses and trade, mobility and transport services, 13 emphasising 'energy efficiency first'); (ii) energy generation (wind, solar, thermic generation); (iii) system integration (grids, storage, sector coupling and hydrogen); (iv) cross-cutting research (energy system analysis, digitalisation, CO2	➔ Partially addressed • The federal government considers only green hydrogen to be sustainable, the final plan indicates that other types of carbon-neutral hydrogen may be used during the transition period, due to Germany's integration in the European energy supply infrastructure. • The document refers to shortages of skilled workers in professions that may undergo an energy transition, such as technical and construction professions. It also acknowledges the difficulty of fully capturing energy transition-related occupational groups. Therefore it does not give a clear indication on the skills that will be needed and in which professions.

	technologies); (v) nuclear safety, both as part of and supporting the exit from nuclear energy. • Hydrogen will be indispensable for the successful decarbonisation of Germany's economy. • As regards innovation and competitiveness, Germany puts the emphasis on cross-cuting issues (e.g. sector coupling, digitalisation, mobility and batteries) and better involvement of start-up.	

Guidance on the implementation of the NECP and the link to the recovery from the Covid-19 crisis

Main points

General recommendations

The German NECP does not always make it clear how those views were taken into account. There is no indication of a strategic environmental impact assessment (SEA) developed on the NECP under Directive 2001/42/EC.

- **On greenhouse gas emissions** in non-ETS sectors, Germany fully addressed the recommendation to specify cost-efficient additional policies and measures, notably in the building, transport and agriculture sectors, to address the significant projected target gap for nonETS sectors. In particular, the final plan provides a comprehensive list of additional policies and measures, with a scenario including additional measures (WAM) that almost achieves the 2030 target for effort sharing.
- **On renewables**, Germany largely addressed the recommendation to **provide detailed and quantified policies and measures** to enable the country to achieve its target contribution, and to put forward trajectories and specific measures to meet the transport target. However, the plan sometimes still **lacks detail on the expected impacts** of the different measures, especially in the heating and cooling sector. Moreover, the high target in the power sector of 65% depends on accelerating the extension of the grid and bringing in faster permitting procedures for wind turbines.
- **On energy efficiency**, Germany largely addressed the recommendation to set a sufficiently ambitious national contribution, which was lacking in the draft plan. Specifically, Germany put forward primary **energy consumption levels of 216 Mtoe by 2030** (240 Mtoe with non-energy consumption), which translates into a reduction in final energy consumption of 185 Mtoe.

- **On energy security**, Germany partially addressed the recommendation to specify the measures supporting the objectives to diversify and reduce energy dependency, including measures ensuring flexibility, as well as information on phasing out nuclear energy.

In particular, Germany sets out ongoing investment plans by market participants, such as for LNG terminals, though the statements made and plans on energy dependency remain vague.

- **Forward-looking objectives** and targets on market integration, notably measures to reinforce market signals including locational signals and to improve the effective impact of market components in the electricity price. Specifically, the plan provides an overview of all measures and details measures to improve flexibility.
- **On research, innovation and competitiveness**, Germany partially addressed the recommendation to clarify the national objectives and funding targets in research, innovation and competitiveness to be achieved between 2022 and 2030.
- **On investment**, Germany partially addressed the recommendation. It extended its analysis of investment needs provided for electricity transmission infrastructure to include an overview of the investment needed.

European Commission's assessment of the final NECP of Greece

2019 Recommendations and Assessment of the final NECP by the Commission

Here following a summarized table, including the 2019 Recommendation from the Commission and the evaluation of the implementation of those recommendation within the final version of the NECP together with the assessment of the final NECP.

	NECP	Related Recommendation and evaluation on its implementation	Assessment
Renewable Energy	The national contribution to the 2030 EU renewable energy target is specified in the plan, amounting to 35% in gross final energy consumption. Renewable electricity is expected to increase significantly in heating and cooling and transport because of the planned electrification of these sectors. This will occur through the deployment of heat pumps, energy storage systems, methane and	Enable a timely and cost-effective achievement of Greece's contribution to the EU 2030 target for renewable energy, by including in the final plan, among others, an indicative trajectory for the implementation. ➔ Largely addressed	This is considered sufficiently ambitious, since it is above the share of 32% that results from the formula in Annex II of the Governance Regulation. The indicative trajectory provides all reference points. The national contribution to the EU's 2030 target for renewable energy of at least 32% increased between draft

	hydrogen produced from renewable electricity, and electric vehicles. Across sectors (electricity, heating and cooling), there is particular emphasis on promoting the role of local energy communities		and final plan from 31% to at least 35%. The plan provides for a trajectory with interim shares of 23.4% in 2022, 27.1% in 2025, and 29.6% in 2027. The main contributing technologies in the renewable electricity sector are wind and solar PV. Hydroelectricity production slightly increases in absolute terms, but its share decreases to 17% in 2030 (from 31% in 2020). Biomass use in electricity increases to reach 4% of total renewable electricity (from 2.3% in 2020). Geothermal and solar thermal remain marginal at respectively 1.6% and 0.8% of total renewable electricity
		Provide detailed and quantified policies and measures complying with the obligations laid down in (EU) Directive 2018/2001 ➔ Partially addressed	The plan provides a detailed list of 27 policies and measures to achieve the renewables target. These include regulatory, economic, fiscal and technical measures for electricity, heating and cooling, and transport, and some cover several sectors. Special policies and measures for regional cooperation are envisaged for RES and combined heat and power (CHP) projects. However, no specific action or time frame is mentioned. Measures on financial support are lacking detail concerning the sector, volume, and instrument for their introduction. Overall, the plan does not provide time frames or quantifications for the policies and measures. Therefore it cannot be assessed if they meet the requirements of the Renewables Directive.
	Greece aims to cover 61% of its **electricity** consumption from renewable sources by 2030. The main contributing technologies are wind and solar photovoltaics		

	Greece aims at a 42.5% share of renewable energy in **heating and cooling**. The main contributing technologies are solar and geothermal, ambient heat and bioenergy. Greece intends to increase renewable energy in heating and cooling by an annual average increase of almost 1.2% per year, 0.1 percentage point higher than the indicative 1.1% per year for Member States where waste heat and cold is not used.	Reconcile the objectives put forward in the draft plan for the share of renewable energy in the heating and cooling sector with the indicative target included in Article 23 of (EU) Directive 2018/2001 and the transport sector in line with Article 25 of (EU) Directive 2018/2001. ➔ Largely addressed	In the heating and cooling sector, the main contributing technologies are solar and geothermal, ambient heat and bioenergy. Greece intends to increase renewable energy in heating and cooling by an average increase of almost 1.2% per year through a significant increase of heat pumps in the tertiary and residential sector, of biomass, of thermal solar systems in the residential sector, as well as the use of RES in district heating. Greece sees a necessity to build new infrastructure for district heating only as it aims to build new district heating systems that can provide 30-40 MWth and that will be powered with residual solid biomass and geothermal energy. In the transport sector, the main contributing technologies are biofuels and electricity. The contribution of biofuels, related to the use of advanced biofuels, is increased by 5% from 2020 to 2030. The contribution of electricity is increased by 7% over the same period.
	Greece aims at a 19% share of renewables in the **transport sector.** The main contributing technologies are biofuels and electricity. The plan shows the contribution of biofuels and electricity to the share of renewables in transport. The contribution of biofuels, related to the use of advanced biofuels, is intended to increase by 5% from 2020 to 2030.		
Energy efficiency	Greece's national contribution for energy efficiency in 2030 is 20.6 Mtoe for primary energy and 16.5 Mtoe for final energy. Table with a total of quantitative and qualitative information on the planned energy efficiency policies and measures.	Substantially increase its ambition towards reducing both final and primary energy consumption in view of the need to increase the level of efforts to reach the Union's 2030 energy efficiency target. ➔ Largely addressed	Significant improvement compared with the draft plan, taking the specific circumstances of the Greek economy into account. The 10% target of electric passenger cars indicated in the draft plan has been increased to 30% in the final plan. The policies and measures are considered to be an improvement in comparison to the draft plan. They are credible in relation to the achievement of the overall targets, but not sufficiently ambitious.
		Clarify the timeline for the adoption and implementation of the policies foreseen to be in place as of 2020, especially for the new instruments. ➔ Partially addressed	For some measures, a clear timetable for their implementation is still missing. The planned budget has been quantified for most measures (or groups of measures). It is not clear what funding sources correspond to each measure specifically. The NECP provides additional information on the renovation of the building stock but

			further details will be determined in the long-term renovation strategy, which has not been submitted yet.
	On energy efficiency in buildings, Greece provides substantial detail on policies and measures, with new measures for 2021 to 2030.		A clear implementation timetable is missing for some measures. The plan to renovate 600,000 homes by 2030, which represents 12% to 15% of all homes, is realistic, but not enough to facilitate the decarbonisation of the building stock by 2050. However, there are no targets for the non-residential sector.
	The planned budget has been largely quantified, and some funding sources have been specified, such as the financial programme 'Electra', blended/hybrid finance programmes, and the National Energy Efficiency Fund. The total planned budget for all energy efficiency measures amounts to EUR 11,000 million.		
Energy Security	The plan sets a target to put an end to the energy isolation of islands by early 2029, interconnecting them with the mainland where possible. The plan announces the setting up of autonomous, innovative hybrid renewable power generation systems and markets for the benefit of consumers.	Specify the measures supporting the energy security objectives on diversification and reduction of energy dependency, including measures ensuring flexibility ➔ Largely addressed	Measures on diversification of sources from third countries and increase of domestic energy production (e.g. hydrocarbon, renewables, storage from renewables) are included. Interconnection of islands and infrastructure projects are included.
	On diversification of sources, the final plan includes measures on diversification of sources from third countries through new electricity and natural gas infrastructure pipelines, Interconnection of Greece-Bulgaria. Increasing domestic energy production, exploiting domestic hydrocarbon resources, and developing new RES plants, coupled with electricity storage systems, are also considered.	Include an assessment of how the infrastructure projects and regional cooperation contribute to the energy security objectives, also making use of regional cooperation. ➔ Largely addressed	Tables of the ongoing and future electricity and natural gas/LNG projects are presented in the final plan and a general analysis on the impact of the lignite decommissioning related to energy security issues is provided. The plan generally describes regional cooperation and there is not much new information about concrete actions to intensify cooperation in order to deliver the plan.

	The final plan includes an objective to gradually put in place applications to feed biomethane or hydrogen into the natural gas network for final uses - as in transport or heating and cooling.		
Internal Energy Market	Concerning the development on the internal energy market, the plan includes 20 policies and measures. To meet its interconnection target of 21% for 2030, the plan lists current 'projects of common interest', which will increase interconnectivity.	Implement the electricity target model and market coupling with neighbours ➔ Largely addressed.	The final NECP includes clear timelines for the implementation of a new electricity market design and coupling of its day-ahead and intraday markets with its neighbours and the pan-EU single coupling projects.
	On energy poverty, Greece reports on the current situation and the number of households affected. It provides measures to address energy poverty under the energy poverty action plan. It includes measures to help vulnerable households with their energy bills, such as well-targeted social tariffs and the potential introduction of an 'energy card'.		These policies and measures are considered credible in relation to the achievement of the target since they are comprehensive in nature
Research, Innovation and Competitiveness	Focus areas of the envisaged research and innovation activities concern the energy efficiency of buildings, renewable energy technologies, energy networks, digitalisation, and the development of smart grids. Actions on energy storage are also planned.	Further quantify the national objectives and funding targets in research, innovation and competitiveness, specifically related to the Energy Union, to be achieved between now and 2030, so that they are readily measurable and fit for purpose to support the implementation of targets in the other dimensions of the integrated national energy and climate plan. ➔ Partially addressed	These efforts are considered credible for achieving the target overall, because Greece has estimated the planned budget for the main policies and measures, particularly under the energy efficiency and renewable dimensions, and to a lesser extent, the R&I dimension of the plan. The policies and measures are realistic and consistent with the objectives, albeit not always quantified. The plan lacks an in-depth analysis of the investment gap between the research and innovation needs and available resources. Targets are general and without a baseline. In addition, there are no specific measures/programmes on how these priorities will be implemented. As regards competitiveness no measurable objectives are provided. The interaction with the SET Plan is missing. The revised document has hardly

			taken into consideration the recommendations on the R&I and competitiveness dimension.
	Greece is interested in developing hydrogen production from renewable electricity and to use hydrogen to decarbonise the transport sector (mainly shipping), together with a long-term hydrogen storage for power generation and incentives to hydrogen related R&I. Greece explicitly refers to the possibility of decarbonising the heating sector and introducing a 'Guarantee of Origin' system as a measure to stimulate the deployment of renewable hydrogen.		The consideration of the measures specified in the strategic energy technology (SET) plan is insufficient. While many of the planned measures concern technologies that are in principle covered by the SET plan, there is no systematic reference to that plan or its actions.
Investments	Total accumulated investments for the period 2020 - 2030 is estimated at EUR 43.8 billion, split over the various sectors. Greece intends to use EU funding sources as well national and private ones including financial tools. Greece calculates the available public funds (national and EU) for the energy sector and climate change, including adaptation at EUR 7.2 billion (in constant 2018 prices), with the rest leveraged through private sources.		The NECP does not explain by policy area/sector where private investment is needed.
			The description of all existing energy subsidies and the timeline to phase them out are still underdeveloped in the NECP. The NECP does not appear to fully reflect internationally used definitions in this regard
	Greece mentions the significance of its participation in the Clean Energy for EU Islands initiative. This initiative is considered to support renewables penetration in autonomous island systems which cannot be interconnected with the mainland. Setting up state-of-the-		

	art renewables plants combined with storage technologies and hybrid renewables plants is therefore promoted.		
Regional cooperation		Intensify the already good regional cooperation arrangements with Bulgaria and Cyprus as well as with the Central and South Eastern Europe Energy Connectivity (CESEC) countries. ➔ Partially addressed	The final plan provides more detail about the implementation of the Target Model and the coupling of Greece with neighbouring markets. Greece will also host the Regional Security Coordinator for South-East Europe.
		In the context of the 'Clean Energy for EU Islands' initiative, enhance cooperation with Member States and island regions facing similar geographic, climatic and infrastructure related challenges and opportunities in their energy transition. ➔ Partially addressed	Details are provided on enhancing cross-border interconnections in terms of projects of common interest (PCIs) and concrete timelines for the interconnection of islands.
		Explore the cross-border potential and the macro-regional aspects of a coordinated energy and climate policy notably in the Adriatic-Ionian with the aim of reducing the region's carbon footprint and implementing an ecosystem approach. ➔ Partially addressed	The plan generally describes existing cooperation. There is little information about future goals and specific actions to intensify cooperation in order to deliver the plan.
		The focus of the regional exchanges could be on internal energy market and energy security areas, in view to the changes in the electricity systems accommodating higher shares of renewable electricity, which will increase	A Regional Coordination Centre will be established in Greece for system operation coordination in the South East Region (Greece, Bulgaria, Romania) and with Italy.

		electricity import and export and enhance the need for system flexibility ➔ Partially addressed	

Guidance on the implementation of the NECP and the link to the recovery from the Covid-19 crisis

Main points:

- On **renewables**, Greece committed to increase the share of renewables in gross final energy consumption to 35%. Where missing, Greece is expected to adopt additional policies and measures and provide time frames and/or quantification of the policies and measures. Greece can accelerate some of its policies and measures to promote renewable energy, particularly in heating & cooling and transport in order to meet the first interim trajectory in 2022.
- On **energy efficiency**, Greece would benefit from adopting and implementing additional policies and measures that would deliver additional energy savings by 2030. Proper implementation of the main instruments and policy measures already identified is needed. Greece is invited to ensure that it is applied in climate and energy planning, in particular in implementing the national strategy supporting a phase-out from lignite. Greece could also explore the possibility of using green transition funding to finance energy efficiency measures, particularly for the renovation of buildings, and the services and tourism sectors.
- Improving **energy efficiency in buildings** has much potential for speeding up energy savings and contributing to the recovery of the economy after the Covid-19 pandemic. Building on the momentum of the Renovation Wave initiative16, there is scope for Greece to intensify efforts to improve the energy performance of the building stock with specific measures, targets and actions, while giving due attention to energy poverty. Greece is expected to provide a robust and comprehensive long-term renovation strategy, in accordance with Article 2a of the Energy Performance of Buildings Directive, which can contribute to the energy efficiency target and the recovery of the Greek economy following the COVID-19 pandemic.
- Given the country’s significant market reforms and the significant change in its energy mix until 2028, Greece is invited to ensure strong regional cooperation to ensure security of supply through the Regional Coordination Centre.
- Concerning the **internal energy market**, Greece would benefit from finalising the electricity market design reforms envisaged in the final plan. This includes creating new electricity markets, coupling its electricity market with Italy and Bulgaria, ensuring the non-discriminatory participation of new market participants and providing appropriate gas trading opportunities

- Greece would benefit from defining clear indicators to track the achievement of milestones towards its **research and innovation and competitiveness objectives.** Greece would need to ensure the link with the activities undertaken under the SET Plan.
- More detail regarding the gap between investment needs and the available sources of financing would help clarifying the framework for the implementation of the plan.
- Greece is invited to continue ongoing efforts on regional cooperation with a view to intensifying exchanges and initiatives that will facilitate the implementation of its national energy and climate plan, particularly on relevant cross-border issues, including those in the context of the CESEC High Level Group. Greece is encouraged to explore the potential of the Clean Energy for EU Islands Initiative to advance the clean energy transition on its islands and the potential of the multilevel climate and energy dialogues. Regarding the participation in the Clean Energy for EU Islands initiative, Greece is encouraged to approach the transition of the small non-interconnected islands, in a holistic way.
- The measures to tackle energy poverty would need to be monitored closely, while the energy poverty action plan is expected to be comprehensive and flexible enough to respond to this challenge and achieve the ambitious national targets.
- Greece is invited to extend and update the identification and reporting on energy subsidies by preparing a more complete inventory, and intensify action to phase them out, in particular for fossil fuels.
- In implementing its plan, Greece is invited to make the best possible use of the various funding sources available, combining scaled-up public financing at all levels (national and local, as well as EU funding) and leveraging and crowding in private financing.

Key areas indicated by the Commission to be considered when developing the national recovery and resilience plan:

1. Measures to continue the implementation of the energy reform agenda, to promote renewables, energy efficiency improvements in particular in buildings, island and energy connections; measures to facilitate the phase-out of lignite-fired power plants while taking into account a just transition to accommodate their decommissioning.
2. Measures promoting electric vehicles and the electro-mobility infrastructure, as well as the further development of city and rail public transport;
3. Measures addressing vulnerability to the impacts of climate change, including investments in climate-proofing infrastructure and the inclusion of adaptation considerations in environmental and planning legislation

European Commission’s assessment of the final NECP of Hungary

2019 Recommendations and Assessment of the final NECP by the Commission

Here following a summarized table, including the 2019 Recommendation from the Commission and the evaluation of the implementation of those recommendation within the final version of the NECP together with the assessment of the final NECP.

	NECP	Related Recommendation and evaluation on its implementation	Assessment
Renewable Energy	Hungary has increased its planned renewables contribution to 21% (from 20% in its draft NECP).	Increase the level of ambition for 2030 to a renewable energy share of at least 23% as Hungary's contribution to the Union's 2030 target for renewable energy, as indicated by the formula in Annex II under Regulation (EU) 2018/1999 and include an indicative trajectory, ➔ Partially addressed	This remains unambitious compared with the renewable share of 23% calculated using the formula in Annex II to the Governance Regulation. Hungary improved the information on renewables considerably in its final NECP, especially in describing, explaining and quantifying the planned measures, and providing information on such matters as trajectories and technologies, and biomass sustainability, as well as the analytical background. More data are provided, except for the reference points for 2022 and 2027.
		Put forward detailed and quantified policies and measures to enable a timely and cost-effective achievement of this contribution. ➔ Fully addressed	The plan explains clearly the measures needed to achieve the national RES contribution and increase shares of renewables in the electricity, heating and transport sectors.
	The main measure relating to renewables in **electricity** is the increase in solar power from the current 680 MW to around 6500 MW by 2030. This is to be achieved through a combination of measures, such as the national support scheme and regulation on minimum requirements for buildings as part of the nearly zero energy buildings (NZEB)		falls within the range of acceptable compliance rates

	The share of renewables in **heating** will be raised from 18.2% in 2020 to 28.7% by 2030	Provide additional details on the specific measures to ensure sustainability for biomass supply and use in the energy sector, given the important contribution of biomass across the Hungarian energy mix, especially in heating and cooling. ➔ Fully addressed	The plan includes detailed information on the supply of and demand for biomass by sector and the forest management measures to ensure the sustainability of biomass production and use.
	The final plan envisages that renewables will account for 14% of the final energy consumption of **transport** by 2030, with one half from first-generation biofuels and one quarter each from advanced biofuels and biogas respectively. First-generation biofuels will be kept at 7%, while the share of second-generation biofuels will be raised to 3.5% by 2030.	Put forward measures to meet the transport target set in its plan and in line with Article 25 of Directive (EU) 2018/2001. ➔ Fully addressed	An estimate of the consumption of energy has been added in the final version.
Energy efficiency	Hungary's national contribution to the EU's 2030 energy efficiency target is set at maximum 18.8 Mtoe of final energy consumption, translating into 30.7 Mtoe for primary energy consumption. T	➔ Substantially increase the ambition towards reducing both final and primary energy consumption in 2030 in view of the need to increase the level of efforts to reach the Union's 2030 energy efficiency target. ➔ Not addressed	These contributions are of very low ambition compared to the EU level of efforts. Moreover, the indicative trajectories and translation of the contribution into primary energy consumption are not clearly presented in the plan. The specific of the envisaged energy efficiency obligation scheme are unknown as yet. This means it is not possible to assess whether the policies and measures proposed will suffice to reach the target.
		make a clear distinction between the existing and additional policies and measures and provide a more comprehensive impact assessment of the planned initiatives and better estimate of the expected energy savings. ➔ Partially addressed	New policies are identified more clearly, but the savings expected have not been calculated.

	introduction of an energy efficiency obligation scheme. Other new measures mostly focus on the residential sector (heating), the renovation of public buildings, and transport (incentives for electric vehicles, modal shift, eco-driving, and others). The new measures in the transport sector combine economic incentives for energy-efficient vehicles with regulatory requirements and information/education measures. The measures for residential and public buildings combine economic incentives for heat exchange/efficient district heating and regulations on nearly zero-energy buildings.	Propose more ambitious policies and measures that would deliver additional energy savings by 2030. ➔ Partially addressed	These measures may not fully exploit the energy-saving potential of Hungarian building stock, and their contribution to reaching the overall target is not quantified. Besides, their impact will depend on the design and implementation of the energy efficiency obligation scheme.
Energy Security		Specify the measures supporting the energy security objectives on diversification and reduction of energy dependency, including measures ensuring flexibility ➔ Partially addressed	Hungary has included a significant number of policies and measures in the final plan, but most of them lack specific timescales, targets and impacts. When considering risks, the plan refers to the need to keep flexible power generation assets in the system The Plan does not explain why a well-integrated Hungarian wholesale power market could not ensure the capacities needed to ascertain energy security.
	plans to replace coal-based district heating with cleaner energy and energy efficiency, to minimise the impact on households. Actions will be financed through receipts from the modernisation fund to be set up after ETS allowances have been auctioned in 2021.	➔	no details of the objectives and policies planned are provided.
Internal Energy Market	the level of interconnectivity with neighbouring counties is currently at 50% of gross total installed capacity. Hungary plans to increase interconnectivity further, to 60% by 2030. To this end, the national development plan looks at a number of cross-border transmission projects. It discusses how growing electricity demand will affect electricity interconnectivity, and the infrastructure needs that implies.		This is significantly above the EU-level target set for 2030. However, there is no roadmap for the implementation of the required flexibility measures.

	As regards energy poverty, Hungary reports that 9.8% of households in 2016 spent at least 25% of their income on energy, which it considers as the main indicator of energy poverty.	➔	The plan refers to the current system that makes energy affordable through regulated prices but provides little information on the current situation and planned objectives. The plan refers to actions to address energy poverty, to be coordinated with planned market reforms. The envisaged policies and measures are not described in detail. No measurable targets are set.
Research, Innovation and Competitiveness		Further quantify the national objectives and funding targets in research, innovation and competitiveness, specifically related to the Energy Union, to be achieved between now and 2030. ➔ Partially addressed	The research, innovation and competitiveness dimension is mainstreamed and consistent with the other dimensions. However, it remains vague. Quantified targets for energy research and innovation, timelines, action plans, or specific budgets have yet to be specified. Hardly any mention is made of competitiveness objectives.
	The plan stresses its leading position in electromobility and batteries with major research and development capacities and top Asian producers establishing production centres in the country.		
	The NECP states the intention to enable the integration of hydrogen in the Hungarian economy. New regulatory measures are announced in the gas, storage and transport sectors addressing the entire hydrogen value chain. The NECP also includes a 2030 target of a renewable electricity-based hydrogen consumption of 51ktoe in the heating and cooling sector and the expectation to use renewable hydrogen as an alternative fuel for transport. With the NECP’s additional measures (WAM) scenario, renewable hydrogen could cover about 1% of the total transport energy needs by 2030.		

	Hungary mentions the strategic energy technology (SET) plan and provides a rich overview of Hungary's participation in the working groups on carbon capture utilisation and storage as well as nuclear safety. Furthermore, it lists competitive EU energy and climate-related programmes for 2014-2020 in Hungary, including ERA-Net projects.	Underpin the objectives with specific and adequate policies and measures, including those to be developed in cooperation with other Member States, such as the Strategic Energy Technology Plan. ➔ Partially addressed	it does not indicate national funds or activities under the programmes and does not specify how the SET plan would contribute to achieve Hungary's national energy and climate objectives.
Investments	Investment priorities are renewable energy sources (mainly solar, while wind energy is disadvantaged by current regulation), energy efficiency measures, and electromobility. The final plan estimates a high level of expected EU funding for investment. The financing sources for most of the planned investments are presented under each Energy Union dimension. The sources for Projects of Common Interest (energy security dimension) are only partially presented. For the remaining four dimensions they are indicated as follows: decarbonisation (ETS allowances, EU grants, quota revenues, national funding, loans, EIB loans, European Clean Mobility Fund, CEF); energy efficiency (EU grants, EIB loans, ECSO schemes, national funding, financial instruments); internal energy market (CEF); research (national funding, EU grants, quota revenues, EIB loans, direct EU funding instruments i.e. Horizon Europe, CEF).	Improve and extend its analysis of investment needs, ➔ Largely addressed Provide a general assessment of the sources of that investment, including appropriate financing at national, regional and Union level. ➔ Largely addressed	No detailed consideration is given to private funding sources. The plan also lacks a consolidated quantitative macroeconomic assessment of the impact of the planned policies and measures, neither in terms of description, nor as quantitative estimates, on GDP, consumption, and employment
		Consider also the cost-effective generation of transfers to other Member States ➔ Not addressed	The final plan does not include any information on the cost-effective generation of transfers to other Member States.
Regional cooperation		Continue the consultation of neighbouring Member States and regional cooperation within the Central and South-Eastern Europe Energy Connectivity (CESEC) High Level Group and in	The final plan describes the mentioned cooperation frameworks (the CESEC high-level group and the Visegrad group) and mentions conferences held in 2019 at which the NECPs were discussed with other Member States

		the context of the Visegrad Group involving Czechia, Hungary, Poland and Slovakia ➔ Largely addressed This includes assessing system adequacy, just transition issues and energy system changes required for accommodating higher shares of renewables and other foreseen developments ➔ Not addressed	belonging to these regional groups. The final plan includes new information on further regional cooperation schemes to do with interoperability, nuclear energy, gas infrastructure, research and development and the Green Fund for the Western Balkans. The need for more interconnections with neighbouring countries is understood to address changes in the energy system, and the NECP includes measures to improve connections with neighbouring countries. However, the plan does not provide an assessment as described in the recommendation.

Guidance on the implementation of the NECP and the link to the recovery from the Covid-19 crisis

Main points:

- Hungary’s plan leaves scope to increase its ambition on both renewables and energy efficiency, to contribute more to the EU climate and energy targets and strengthen the green transition.
- Hungary might consider tapping into the potential of wind energy, a source left out of consideration so far. The electricity sector will require significant investment in renewables, but also renewable heating and cooling systems for buildings and transport. An increased empowerment of renewable energy self-consumption and renewable energy communities would be a powerful leverage to expand renewables and contribute to reducing energy poverty and import.
- As regards energy efficiency, Hungary would benefit from adopting and implementing additional policies and measures that would deliver additional energy savings by 2030. Furthermore, Hungary is invited to implement the ‘energy efficiency first’ principle across all areas of the energy system, taking into account the co-benefits of energy efficiency when prioritising investments. The improvement of energy efficiency in buildings has much potential for speeding up energy savings and contributing to the recovery of the economy after the COVID-19 pandemic (renovation Wave). Further support to the renovation of public and private buildings could be provided with increased public funding and by leveraging EU and national budgets with private money, combining grants, lending, guarantees and loan subsidies.

- As regards energy infrastructure, a carbon free, flexible and intelligent power sector will require the integration of solar power plants, the spread of smart metering, the provision of storage and gas power plant solutions that improve the flexibility of the system, and the replacement of lignite-based generation.
- Investments: The probability that interest rates will remain very low in the medium term highlights the advantages of early investment, both public and private, to secure economic and social resilience and well-being while preserving environmental sustainability.
- Hungary is invited to continue ongoing efforts on regional cooperation with a view to stepping up exchanges and initiatives that will facilitate implementation of its national energy and climate plan, especially as regards relevant cross-border issues, including those in the context of the CESEC High-Level Group. Hungary is also invited to exploit the potential of the multilevel climate and energy dialogues to a greater extent, by actively engaging with regional and local authorities, social partners, civil society organisations, the business community, investors, and other relevant stakeholders, and to discuss with them the various scenarios envisaged for its energy and climate policies.
- The momentum of the ‘renovation wave’ initiative of the European Green Deal provides an opportunity to step up efforts to tackle energy poverty by improving the energy performance of the existing building stock through specific measures.
- Hungary is invited to make the best possible use of the various funding sources available, combining scaled-up public financing at all levels (national and local, as well as EU funding) and leveraging and crowding in private financing.

Key areas indicated by the Commission to be considered when developing the national recovery and resilience plan:

1. Measures supporting investments in energy efficiency in residential housing and public buildings;
2. Measures in sustainable public transport and alternative transport modes, both in the capital region and across the country;
3. Measures to promote renewables in the electricity and heating sectors, including measures to boost electricity production with solar photovoltaics, and measures to upgrade existing infrastructure, storage capacity and smart grids.

European Commission’s assessment of the final NECP of Ireland

STRUCTURE

25. Consideration by the Commission on the implementation of the recommendation from 2019

The October 2020 assessment document includes a general overview of the implementation of the Commission recommendations from 2019 in the final NECPs.

26. Assessment of the final NECP (objectives, contributions, measures, impact, investments)

This section consists in a general summary of the planned measures, divided by areas (Decarbonisation, Renewable energy, Energy efficiency, Energy security, Internal energy market. Research innovation and competitiveness..), with an evaluation on the basis of targets, implementation and Impact. The document focuses on the trajectories outlined to achieve the described targets, however never going into too much detail technology-wise. It is and update of the 2019 Report.

27. Guidance on the implementation of the NECP linked to the recovery plans from the Covid-19 crisis

This section addresses the link between the final plan and the recovery efforts from after the COVID-19 crisis by pointing at possible priority climate and energy policy measures XX could consider when developing its national recovery and resilience plan in the context of the Recovery and Resilience Facility.

28. Annexes:

- I: Potential funding from EU sources to XXX.. 2021 – 2027
- II: Detailed assessment of how Commission recommendation have been addressed

CONTENT

2019 Recommendations and Assessment of the final NECP by the Commission

Here following a summarized table, including the 2019 Recommendation from the Commission and the evaluation of the implementation of those recommendation within the final version of the NECP together with the assessment of the final NECP.

	NECP	Related Recommendation and evaluation on its implementation (NECP assessment)	Assessment
GHG emissions	Ireland's 2030 target for greenhouse gas (GHG) emissions not covered by the EU Emissions Trading System (non-ETS), is -30% compared to 2005, as set in the Effort Sharing Regulation (ESR). Building on the policy framework of the National Mitigation Plan (NMP) and Project Ireland 2040, the Government published its Climate Action Plan in June 2019. The Climate Action Plan identifies how Ireland will achieve its 2030 targets for greenhouse gas emissions in a manner consistent with a trajectory to achieve net zero emissions by 2050.	Put forward additional measures, notably in the building and transport sectors, to cost-effectively reduce the significant projected gap to its 2030 greenhouse gas target for sectors not covered by the EU emissions trading system of -30% compared to 2005. ➔ Largely addressed	The final NECP fully integrates the ambition, objectives, policies and measures as planned under the recently adopted climate action plan 2019.
Renewable Energy	Ireland has established an objective of achieving a 34% share of renewable energy in energy consumption by 2030. "Ireland has established an ambitious and challenging target of increasing reliance on renewables from 30% to 70% by 2030. " (p.11)	Put forward, as Ireland's contribution to the Union's 2030 target for renewable energy, a share of renewable energy of at least 31% as indicated by the formula in Annex II under Regulation (EU) 2018/1999. ➔ Fully addressed	The NECP puts forward a renewable energy target of 34.1% – Ireland's contribution to the 2030 targets.
	In the electricity sector, Ireland aims to use renewable energy sources to cover 70% of its electricity consumption by 2030. Ireland is targeting at least 3.5 GW of offshore renewable energy of mainly offshore wind, the development of up to 1.5 GW of grid scale solar energy, and an increase in onshore wind capacity of up to 8.2 GW. This will be delivered in a competitive framework of auctions and corporate contracting with a renewed focus on community and citizen participation.	Include an indicative trajectory in the final integrated national energy and climate plan that reaches all the reference points pursuant to Article 4(a)(2) of Regulation (EU) 2018/1999 in accordance with that share, in view of the need to increase the level of efforts for reaching this target collectively. ➔ Not addressed.	The proposed trajectory will not be in line with the trajectory waypoints as set out in the Governance Regulation. Ireland states that this is primarily due to the fact that large projects, particularly offshore wind projects, cannot be constructed in shorter timeframes and will not become operational in Irish waters until mid-decade.

		Ensure that the renewable energy target for 2020 set in Annex I of Directive 2009/28/EC of the European Parliament and of the Council (9) is fully met and maintained as a baseline from 2021 onwards, and explain how it intends to meet and maintain such baseline share. ➔ Not addressed.	2020 target of 16% will be missed in 2021 in both WEM and WAM scenarios.
Energy efficiency	Ireland set its national contribution for energy efficiency in primary energy savings (62 171 GWh) and final energy (56,159 GWh) by 2030. According to the WAM scenario trajectories, primary energy consumption equals 13.7 Mtoe (159,146 GWh) and final energy consumption equals 11.2 Mtoe (130,493 GWh) in 2030. Ireland notified its intention to achieve the cumulative amount of energy savings of 5.18 Mtoe to the European Commission under Article 7 of the Energy Efficiency Directive.	Substantially increase its energy efficiency ambition by lowering the level of both final and primary energy consumption in absolute terms in view of the need to increase the level of efforts to reach the Union's 2030 energy efficiency target. ➔ Partially addressed	Ireland notified a higher ambition level to the Commission in its final NECP. Under the WAM scenario both final and primary energy consumption in 2030 are 14% lower in the final NECP and increased its estimated amount of energy savings by 2030. However, the ambition still remains low compared to the efforts at EU level.
		Support this with policies and measures that would deliver additional energy savings by 2030. ➔ Fully addressed	Additional policies and measures are provided. The final NECP provides many measures related to buildings. The national development plan has indicated funding of EUR 4.5 billion for energy efficiency improvements across the residential and public sector. The long-term renovation strategy has not been submitted yet.

Energy Security	Maintaining a high level of security of supply is a priority in the ongoing transformation of Ireland's energy system, with an objective to achieve an electricity system that is 70% renewable by 2030 and increase the share of domestic renewable energy.	Specify the measures supporting the energy security objectives on diversification and reduction of energy dependency ➔ Partially addressed	Ireland has specified key measures in the plan. A review is being carried out on the security of energy supply of Ireland's natural gas and electricity systems. The review is focused on the period to 2030 in the context of ensuring a sustainable pathway to 2050. In light of uncertainties related to the UK's withdrawal from the EU, Ireland will work closely with its EU partners to maintain existing good regional cooperation between Ireland and the UK in relation to emergency preparedness and response. The National Cyber Security Council (NCSC) is working with providers of critical national infrastructure to improve the overall level of cybersecurity in the energy sector. Some measures are not clearly outlined in any detail or are still only partially developed.
	As regards gas and electricity, the plan puts in place measures to maintain the resilience of Ireland's gas and electricity systems to 2030 and beyond. Ireland expects to rely increasingly on natural gas when coal and peat are no longer part of its energy mix from 2025.	… in particular in the gas and oil sector in light of uncertainties related to the withdrawal of the United Kingdom from the European Union. ➔ Partially addressed	Ireland states that 'a review of the security of energy supply of Ireland's natural gas and electricity systems is being carried out. The focus of the review is the period to 2030 in the context of ensuring a sustainable pathway to 2050.' In terms of oil, 'The Department is currently developing the Oil Emergency Allocation Plan (OEAP) to enable the allocation of oil to ensure the continuation of societal functioning in a scenario where oil availability is limited.'
Internal Energy Market	No recommendation		
Research, Innovation and Competitiveness		Further elaborate on the national objectives and funding targets research, innovation and competitiveness, specifically related to the Energy Union, to be achieved between now and 2030, so that they are readily measurable and fit for purpose to support the implementation of	The plan identifies the challenge of increasing the level of investment in research and innovation to keep pace with its GNP growth rates. However, it does not set a specific target for 2030 and in general its objectives are not readily measurable, so it is unclear whether they are fit for purpose.

		targets in the other dimensions of the integrated national energy and climate plan. ➔ Partially addressed	
		Underpin such objectives with specific and adequate policies and measures, including those to be developed in cooperation with other Member States, such as the Strategic Energy Technology Plan. ➔ Partially addressed	Some specific policies and measures provided e.g. Innovation 2020 = five-year strategy on research and development of science and technology Regarding the SET plans the NECP states: 'Through Ireland's active participation in Europe's SET Plan Steering Group and within individual SET Plan Implementation Groups, research calls are aligned with SET Plan priorities. This enables better alignment of Irish research priorities with research and innovation programmes both at EU level and across other member states. This also increases co-operation between national programmes to avoid duplication of research.'
Investments	No recommendation		
Regional cooperation	On regional cooperation,	Build on the framework of the North Seas Energy Cooperation and the Clean Energy for EU Islands Initiative in order to deliver on the renewables target and ensure timely implementation of ongoing interconnection projects. ➔ Fully addressed	Ireland has stated that it works together with the other North Seas Energy Cooperation countries on the possibilities to create concrete cooperation projects. Besides joint offshore wind projects that would be connected to and supported by several Member States, this includes the work on possible 'hybrid' solutions that would use cross-border solutions for connecting offshore wind farms to the grid and seek synergies with interconnection capacity between countries, and on the corresponding market arrangements.
		In light of the United Kingdom's decision to leave the European Union, provide for measures to ensure continued regional cooperation with the UK on emergency preparedness and response	Ireland states its intention for 'continued regional co-operation with the UK on emergency preparedness and response for electricity and gas security of supply.'

		for electricity, and security of supply for gas and oil. ➔ Fully addressed	The objective states that: ‘Following the withdrawal of the United Kingdom from the EU, engage with our EU partners to put in place an EU/UK framework for continued necessary regional cooperation between Ireland and the UK on matters related to gas and electricity security of supply, including emergency preparedness and response and solidarity in an emergency situation.’

Guidance on the implementation of the NECP and the link to the recovery from the Covid-19 crisis

Main points:

- On **renewables**, Ireland committed to increase the share of renewables in gross final energy consumption to 34.1% in 2030. Considering the importance of offshore wind projects in Ireland’s 70% renewable electricity target, it is important that efforts are made to ensure that the regulatory and enabling framework for offshore renewable energy is implemented without delay. As regards renewable heat, the policies and measures to achieve the target, and in particular the expected investment needs and budgets, are not clearly defined. Specific steps to achieve the ambitious target of 936,000 electric vehicles on the road by 2030 are also not clearly explained. The final plan would also need to explain how the very significant increase in biomass use for energy will be combined with the policy on land and forestry, which relies upon increasing carbon removals.
- On **energy efficiency,** since still rather low level of ambition, Ireland would benefit from adopting and implementing additional policies and measures that would deliver additional energy savings by 2030. Improving energy efficiency in buildings has great potential for speeding up energy savings and contributing to the recovery of the economy after the COVID-19 pandemic. Building on the momentum of the ‘Renovation Wave’ initiative, there is scope for Ireland to intensify efforts to improve the energy performance of the existing building stock with specific measures, targets and actions, while giving due attention to energy poverty. Ireland is expected to provide a robust and comprehensive long-term renovation strategy, in accordance with Article 2a of the Energy Performance of Buildings Directive, which can contribute to the energy efficiency target and the recovery of the economy after the COVID-19 pandemic.
- In terms of **energy security**, introducing measures to address cyber security and their implementation will improve resilience and flexibility of the energy sector.
- Concerning the **internal energy market**, Ireland has introduced a capacity mechanism to address generation adequacy concerns. In line with Article 20 of Regulation (EC) No 2019/943, Ireland proposed measures to improve the market’s functioning via a dedicated

implementation plan notified to the Commission. A swift follow-up on such measures and the Commission's opinion on this plan is crucial to support the required reforms.

- Ireland would benefit from setting out clear indicators to track the achievement of milestones towards its **research and innovation and competitiveness** objectives. Ireland would also benefit from further strengthening the link between the competitiveness objective and the policies and measures to put in place for the different sectors by 2030.
- Ireland has been rather proactive on **regional cooperation**, notably in the context of the North Seas Energy Cooperation. Ireland is invited to continue ongoing efforts, in particular in relevant cross-border issues. Ireland is also encouraged to explore the potential of the Clean Energy for EU Islands Initiative and invited to better exploit the potential of the multilevel climate and energy dialogues to actively engage with regional and local authorities, social partners, civil society organisations, business community, investors and other relevant stakeholders.
- In the context of the Recovery and Resilience Facility, which is expected to be operational on 1 January 2021, Ireland's final plan constitutes a strong basis for it to design the climate and energy-related aspects of its national recovery and resilience plan, and to deliver on broader European Green Deal objectives.

Key areas indicated by the Commission to be considered when developing the national recovery and resilience plan:

1. **Measures** to improve the **energy efficiency** of the built environment through the deep retrofitting of buildings as well as social housing; measures to support investments in **renewable energy generation** and to promote the uptake of heating systems based on renewable energies; measures aimed at strengthening and expanding the transmission and distribution lines, including **electricity interconnections** with neighbouring countries.
2. **Measures** to support the shift towards sustainable modes of transport, including **decarbonised public transport** in urban areas;
3. Reforms to put in place the new planned **governance framework** and **long-term objectives** for climate policy.

European Commission's assessment of the final NECP of Italy

STRUCTURE

29. Consideration by the Commission on the implementation of the recommendation from 2019

The October 2020 assessment document includes a general overview of the implementation of the Commission recommendations from 2019 in the final NECPs.

30. Assessment of the final NECP (objectives, contributions, measures, impact, investments)

This section consists in a general summary of the planned measures, divided by areas (Decarbonisation, Renewable energy, Energy efficiency, Energy security, Internal energy market. Research innovation and competitiveness..), with an evaluation on the basis of targets, implementation and Impact. The document focuses on the trajectories outlined to achieve the described targets, however never going into too much detail technology-wise. It is and update of the 2019 Report.

31. Guidance on the implementation of the NECP linked to the recovery plans from the Covid-19 crisis

This section addresses the link between the final plan and the recovery efforts from after the COVID-19 crisis by pointing at possible priority climate and energy policy measures Italy could consider when developing its national recovery and resilience plan in the context of the Recovery and Resilience Facility.

32. Annexes:

- I: Potential funding from EU sources to Italy 2021 – 2027
- II: Detailed assessment of how Commission recommendation have been addressed

CONTENT

2019 Recommendations and Assessment of the final NECP by the Commission

Here following a summarized table, including the 2019 Recommendation from the Commission and the evaluation of the implementation of those recommendation within the final version of the NECP together with the assessment of the final NECP.

	NECP	Related Recommendation and evaluation on its implementation	Assessment
Renewable Energy	The **renewables share** is set at 30% in gross final consumption of energy in 2030	Underpin the welcomed level of ambition of Italy's 30% renewable energy share for 2030 as contribution to the Union's 2030 target for renewable energy by detailed and quantified policies and measures. ➔ Partially addressed	**sufficiently ambitious** as it is above the share of 29% by 2030 The indicative trajectory to reach the 30% contribution in 2030 has been slightly updated, including specific reference points for 2022 (renewables share of 21%), 2025 (23%) and 2027 (26%). These reference points are just below the trajectory indicated in the Governance Regulation. Due to the lack of information at policy level it is difficult to see whether the targets might be achieved, as the policies which are evaluated are not achieving targets. The number and type of policies might not be enough to achieve targets, particularly after 2022 where measures have yet to be budgeted and approved.
		Reduce the complexity and regulatory uncertainty and provide additional details on the enabling frameworks for renewable self-consumption and renewable energy communities. ➔ Fully addressed	The plan to adopt new standards to make it possible to implement direct lines, active customers, citizen energy communities and closed-off distribution systems, self-consumption of energy from renewable sources and renewable energy communities. The final NECP further describes measures to promote local energy communities, selfconsumption and administrative simplification.
	electricity sector: renewable energy generation is projected to reach almost 55% in 2030 (compared to 34.1% in 2017), with **solar power** becoming the main source of renewable electricity (52GW of installed capacity), ahead of the current main source which is **hydropower** (19.3 GW of installed capacity). **Wind** power capacity and electricity share will be roughly doubled by		The number and type of policies might not be enough to achieve targets; particularly beyond 2022 where measures have yet to be budgeted and approved. Planned capacities are generally described but are not split between new capacities and repowering

	2030 compared to 2017 (19.3 GW, of which 0.9 GW offshore)		
	Heating and cooling: the ambition of the final plan has been slightly increased compared to the draft plan – to a share of 33.9% by 2030 (compared to 20.9 in 2020 – a 13% increase). Consumption from renewables is expected to surpass 15 Mtoe in the heating and cooling sector.	Increase the level of ambition of renewables in the heating and cooling sector to meet the indicative target included in Article 23 of Directive (EU) 2018/2001. ➔ Largely addressed	The plan states that the principal instruments to promote the renewables consumption in heating are often integrated with those for energy efficiency and are already operational. However, these measures are not assessed in terms of contribution to the renewable target in heating and cooling. There is also no calendar underpinning the annual increase of renewable heating and cooling for the 2021-2030 period.
	Transport: the share of renewable energy has been slightly increased compared to the draft plan, to reach 22% by 2030. The main measures are to promote advanced biomethane and introduce a mandatory quota for the consumption of conventional and advanced biofuels by 2030. Other measures aim for increased energy efficiency and an increase of renewable electricity use in road and rail.	Put forward measures to meet the transport target in Article 25 of Directive (EU) 2018/2001. ➔ Largely addressed	The renewable transport target is challenging but policies seem to be in place to support such an increase of renewable in this sector. The plan includes a description of 19 measures, including support to advanced biofuel, penetration of Electric Vehicles (EV) and modal shift to increase efficiency. Infrastructure policies are also consistent with this target and budget and policies are in place to create an EV and alternative fuels network.
Energy efficiency	Italy's national contribution for energy efficiency in 2030 is 125.1 Mtoe for primary energy and 103.8 Mtoe for final energy consumption. It is expected that the savings will be achieved mostly in the residential sector (35%) and transport (27%), followed by the commercial (25%) and industry (13%).		The expected savings of the measures in relation to Article 7 were provided together with other elements required, which were described in a dedicated separate document accompanying the plan.

	Italy sets out nine main measures to achieve the energy efficiency goals and the plan provides information on all of them, mainly a continuation of the policy architecture already in place. Some new elements can be seen in the measures on sustainable mobility and in the National Fund for Energy Efficiency. The largest impacts are attributed to the tax deduction mechanism for building renovation and the white certificate scheme.	As regards energy efficiency, ensure that the key policy instruments illustrated in the draft integrated national energy and climate plan would still deliver adequate savings in the period 2021-2030. ➔ Partially addressed	The measures seem sufficient **if properly implemented and upgraded.** Indeed, the final NECP does not present significant improvements compared to the draft NECP and the goals under Articles 5 and 7 of the Energy Efficiency Directive are confirmed with minor changes. However, additional details including on the impacts of the planned measures are provided in the Article 7 notification accompanying the plan.
	Energy efficiency in buildings: The plan mentions that the exact number of buildings to be renovated will be determined in the long-term renovation strategy.	Given the significant untapped potential, continue to work on strengthening energy efficiency measures for buildings. ➔ Largely addressed	The NECP contains an extensive description of current and planned policies and measures for buildings. However, a clear timetable for their implementation is missing and there is no estimation of wider benefits.
Energy Security	Italy aims to reduce the level of dependency from 77.7% in 2016 to 75.6% in 2030 and to 74.6% in 2040 and in terms of electricity storage to increase gradually available capacity, in particular 1,000 MW by 2023 and 6,000 MW in addition to 4,000 MW distributed storage by 2030.	Specify the measures supporting the energy security objectives on diversification and reduction of energy dependency, including measures ensuring flexibility. ➔ Partially addressed	When considering risks, the plan does not fully take into account the plans of the other connected Member States or the specific risks of isolated territories such as Sicily or Sardinia, even though the plan states that the decarbonisation objective is posing a number of problems as regards managing the security.
	On **electricity**, the plan identifies the need for updating the emergency plan in line with the risk-preparedness regulation and support measures regarding flexibility and resilience of the system. It provides a detailed description of the new capacity market, as well as the need for storage capacity and demand response. The plan envisages significant further measures and investments to reach 6,000 MW of storage and EUR 36.2 billion of distribution and transmission network.	Take into account the regional context and the actual potential of the interconnectors and of the generation capacities in the neighbouring countries when assessing resource adequacy in the electricity sector. ➔ Partially addressed	The plan mentions the need for coordinated actions carried out by European countries but gives a limited explanation about the regional context when assessing whether resource is sufficient.
			The plan considers cybersecurity and cross-border coordination in the energy sector but does not specify measures.

Internal Energy Market	According to its NECP, Italy is considering introducing a mandatory quota for renewable gases (including hydrogen) and to establish enabling rules for injection of hydrogen into existing natural gas infrastructures. It is expected to build a 'hybrid' electricity-gas energy system, which can boost the use of alternative fuels in the transport sector. The plan forecasts reaching around 1% of the renewable target for the transport sector through the direct use of hydrogen in cars, buses, trucks, trains, and possibly sea transport.	Set clear objectives, milestones and timelines to deliver on the envisaged reforms in the energy markets, notably in the wholesale natural gas markets and in the operation of both the electricity and natural gas retail markets. ➔ Partially addressed	The plan provides a sufficient overview of current market conditions for gas and electricity, including levels of competition and liquidity of markets. Forward-looking objectives and targets for strengthening market integration are still needed, particularly for wholesale natural gas markets and the phase-out of electricity regulated prices.
Research, Innovation and Competitiveness	The plan identifies relevant areas for research and innovation priorities in 2030 and 2050, mostly related to renewables (photovoltaics, concentrating solar power, and energy from the sea), storage (including hydrogen, power to gas), the integration of renewables within the energy system, the devices for the security of the electrical system, e-mobility, bio-refineries, materials processes and systems for the energy efficiency in the industry and in buildings.	Clarify the national objectives and funding targets in research, innovation and competitiveness, specifically related to the Energy Union, to be achieved between 2021 and 2030, so that they are readily measurable and fit for purpose to support the implementation of targets in the other dimensions of the integrated national energy and climate plan. ➔ Not addressed	There is an increasing alignment of the Italian energy research and innovation objectives with the R&I priorities identified with the strategic energy technology (SET) plan. However, even though the final NECP provides more information on the forward-looking analysis and on the way to approach to time horizon 2030 and 2050. It is still not specific on how the envisaged research and innovation resources are allocated to the different research priorities that are presented. The objectives on competitiveness objectives are barely mentioned. The relationship between policies and measures (e.g. funding instruments) and research and innovation objectives is quite loose. The cooperation with the SET plan is only broadly addressed.
	The final NECP confirms the target of doubling the public funds for research in clean energy, from EUR 222 million in 2013 to EUR 444 million in 2021.		In light of the progress made by Italy as illustrated in the 2020 Mission Innovation country report, it appears very ambitious and challenging to maintain the commitment taken.

	Main focus for improving competitiveness: digital architecture and automation systems linked to network services Other sectors specifically mentioned as targeted in terms of objectives for national competitiveness and developing perspectives in foreign markets are (i) the circular economy, (ii) geothermal energy, (iii) liquefied petroleum gases and methane, (iv) the bioethanol sector, (v) the production of batteries and electrochemical, and (vi) photovoltaics.		
	In terms of policies and measures, the NECP mostly describes a large number of funds to support research, incentives to engage the private sector and small and medium enterprises in research and innovation, and support them in modernising operations and increasing competitiveness. In addition, the NECP illustrates the establishment of 'energy cluster' public private partnerships. The national plan for industry 4.0 offers a range of support instruments to address the increasing digitalisation of the energy sector.		
Investments	Investment needs: The overall assessment of investment needs is estimated to represent EUR 1 194 billion for 2017-2030, mainly for the transport sector – EUR 759 billion, followed by the residential sector with EUR 180 billion. The additional overall investment effort with respect to the investment needs under current policies over the considered period amounts to EUR 186 billion.		The plan does not provide clear details on the methodology applied to calculate investment needs. The plan does not identify risk factors, and does not develop a strategy to close the investment gap.
Regional cooperation		Carry out consultations with neighbouring countries and within the Central and South-Eastern Europe Gas Connectivity (CESEC) High-Level Group in view of the finalisation of the integrated national energy and climate plan.	The NECP illustrates preliminary cooperation with the neighbouring countries on Central and South-Eastern Europe Gas Connectivity (CESEC) that allowed to identify some possible lines of cooperation including cooperation on alternative fuels in the transport sector, on RES and on

		➔ Partially addressed	energy efficiency. However, specific outcomes that are expected from such cooperation are still to be developed. Moreover, cooperation with neighbours such as France, Germany and Switzerland is not reported.
		Explore further the cross-border potential and the macroregional aspects of a coordinated energy and climate policy, notably in the Adriatic with the aim of reducing the region's carbon footprint and implementing an ecosystem approach and further harness the potential of deeper Mediterranean cooperation. ➔ Partially addressed	The final NECP illustrates several initiatives aimed at strengthening cooperation in the Adriatic including a new Memorandum of Understanding between Italy and Greece to promote industrial partnerships focusing on sustainability and on the diversification and security of energy supplies. The NECP also refers to further initiatives for a better coordination of new projects and infrastructure in the Adriatic. However, those remain to be defined in detail.

Guidance on the implementation of the NECP and the link to the recovery from the Covid-19 crisis

Main points:

- On **renewables**, Italy committed to increase the share of renewables in gross final energy consumption to 30% in 2030 and would necessitate additional policies and measures. Implementing **new initiatives to overcome administrative burden** would be important for the swift implementation of the measures. Italy might consider tapping into the potential of other new sources and technologies. Further steps could also be taken to preserve existing renewable energy production by promoting, revamping and repowering previous installations, in particular existing wind power plants.
- On **energy efficiency,** achieving the ambitious contribution could be supported by making use of funding dedicated to green transition to finance energy efficiency policy and by developing instruments which would be sustainable over time from the financial point of view. **Improving energy efficiency in buildings** has much potential for speeding up energy savings and contributing to the recovery of the economy after the COVID-19 pandemic. Building on the momentum of the **Renovation Wave** initiative, there is scope for Italy to intensify efforts to improve the energy performance of the existing building stock with specific measures, targets and actions.
- On **energy security** Italy would benefit from further developing the information on the regional context when assessing resource adequacy in the electricity sector.

- Italy would benefit from defining clear indicators to track achievement of milestones towards its **research and innovation and competitiveness** objectives. The start of mature public investment projects supporting the green transition can have an important role to play in contributing to the economic recovery after the Covid-19 crisis.
- Italy would benefit from stepping up regional **cooperation with neighbouring countries**, in particular by promoting renewable and sustainable projects across the Mediterranean and by further exploring the possibilities within the **clean energy for EU islands initiative** to advance the clean energy transition on its islands. Italy is also invited to better exploit the potential of the **multilevel climate and energy dialogues.**
- The final plan constitutes a strong basis for Italy to design climate and energy-related aspects of its national recovery and resilience plan, and to deliver on broader European Green Deal objectives.

Key areas indicated by the Commission to be considered when developing the national recovery and resilience plan:

1. **Measures and investments** to promote **energy efficiency of buildings**; measures and investments to **decarbonise the power sector** (boosting renewable electricity production, reducing the role of natural gas and increasing the role of renewable gas while continuing the planned phase out of coal by 2025), and **upgrading energy infrastructures**; measures and investment to **support circular economy**; **reviewing taxes and subsidies** to make them consistent with the green transition, while taking into account redistributive aspects;
2. Measures and investments to develop sustainable transport, including infrastructure;
3. Measures promoting **climate change adaptation**, including to ensure the climate-proofing of existing and future infrastructures.

European Commission’s assessment of the final NECP of Latvia

STRUCTURE

33. Consideration by the Commission on the implementation of the recommendation from 2019

The October 2020 assessment document includes a general overview of the implementation of the Commission recommendations from 2019 in the final NECPs.

34. Assessment of the final NECP (objectives, contributions, measures, impact, investments)

This section consists in a general summary of the planned measures, divided by areas (Decarbonisation, Renewable energy, Energy efficiency, Energy security, Internal energy market. Research innovation and competitiveness.), with an evaluation on the basis of targets, implementation and Impact. The document focuses on the trajectories outlined to achieve the described targets, however never going into too much detail technology-wise. It is and update of the 2019 Report.

35. Guidance on the implementation of the NECP linked to the recovery plans from the Covid-19 crisis

This section addresses the link between the final plan and the recovery efforts from after the COVID-19 crisis by pointing at possible priority climate and energy policy measures Italy could consider when developing its national recovery and resilience plan in the context of the Recovery and Resilience Facility.

36. Annexes:

- I: Potential funding from EU sources to Latvia 2021 – 2027
- II: Detailed assessment of how Commission recommendation have been addressed

CONTENT

2019 Recommendations and Assessment of the final NECP by the Commission

Here following a summarized table, including the 2019 Recommendation from the Commission and the evaluation of the implementation of those recommendation within the final version of the NECP together with the assessment of the final NECP.

NECP	Related Recommendation and evaluation on its implementation	Assessment

Renewable Energy	The national contribution to the 2030 EU renewable energy target is specified in the plan and the **renewable share** is set at 50% in gross final consumption of energy in 2030.	Significantly increase the level of ambition for 2030 to a renewable share of at least 50% as Latvia's contribution to the Union's 2030 target for renewable energy, as indicated by the formula in Annex II under Regulation (EU) 2018/1999. ➔ Fully addressed	Latvia's energy and climate plan **lacks concrete policy measures** and instruments, quantified results, and targeted actions. Overall, it is not clear how the proposed overall renewable contribution will be achieved by 2030. There are only a few specific measures which appear to be the continuation of existing measures without the necessary update and additional efforts to achieve the planned 2030 contribution. The sectors and subsectors are not covered by measures.
		Include an indicative trajectory in the final integrated national energy and climate plan that reaches all the reference points pursuant to Article 4(a)(2) of Regulation (EU) 2018/1999 in accordance with that share, in view of the need to increase the level of efforts for reaching this target collectively ➔ Partially addressed	Sectoral trajectories and quantities of technologies that would underpin the reference points and the progress towards fulfilling the overall renewable contribution are lacking.
	On **electricity**, Latvia aims to increase the share of electricity produced from renewable energy sources by 2030 to more than 60%.	Put forward detailed and quantified policies and measures that are in line with the obligations laid down in Directive (EU) 2018/2001 and enable a timely and cost-effective achievement of this contribution.	The policies and measures are considered **sufficient** to achieve the target.
	Latvia aims to increase the share of renewable energy in **heating and cooling** to 57% by 2030 and asserts that it will implement a 0.55 percentage point average annual renewable share increase in heating and cooling	Put forward detailed measures to meet the indicative target in the heating and cooling sector included, in Article 23 of Directive (EU) 2018/2001 and the transport target in Article 25 of Directive (EU) 2018/2001 ➔ Not addressed	The proposed trajectory only amounts to a 0.42 pp. average annual increase in the share of renewables from 53.4% in 2020 to 57.59% in 2030.

	On **transport**, Latvia plans to achieve a 7% share from renewable energy in 2030 by committing to reaching 3.5% with advanced biofuels, and by increasing the electrification of rail and through electromobility. Latvia has envisaged to reduce biofuels produced from food and feed stock after 2025.	Provide more details on the enabling frameworks for renewable self-consumption and renewable energy communities with measures, in line with Articles 21 and 22 of Directive (EU) 2018/2001. ➔ Not addressed	The plan does not provide detailed information on trajectories and measures, and it is **not clear** how these targets would be achieved. In addition, the plan does not clearly explain the contributions and applicable multipliers. Although the plan mentions a supplier obligation for mandatory biofuel blending obligation and use of biofuels in public transport, it is not clear how these measures will contribute to the advanced biofuel sub-target.
Energy efficiency	Latvia's national contribution for **energy efficiency** in 2030 is 4.1 Mtoe for primary energy and 3.6 Mtoe for final energy.		The plan provides descriptive information on policies and measures beyond 2020, mostly targeting the building and transport sectors, but also the heating and cooling sector. The **implementation** of those measures **will heavily depend on** the available **EU funding**.
	Latvia notified the cumulative energy savings of 1 760 ktoe (in line with the 0.8% annual energy savings rate from final energy consumption) to be achieved under Article 7 of the Energy Efficiency Directive for the period 2021-2030. Latvia aims to achieve the energy savings obligation via the extended energy efficiency obligation scheme (EEOS) and a wide range of alternative policy measures targeting the residential, industry and transport sectors, also via the use of taxation measures	Regarding energy efficiency, increase the level of ambition, especially towards reducing primary energy consumption. Support it with policies and measures that would deliver additional energy savings to reach the Union's 2030 energy efficiency target. ➔ Largely addressed	Latvia increased the ambition level for primary energy consumption but did not change its final energy consumption contribution. The policy measures seem to be **comprehensive and appropriate** to deliver the energy efficiency ambition, provided there will be available funding.
	Regarding energy efficiency in **buildings**, Latvia plans to upgrade the energy performance of its whole residential building stock. The target envisaged (average consumption of up to 120 kWh/m2 /year for heating in 2030) supported by specific renovation objectives (notably renovation of at least 2,000 multi-apartment buildings and at least 5,000 single family buildings by 2030) seems realistic.	Provide more detailed description of the planned policies, in buildings and transport sector as well as concrete estimates of energy savings of existing and planned policy measures by 2030 and timelines for accompanying investments. ➔ Partially addressed	Annex 4 contains a comprehensive overview of policies targeting different sectors, notably buildings and transport, but **fails to provide the impacts and investment** amounts allocated per policy measure (except for a few) and it is therefore hard to assess the impact of those measures.

Energy Security	Latvia aims to increase security of supply mainly through the increase of renewables (including biofuels in the transport sector), the **diversification of energy resources** and supply routes but also through energy efficiency measures. In fact, Latvia aims to significantly increase the installed wind and solar technology capacity in view of diversification of energy sources. Latvia has set the target to reduce the **share of imports** in gross national energy consumption to 30-40% by 2030; imports may not be larger than 14.1 TWh by 2030.	Specify the measures supporting the energy security objectives on diversification and reduction of energy dependency, including measures ensuring flexibility, including an assessment of how proposed policies and measures ensure the achievement of the target to decrease energy dependency. Consider the regional context when assessing the resource adequacy in the electricity sector ➔ Partially addressed	Most of the policies and measures in the plan are of a general nature, with **no specific timeline**. Latvia did not fully address the Commission recommendation to design measures to develop more competitive retail markets and did not assess how measures ensuring flexibility will impact energy security.
			The plan does not elaborate on **cybersecurity**. Overall, the planned policies and measures are considered **not sufficiently elaborated** in relation to the achievement of the objectives to provide a comprehensive framework for the energy security dimension.
	Latvia identifies the need to develop a well-functioning legal framework for the implementation of **demand-response** services at regional level		While the plan envisages to establish a legal framework for the development of aggregators by 2022, it **does not include any quantitative indicators** apart from the timeline.
Internal Energy Market	Latvia's final plan states the need to maintain the country's generation capacity, including from a growing share of renewables. The plan sets an **interconnectivity level in electricity** of at least 60% by 2030, which is well above the target set at EU level. Latvia's final plan presents targets and objectives for the rollout of smart meters for electricity and includes a timeline for this.	Define forward-looking objectives and targets concerning market integration, in particular measures to develop more competitive wholesale and retail markets. ➔ Partially addressed	Latvia **does not specify a target** for gas smart meters. Latvia also does not plan to set other goals for the integration of the retail electricity and gas markets given the recently liberalised domestic electricity and gas markets.

Research, Innovation and Competitiveness	In the final NECP, Latvia reduced its indicative research and innovation target from 3% to 2% of GDP by 2030 with an indicative sub-target of 25% for the decarbonisation objective.The plan contains some general innovation support measures and energy efficiency and renewable energy are envisaged to be the main priority areas for research and innovation.	Clarify the national objectives and funding targets in research, innovation and competitiveness, specifically related to the Energy Union, to be achieved between 2020 and 2030, so that they are readily measurable and fit for purpose to support the implementation of targets in the other dimensions of the integrated national energy and climate ➔ Not addressed	Most measures are expected to be supported from EU funds; no clear commitments are indicated with respect to state budget funding.
	Latvia participates to some extent in three **strategic energy technology (SET) plan** implementation working groups: (i) positive energy districts; (ii) energy systems; and (iii) energy efficiency in industry. Indicative funding to energy efficiency, renewable energy sources, smart energy systems and sustainable transport is expected to account for 93% of the total R&I investments for sustainable energy for 2021 to 2027.	Underpin such objectives with specific and adequate policies and measures, including those to be developed in cooperation with other Member States, such as the Strategic Energy Technology Plan. ➔ Not addressed	Latvia **does not explain** its activities and funds allocated under each implementation plan or how the strategic energy technologies (SET) plan contributes to achieving their national energy and climate objectives.
Investments	The planned amount of investments needed to implement the policies and measures in the plan adds up to EUR 8.2 billion from 2021 to 2030 (corresponding to around 2.7% of GDP per year). The EU funding programmes will remain the main source of funding for the investment.	No recommendation	
Regional cooperation		Intensify the good regional cooperation arrangements between Baltic countries (Estonia, Latvia and Lithuania); extend them to new areas and broaden the geographic reach to include the Nordic countries (Denmark, Finland, Iceland, Norway and Sweden). The focus of the regional exchanges should be on internal energy market	Latvia intends to strengthen cooperation between the Baltic countries on developing policies in the transport sector. Agricultural and forestry activities are also mentioned but are not described in detail. Latvia aims to continue cooperation under the Regional Gas Market Coordination Group and the Baltic Energy Market Interconnection Plan

		and energy security areas, in view of the changes in the electricity systems accommodating higher shares of renewable electricity, which will increase electricity import/export and enhance the need for system flexibility, as well as the decarbonization of the transport sector and regional cooperation in research. ➔ Largely addressed	(BEMIP), in particular to develop offshore wind power capacities in the Baltic Sea.

Guidance on the implementation of the NECP and the link to the recovery from the Covid-19 crisis

Main points:

- **On renewables**, Latvia is committed to increasing the share of renewables in gross final energy consumption to 50% by 2030. It might risk falling short of its 2030 contribution if the speed of renewables deployment is not kept. Latvia would therefore benefit from setting specific policies and measures and exploring additional resources that can be mobilized to achieve its renewable objectives.
- Regarding **energy efficiency**, Latvia would benefit from introducing additional policies and measures to deliver additional energy savings by 2030 given its high untapped energy savings potential, especially in transport, buildings, and industry. To achieve a higher impact, those measures could build on the existing policies and instruments which had proved successful so far, namely buildings renovation programs and energy efficiency measures in industry.
- Building on the momentum of the '**renovation wave'** initiative, there is scope for Latvia to intensify efforts to improve the energy performance of the existing building stock with well-designed measures, targets and action, while giving due attention to energy poverty.
- In terms of **energy security,** Latvia is encouraged to concentrate on the swift implementation of all investments and measures required for synchronization with the European continental grid, together with Lithuania and Estonia. In the context of significant increases in renewable electricity generation, more detailed consideration, and measures on generation adequacy from a regional perspective may be necessary.
- As regards the **internal market**, Latvia would benefit from strengthening the monitoring and analysis of retail market competitiveness, in anticipation of a fully functioning competitive electricity market.

- Latvia would benefit from developing targeted national energy-related policies and measures in **research, innovation, and competitiveness**. This would help it achieve the national objective of total research and innovation spending of 2% of GDP by 2030 and the objectives of the European Green Deal.
- Latvia estimates that between 2021 and 2030, approximately EUR 8.2 billion in **investments will be needed** to implement the policies and measures in the national energy and climate plan, corresponding to about 2.7% of GDP per year.

Key areas indicated by the Commission to be considered when developing the national recovery and resilience plan:

1. Measures accelerating the deep renovation of buildings and improving energy efficiency in the industry as well as in the heating and cooling sectors
2. **Measures improving** energy efficiency and **renewable energy** use in **transport**, including by developing the infrastructure for **electric mobility**, and supporting a modal shift; measures to complete Rail Baltica.
3. **Measures supporting** the further deployment and integration of **renewable energy**, including promoting the use of renewables in buildings; measures to **phase out fossil fuel tax advantages**, and aligning **heating tariffs** and **car taxation** with emission intensity; in cooperation with other concerned Member States, investments and related measures required for the synchronization with the European continental grid by 2025.

European Commission’s assessment of the final NECP of Lithuania

STRUCTURE

37. Consideration by the Commission on the implementation of the recommendation from 2019

The October 2020 assessment document includes a general overview of the implementation of the Commission recommendations from 2019 in the final NECPs.

38. Assessment of the final NECP (objectives, contributions, measures, impact, investments)

This section consists in a general summary of the planned measures, divided by areas (Decarbonisation, Renewable energy, Energy efficiency, Energy security, Internal energy market. Research innovation and competitiveness..), with an evaluation on the basis of targets, implementation and Impact. The document focuses on the trajectories outlined to achieve the described targets, however never going into too much detail technology-wise. It is and update of the 2019 Report.

39. Guidance on the implementation of the NECP linked to the recovery plans from the Covid-19 crisis

This section addresses the link between the final plan and the recovery efforts from after the COVID-19 crisis by pointing at possible priority climate and energy policy measures Lithuania could consider when developing its national recovery and resilience plan in the context of the Recovery and Resilience Facility.

40. Annexes:

- I: Potential funding from EU sources to Lithuania 2021 – 2027
- II: Detailed assessment of how Commission recommendation have been addressed

CONTENT

2019 Recommendations and Assessment of the final NECP by the Commission

Here following a summarized table, including the 2019 Recommendation from the Commission and the evaluation of the implementation of those recommendation within the final version of the NECP together with the assessment of the final NECP.

	NECP	Related Recommendation and evaluation on its implementation	Assessment
Renewable Energy		Underpin the welcomed 2030 renewables ambition level by	Sufficiently ambitious as it is above the share of 34% by 2030.

	The renewable share is set at 45% in gross final consumption of energy in 2030. ○ In heating, the share of renewables is to rise to 67.2% by 2030 from the current 47.3%. ○ In district heating, which supplies 53% of the country's heat demand, and 76% in cities, the planned renewables share for 2030 is 90%. ○ In transport, Lithuania aims to reach a 15% renewables share. ○ In the electricity sector, Lithuania aims to cover a 45% share of its electricity consumption from renewable energy sources by 2030. It also projects that at least 30% of consumers will generate electricity for their own use. Wind energy is expected to be the main source of electricity generation, accounting for at least 70%, while solar energy is estimated to account for 3%, biofuels 9%, hydropower 8% and biogas 2% by 2030.	detailed and quantified policies and measures and to include an indicative trajectory. ➔ Fully addressed	The added indicative trajectory reaches all reference points. Planned measures are described in detail. The final plan provides detailed trajectories and planned capacities in absolute values for each technology, sector and subsector. The planned measures are described in great detail; measures to implement renewable energy communities and renewable self-consumption have also been included.
		Provide additional details on simplification of administrative procedures and on the enabling frameworks for renewable self-consumption and renewable energy communities. → Largely addressed	Lithuania included its measures on the simplification of administrative procedures, including the setting-up of contact points and simple notification for the installation of small electrical capacities up to 30 kW, which is higher than the required minimum level of 10.8 kW required in Renewable Energy Directive II. Enabling frameworks for self-consumption and renewable energy communities have been set up and specific measures are included in the plan.

	The strategy for reaching the target of 15% renewables in transport by 2030 is based on diversification of fuels and integration of alternative fuels by reducing dependence on imported fossil fuels.	Put forward measures to meet the transport target set in its draft integrated national energy and climate plan → Largely addressed	The plan contains specific measures to promote electromobility, the use of alternative fuels and renewables (e.g. in public transport, rail electrification), by reducing dependence on imported fossil fuels, and through the development of charging infrastructures in the main cities and along the core trans-European road networks. The approach for the uptake of electrification and the use of biofuels in the transport sector could be further detailed. The 2020 target of 10% will be missed by approximately 5 pp.
	For heating and cooling, Lithuania's plan indicates a share of 67.2% of renewables and 90% for district heating. This is in line with the indicative 1.3 and 1 percentage points calculated as annual averages for 2021-2025 and 2026-2030 respectively, including the role of waste heat, which will be one of the sources for transforming the district heating sector.		The increase in the share of renewables in heating and district heating and cooling surpasses the requirements to have an annual average increase of at least 0.65 percentage points in overall heating.
		Include an indicative trajectory that reaches all the reference points pursuant to Article 4(a)(2) of Regulation (EU) 2018/1999. ➔ Fully addressed	Lithuania provides detailed trajectories that meet the reference points.
Energy efficiency	Lithuania's national contribution for energy efficiency is expressed in terms of primary and final energy intensity and should be 1.5 times lower in 2030 than in 2017. This national contribution does not	Substantially increase the level of ambition towards reducing final and primary energy consumption in 2030. → Partially addressed	Lithuania has revised its ambition for energy efficiency upwards, including due to the improved modelling methodology.

	clearly translate into absolute values of energy consumption, but according to the WAM scenario projections in 2030 primary energy consumption should reach 5.5 Mtoe and final energy consumption 4.5 Mtoe.		
	Lithuania has new policies and measures to reap the potential for energy efficiency savings in the buildings sector. Buildings are to be upgraded or renovated. The plan further indicates measures for the modernisation of indoor heating and hot water systems in multi-apartment buildings and outlines measures for reducing energy poverty.	Update and scale up energy efficiency policies and measures. ➔ Largely addressed	Lithuania has provided more detail on energy savings from the proposed and new existing energy efficiency measures intended to achieve its 2030 contribution. More detailed information is provided for policies and measures focusing on transport, households and industry.
	The plan has descriptive information on **policies and measures** beyond 2020 targeting mainly buildings and transport sectors, as well as industry sector. Cross-cutting policies such as taxation are to play a key role, with 6 TWh energy savings expected to be achieved from various excise duties applicable to fuels.	Provide more information on energy efficiency policies and measures, by indicating which ones will be continued after 2020, what new policies will be introduced after 2020 and what impacts they will have. ➔ Largely addressed	The existing policies will deliver an estimated impact of 22 TWh, while the impact from new policies is expected to reach 21 TWh in 2030. Policies focus on priority areas in the context of the clean transition, such as renovation of buildings, while also targeting the transport sector (e.g. support scheme to promote electro mobility). However, information as regards the energy savings obligation (Art. 7 of Directive 2012/27/EU) lacks detail on some key elements of the calculation methodology (notably additionality, materiality, monitoring and verification of the energy savings claimed).
Energy Security	Maintaining high levels of security of supply is a priority in the ongoing transformation of the energy system, with the objectives by 2030	Specify the measures supporting the energy security objectives on diversification	Clearer objectives are set for the diversification of sources, as well as for renewables and energy efficiency promotion. The plan also explores the possibility of using LNG from different supply routes. Finally, also the role of gas is better explained.

	of 45% renewables powered electricity and increasing the share of domestic renewable energy for electricity generation to 70% to replace imports.	and reduction of energy dependency ➔ Fully addressed	
		Include measures ensuring flexibility, and electricity generation adequacy in light of the ambitious renewables target, such as additional measures on demand response and storage. ➔ Partially addressed	The final plan promotes the participation of all resources, better integration of renewables, and favours the active role and protection of prosumers and consumers.
		Take into account the regional context and the actual potential of the interconnectors and the generation capacities of neighbouring countries. → Partially addressed	When considering risks, the plan takes into account the plans of the other connected Member States and elaborates on a number of projects that focus on interconnectors with neighbouring countries for both gas and electricity. However, the generation capacities of the neighbouring countries are not sufficiently taken into account.
Internal Energy Market	The plan states that Lithuania's interconnectivity level is already 62% and the country aims to increase it to 111% by 2030. This high level is due to the fact that the three Baltic countries' electricity systems are already interconnected, while further connections with the Nordic electricity market are either completed or are being considered.	Set clear objectives, milestones and timelines. ➔ Largely addressed	The final plan includes policy objectives and measures related to the internal energy market. The policies and measures are consistent with the other dimensions and correspond with future projections and objectives beyond 2030. Moreover, the plan sets as a priority market integration in coordination with neighbouring countries – the Baltic countries and Finland. The final plan better outlines the reform of the electricity market, including the objective of phasing out retail price regulation and the intention to increase the liquidity of the gas market by further regional integration. The final plan also promotes the participation of all resources, better integration of renewables, and favours the active role and the protection of prosumers and consumers, including digitalisation.

	Given the electricity sector target of 45% renewable electricity in 2030, the plan provides an overview of the development of the different sources of flexibility that are necessary to integrate the rising share of renewable energy into the electricity system. The plan provides an overview of current market conditions for gas and electricity, including levels of competition and liquidity of markets.		
Research, Innovation and Competitiveness	Lithuania's national objective is to go from being an energy technology importer to an exporter. This overall goal has been translated into targets and actions set out in two major national strategies: the national energy independence strategy (adopted in 2018) and the smart specialisation strategy (2014-2020, with target values for 2023). Funding targets are set for the R&I sector as a whole (1.9% of GDP by 2023 against 1.04% in 2015).	Clarify the national objectives and funding targets ➔ Partially addressed	Both strategies include a high level of detail on actions and appropriate budget provisions, which are proportionate to their objectives and qualitative and quantitative targets. Therefore, these efforts are considered credible. Even though Lithuania does not identify R&I energy specific targets, the plan presents a number of interventions running under different programmes relevant for the energy R&I sector. The cumulative budget of these programmes adds up to more than EUR 1 million for the period 2018-2023, including both national and EU public resources. Overall, the measures are fairly specific and the budget is considerable. However, the fact that they spread across many different 'intervention areas' may constitute some risk for the overall impact in the energy sector. The programmes and measures presented are consistent with the objectives of EU energy and climate policy.
	As regards competitiveness, Lithuania's priorities include the digitalisation of industry, industrial transformation towards a circular economy and further integration of its national industries into European strategic value chains. The most relevant strategic value chains are:		The plan includes specific measures to achieve the national priorities on competitiveness; these include specialisation measures and measures to foster innovation in business and the public sector. The measures are consistent with the national objectives on competitiveness.

	(i) batteries; (ii) interconnected, clean and self-contained vehicles; and (iii) the low carbon industry and hydrogen technologies and systems.		
	Nine SET plan areas are recognised in the NECP as possibly relevant for achieving the country's energy R&I ambition.	Underpin objectives to be developed in cooperation with other Member States, such as the SET Plan.	Cooperation with the strategic energy technology (SET) plan is broadly addressed. Currently, Lithuania does not participate actively in the SET plan framework, except on nuclear safety. The plan did not explain how SET plan contributes to reach Lithuania's national energy and climate objectives.
Investments	Further investments in storage of electricity, including batteries and network infrastructure.	Extend the analysis of investment needs and provide details on funding sources. → Largely addressed	The recommendation to extend the analysis of investment needs has been fully addressed. The plan contains a complete overview of financing needs broken down by sector and connected to the various policies and measures. On the funding side, the recommendation has been largely addressed. An assessment of public and EU funding has been provided, as well as non-quantified details of which policies and measures the respective funds plan to finance. However, no details are provided on sources of private funding.
Regional cooperation	The plan elaborates on the forums for regional cooperation and extends collaboration into the research area.	Intensify already good regional cooperation arrangements between Baltic countries, extending them to new areas and broading the geographic reach to include Nordic countries. ➔ Largely addressed	Lithuania builds on a strong existing cooperation framework between the Baltic countries. The two main regional cooperation forums, which have been consulted on the NECP on a regular basis, were the BEMIP working group and the Baltic Council of Ministers. The draft national plan was also presented at the Nordic-Baltic Energy Conference both in 2018 and 2019. Cooperation with Nordic countries is highlighted in the plan in connection with the electricity market and research and innovation.

	The main objective for the electricity sector is the synchronous operation of the Baltic countries' power system with the continental European electricity network. The three Baltic countries' electricity systems are already interconnected (the interconnectivity at regional level for the three Baltic countries is 23%), while further connections with the Nordic electricity market are either completed or are being considered.	The focus of the regional exchanges should be on internal energy market and energy security areas, in view to the changes in the electricity systems accommodating higher shares of renewable electricity, which will increase electricity import/export and enhance the need for system flexibility, as well as the decarbonisation of the transport sector and regional cooperation in research. ➔ Fully addressed	Through the dedicated BEMIP working group, Lithuania works with other Baltic countries on the development of an electricity and gas market. The necessity to connect regional electricity markets to manage the challenges of an increased share of renewables is understood, as the creation of the Single Baltic-Nordic balancing market shows. The plan also describes cooperation on energy security. Lithuania aims to deploy technologies for the management of international transport corridors and for the integration of transport modes.

Guidance on the implementation of the NECP and the link to the recovery from the Covid-19 crisis

Main points:

- On **renewables**, Lithuania committed to increase the share of renewables in gross final energy consumption to 45% by 2030. The ambitious policy objectives would require swift and effective implementation of the planned policies and measures. This is particularly the case in the transport sector, where such action would be needed to raise the current low level of renewables and shift to advanced biofuels and electromobility. Lithuania would benefit from ambitious offshore wind development. Specific policy instruments would still need to be put in place to ensure successful achievement of the renewable heat objectives by 2030. Measures to increase renewables in buildings could be coordinated with renovation programmes. In that context, Lithuania would benefit from diversifying the energy mix in the heating sector, apart from biomass, maximising the role of waste heat, and maintaining constant vigilance on the sustainability of biomass.
- On **energy efficiency**, Lithuania would benefit from introducing additional policies and measures given its high untapped energy savings potential, especially in the transport and building sectors. Building on the momentum of the **Renovation Wave** initiative, there is scope

for Lithuania to intensify efforts to improve the energy performance of the existing building stock with concrete measures, targets and actions with due attention to energy poverty.

- As regards **energy security**, Lithuania is encouraged to concentrate on the swift implementation of all investments and measures required for the synchronisation with the European continental grid, together with Latvia and Estonia.
- As regards **research, innovation and competitiveness** Lithuania is invited to further develop the timeline beyond 2023 to ensure, among other goals, implementation of its ambitious renewable energy targets and the transition from being an energy technology importer to an energy technology producer and exporter.
- Lithuania is invited to continue ongoing efforts on **regional cooperation** with a view to intensifying exchanges and initiatives that will facilitate the implementation of its national energy and climate plan. Lithuania is also invited to better exploit the potential of **multilevel climate and energy dialogues** to actively engage with regional and local authorities, social partners, civil society organisations, business community, investors and other relevant stakeholders and to discuss with them the different scenarios envisaged for its energy and climate policies.

The green transition in Lithuania would receive a further boost from rapid phase-out of the **fossil fuel subsidies** identified in the NECP and recent Commission analyses. This would involve further development and implementation of concrete plans with associated timelines, coupled with measures to mitigate the risk of households' energy poverty.

Key areas indicated by the Commission to be considered when developing the national recovery and resilience plan:

1. Measures addressing **energy efficiency and renewable energy in buildings**, in particular through the modernisation of heating systems; measures addressing **energy efficiency in industry**; measures increasing **renewable electricity production** and supporting the implementation of the **renewable energy targets**; in **cooperation with other concerned Member States**, investments and related measures required for the **synchronisation with the European continental grid** by 2025;
2. Measures promoting **sustainable transport**, including public transport at local, regional and national levels, through investments in e-mobility, the deployment of **recharging infrastructure** and **alternative fuels**, including **advanced biofuels**; measures aimed at the completion of Rail Baltica;
3. Measures promoting **a green tax reform**, by increasing environmental taxes and cancelling tax exemptions, while taking into account distributional effects.

European Commission’s assessment of the final NECP of Luxembourg

STRUCTURE

41. Consideration by the Commission on the implementation of the recommendation from 2019

The October 2020 assessment document includes a general overview of the implementation of the Commission recommendations from 2019 in the final NECPs.

42. Assessment of the final NECP (objectives, contributions, measures, impact, investments)

This section consists in a general summary of the planned measures, divided by areas (Decarbonisation, Renewable energy, Energy efficiency, Energy security, Internal energy market. Research innovation and competitiveness..), with an evaluation on the basis of targets, implementation and Impact. The document focuses on the trajectories outlined to achieve the described targets, however never going into too much detail technology-wise. It is and update of the 2019 Report.

43. Guidance on the implementation of the NECP linked to the recovery plans from the Covid-19 crisis

This section addresses the link between the final plan and the recovery efforts from after the COVID-19 crisis by pointing at possible priority climate and energy policy measures Luxembourg could consider when developing its national recovery and resilience plan in the context of the Recovery and Resilience Facility.

44. Annexes:

- I: Potential funding from EU sources to Luxembourg 2021 – 2027
- II: Detailed assessment of how Commission recommendation have been addressed

CONTENT

2019 Recommendations and Assessment of the final NECP by the Commission

Here following a summarized table, including the 2019 Recommendation from the Commission and the evaluation of the implementation of those recommendation within the final version of the NECP together with the assessment of the final NECP.

	NECP	Related Recommendation and evaluation on its implementation	Assessment
Renewable Energy	The national contribution to the 2030 EU renewable energy target is set at 25% in gross final consumption of energy in 2030 Luxembourg's national contribution builds on domestic renewable energy development, by which Luxembourg is set to achieve a figure of 19.6% for renewable energy in gross final energy consumption.	Underpin the welcomed level of ambition of Luxembourg's 23-25% renewable energy share for 2030 as contribution to the Union's 2030 target for renewable energy by detailed and quantified policies and measures that are in line with the obligations laid down in Directive (EU) 2018/2001 of the European Parliament and Council in a way that enables a timely and cost-effective achievement of this contribution. ➔ Partially addressed	It is considered **sufficiently ambitious**. This is above the share of 22% by 2030 that results from the formula in Annex II to the Governance Regulation. The NECP presents a number of policies, self-consumption and energy community concepts, as well as the creation of solar and heat cadastre that will be developed to achieve this level of ambition. However, the plan still lacks sufficient detail on how these initiatives will be administered and implemented.
		Include an indicative trajectory that reaches all the reference points pursuant to Article 4(a)(2) of Regulation (EU) 2018/1999. Ensure that the renewable energy target for 2020 set in Annex I of Directive 2009/28/EC of the European Parliament and of the Council is fully met and maintained as a baseline from 2021 onwards and explain how such a baseline share will be met and maintained. ➔ Partially addressed	Based on its indigenous renewable energy development, Luxembourg is not set to achieve the reference point for 2025. However, it already anticipates the use of cooperation mechanisms to maintain its baseline and achieve its reference point for 2025. Reference points for 2022 and 2027 are not provided.

	Electricity sector: Luxembourg aims to cover a 33.6% share of consumption from renewable energy sources by 2030. This will be achieved through the development of several wind farm projects by maintaining existing injection/market premium rates and removing existing barriers, and by giving municipalities and citizens the possibility to participate via their own financing. The plan also includes the development of photovoltaic systems through new incentives such as increased feed-in tariffs in order to maximise the use of roofs, integrating the concepts of self-consumption and energy cooperatives into the field of photovoltaics, and creating a national solar cadastre.	Provide additional details on simplification of administrative procedures and on the enabling frameworks for renewable self-consumption and renewable energy communities, in line with Articles 21 and 22 of Directive (EU) 2018/2001. ➔ Partially addressed	Details on new legislation to support **renewable self-consumption and renewable energy communities** have been provided. Measures to support the simplification of administrative procedures are still under discussion, and have not been provided in the final plan.
	Heating and cooling: the trajectory in the final draft plan shows an annual average increase for the share of renewables in line with the requirements of the Renewable Energy Directive, even without the role of waste heat being included. The key policies and measures are: (i) the development of heat pump systems through financial support and improved information; (ii) more systematic identification and more consistent consideration of the potential of shallow geothermal energy; (iii) the building of a new urban heating/cooling system based on renewables; (iv) the supply of low-temperature heating networks from renewables; and (v) the creation of a thermal cadastre.		
	Transport: Luxembourg mainly refers to the role of biofuels and includes the contributions of eligible fuels, as well as the limits for conventional fuel produced from food and feed crops as	Put forward detailed measures to meet the transport target and electrification penetration described in the draft integrated national	**When setting the transport target** in the final plan, Luxembourg mainly refers to the role of biofuels and does include the contributions of eligible fuels, as well as the limits for conventional fuel produced from food and feed crops as required in Articles 25-27 of Directive 2018/2001. The key

	required in Articles 25-27 of Directive 2018/2001. The key policies and measures are: (i) the development of a comprehensive strategy for the use of sustainable biofuels; (ii) systematic additions of second-generation biofuels; (iii) the development of electromobility; and (iv) production together with the deployment of a European network of 'green' hydrogen filling stations.	energy and climate plan, in line with Article 25 of Directive (EU) 2018/2001. ➔ Largely addressed	policies and measures to achieve this are: (i) the development of a comprehensive strategy for the use of sustainable biofuels; (ii) systematic additions of second-generation biofuels; (iii) the development of electromobility; and (iv) production together with the deployment of a European network of 'green' hydrogen filling stations.
Energy efficiency	Luxembourg's national contribution for **energy efficiency** in 2030 is 3.06 Mtoe (35 568 GWh) for final energy.	Define its contribution as a specific value for both primary and final energy consumption. ➔ Partially addressed	It is considered as sufficient. This recommendation was partially addressed. The value for final energy consumption was established, but the value expressed in primary energy consumption is absent.
	The cumulative energy savings to be achieved under Article 7 of Energy Efficiency Directive were not presented in the plan. Luxembourg indicates that the energy efficiency obligation scheme will continue with the addition of alternative policy measures, most notably voluntary agreements with industry, an extended energy audit scheme and new financial instruments.	And clearly present the expect savings and a more detailed impact assessment of the proposed policies and measures. ➔ Not addressed	These **policies and measures are considered credible**, but their actual impact on the cumulative energy savings target is uncertain as there is no detailed description of measures including estimated cumulative energy savings and other elements required by Annex III to the Governance Regulation. A **new comprehensive set of measures on energy efficiency that cover all sectors has been proposed**. However, only sectoral impacts on energy savings are provided, while an estimation of impacts on measure level is absent. The information on buildings is much improved, presenting many key elements of the long-term renovation strategy, which was submitted on 26 June 2020.
	The **long-term renovation strategy** under the Energy Performance of Buildings Directive was submitted on 26 June 2020. The final NECP already includes many key elements from the strategy. The plan presents an ambitious target to increase the renovation rate (to 3% per year) and the depth of renovation (deep renovation), with the aim of rehabilitating all existing houses		

	to net zero by 2050. Several measures are presented, notably: (i) a renovation obligation (setting the energy standard of office buildings at energy class C from 2023 onwards); (ii) the phase-out of fossil heating systems (complemented by a fuel oil replacement programme); (iii) a reduced VAT rate of 3% for renovation measures as well as the introduction of an energy passport 'plus' in the building stock. Renovation of residential buildings will be supported through a support programme which provides investment aid and interest-reduced or, to support low-income households, interest-free loans.		
Energy Security	Maintaining a high level of **security of supply** is a priority in the ongoing transformation of the energy system, with an objective of 33.6% renewable electricity system and an increasing share of domestic renewable energy (19.6%).		
	The plan makes links with the **emergency plans for gas, electricity and oil,** provided for by the applicable sectoral rules. References are made to the existing preventive action and emergency plans for gas.		When considering risks, the plan **does not take into account the plans of the other connected Member States**. Moreover, there is no target date for the adoption of the risk preparedness plan.
	The plan is still lacking detailed information on further measures and investments in **electricity storage, demand response or other flexibility measures**. The plan does not include considerations on cybersecurity in the energy sector.		The planned policies and measures are **not detailed enough**, in particular in terms of specific objectives and their expected contribution to energy security and to the reduction of import dependency.

Internal Energy Market	The plan states that Luxembourg will have an **electricity interconnectivity** level of 400% for 2030. The final plan provides an overview of the development of different sources of flexibility needed to integrate the rising share of renewable energy into the system.		This is well above the target set at EU level. The final plan **does not include sufficient policy objectives and measures for the internal energy market** (in particular related to storage, aggregation, real-time price signals, and wholesale and retail market concentration levels). Those measures are considered **not sufficiently elaborated** in terms of how they will contribute to achieving the objectives. Finally, the plan provides an insufficient overview of current market conditions for gas and/or electricity, in particular regarding levels of competition and liquidity of markets. The final plan makes reference to the reports of the Luxembourg Institute of Regulation (ILR) on electricity and gas market, but without giving details of their content.
	Luxembourg plans to have by 2020 **smart meters** installed for 95% of households, enabling them to monitor their electricity consumption better. Further measures to reduce costs for households include fostering competition on the market and promoting switching of supplier, while any renewable energy from self-production or a cooperative will be exempted from electricity taxation and non-discriminatory grid connection fees.		
Research, Innovation and Competitiveness	The plan identifies relevant areas where **research and innovation efforts are necessary**. The plan includes a concentration of R&I efforts for renewables, energy efficiency, and sustainable cities and buildings. The Commission considers these efforts are sufficient in relation to the achievement of the NECPs' objectives as Luxembourg has made green technologies one of the priorities of its national economic diversification strategy.	Clarify the national objectives and funding targets in research, innovation and competitiveness, specifically related to the Energy Union, to be achieved between 2020 and 2030, so that they are readily measurable and fit for purpose to support the implementation of targets in the other dimensions of the integrated national energy and climate plan. ➔ Partially addressed	The plan identifies relevant areas and objectives for R&I and competitiveness. However, these objectives **do not have a specific timeline or quantified targets.** In addition, any specific policy or measures on energy and climate research and innovation will run only up until 2023, not the entire 2020 to 2030 period. Competitiveness is of high importance to Luxembourg and is linked to piloting 'green development', but **without measurable objective**s having been provided. Cooperation with the SET Plan is **not addressed.**

		Underpin such objectives with specific and adequate policies and measures, including those to be developed in cooperation with other Member States, such as the Strategic Energy Technology Plan. ➔ Not addressed	
	In its national energy and climate plan, Luxembourg notably clarifies how to deploy **hydrogen** produced **from renewable electricity for use in industry**, in the **mobility sector** and for **seasonal storage of electricity**. The steel industry in Luxembourg is already actively developing this. Luxembourg intends to cooperate with other EU countries on identifying demand, policy instruments and practical measures for imports. Luxembourg insists on renewable-based hydrogen and the need to increase production efficiency in electrolysis for hydrogen to be able to play a role in decarbonising transport and provide seasonal storage.		
	Main focus for **improving competitiveness**: digital architecture and automation systems linked to network services Other sectors specifically mentioned as targeted in terms of objectives for national competitiveness and developing perspectives in foreign markets are (i) the circular economy, (ii) geothermal energy, (iii) liquefied petroleum gases and methane, (iv) the bioethanol sector, (v) the production of batteries and electrochemical, and (vi) photovoltaics.		

Investments	The information provided on in**vestment needs and mechanisms and funding sources** to leverage them are covered in detail qualitatively	Provide a comprehensive assessment of overall investment needs to achieve the objectives, as well as information on the financial sources to be mobilised for implementation of the existing and planned policies and measures. ➔ Largely addressed	The sources of funding and corresponding amounts per sector are **not systematically indicated**, nor is there any description of the methodology used, or any information on how cohesion policy funds could be used. The plan presents an overview of the different policies and measures to achieve the public investment needed to reach the 2030 and 2050 targets in energy, transport, buildings and research. The total amount of investments for the planned policies and measures is not provided, only those for key sectors such as energy efficiency (including e-mobility charging infrastructure) and renewables. In addition, there is no information on how cohesion policy funds could be used. The **macroeconomic impact** on the main variables, including the general government balance, is estimated to be minor over the projection period and to record a deficit of EUR 60 million in 2030. This is because the additional expenditure is forecast to be mostly offset by higher revenues from carbon pricing, the precise terms of which are not yet known. The estimated amounts of public finance resources are not detailed, although carbon pricing revenues are estimated at EUR 150 million per year. In 2030, government debt would be around EUR 80 million higher, while the financing sources (own resources, national borrowing or EU funds) are not specifically stated. According to the final plan, the tax measures estimates are preliminary and would be analysed before their final adoption, in the context of the forthcoming tax reform.
Regional cooperation		Intensify the already excellent regional cooperation within the Pentalateral Energy Forum based on the political declaration of 4 March 2019 to extend this regional cooperation to specifically include the development and monitoring of the national energy and climate plans in particular as regards relevant issues for cross-border cooperation.	The NECP also refers to a shared vision for decarbonised electricity supply by 2050 with reference to cooperation within the Pentalateral Energy Forum (PLEF21). In the context of the forum, Luxembourg is also working to: (i) reinforce cross-border cooperation on renewable energy; (ii) foster the integration of electromobility options and services without regional constraints; (iii) explore options for carbon pricing and their cross-border impact on electricity prices; and (iv) strengthen cooperation in the supply of electricity, gas and hydrogen.

		➔ Largely addressed	
		Consider specifically efforts to decarbonise transport from a regional perspective. ➔ Largely addressed	To decarbonise transport, the NECP focuses on regional cooperation through: • the development of a climate pact with municipalities; • the development of the sustainable mobility strategy; • cross-border issues (including reducing cross-border traffic congestions, by front-loading sustainable mobility projects: urban public transport, tram and cross-border rail, fleets and multimodality; • supporting teleworking by frontier workers (on a voluntary basis) with an appropriate tax treatment and with the creation of co-working spaces; • developing electric mobility, developing cross-border inclusive city (including at neighbourhood level) and spatial planning); • reducing lorry traffic (e.g. through the Eurovignette) and facilitating the shift of freight transport to alternative powertrains and to rail (the Lean + Green initiative); • implementing electromobility, second-generation biofuels and green hydrogen.

Guidance on the implementation of the NECP and the link to the recovery from the Covid-19 crisis

Main points:

- On **renewables**, Luxembourg committed to increasing the share of renewables in gross final energy consumption to **25% by 2030**. However, Luxembourg would benefit from **further developing renewables** on its territory to reduce energy import dependency, while creating local jobs and value added. Efforts in **building renovation** will go hand in hand with renewable technologies including heat pumps, photovoltaics (planned fivefold increase up to 2030) and waste heat reused from data centres. **Further cooperation** within the North Seas Energy Forum and the Pentalateral Energy Forum (PLEF) could facilitate the further use of cooperation mechanisms to ensure that Luxembourg meets its trajectory and contribution.

- On **energy efficiency,** actions that would help ensure achievement of the overall targets include most notably a **quantitative assessment of impacts of planned policy measures** under Article 7 of the Energy Efficiency Directive (EED), including all elements required by Annex III to the Governance Regulation, and a comprehensive approach to the renovation of central government buildings in line with Article 5 EED. In addition, the policy framework would benefit from full implementation of the 'energy efficiency first' principle in related policy and investment decisions.
- On energy security, Luxembourg would benefit from further developing measures supporting the energy security objectives, including measures on diversification of energy sources and reduction of energy dependency. Likewise, Luxembourg is invited to develop specific measures to preserve and strengthen cybersecurity in the energy sector.
- Luxembourg would benefit from aligning the priorities of its **research and innovation programmes** and necessary funds with its energy and climate ambitions. The ecosystems already in place for competitive development of new products and services and startups are a useful first step in this regard. Further strengthening of the link between the competitiveness objective and the policies and measures to be put in place for the different sectors by 2030 would also be beneficial.
- The plan does not assess the overall amount of (public/private and public) **investment needs** for the period 2020-2030.
- **Regional cooperation** is important for Luxembourg to ensure security of energy supplies and to build further renewable energies, particularly in the North Sea19. The NECP also refers to a shared vision of decarbonised electricity supply by 2050 with reference to cooperation within the Pentalateral Energy Forum (PLEF). Luxembourg is invited to continue ongoing efforts on regional cooperation with a view to intensifying exchanges and initiatives that will facilitate the implementation of its national energy and climate plan, in particular as regards relevant cross-border issues. Luxembourg would notably need to continue promoting a cross-border approach to solving the mobility issues which contribute to GHG emissions. Luxembourg is encouraged to make further good use of regional forums, EU support and the upcoming EU offshore renewable energy strategy.
- The final plan constitutes a strong basis for Luxembourg to design climate and energy-related aspects of its national recovery and resilience plan, and to deliver on broader European Green Deal objectives.

Key areas indicated by the Commission to be considered when developing the national recovery and resilience plan:

1. Measures supporting energy efficiency in buildings and in businesses' production systems; measures to support the supply of energy-efficient affordable housing;
2. Measures to support investments on renewables, in particular to support systems based on renewable technologies in buildings and industry;

3. Measures to support investments in sustainable mobility, in particular related to urban public transport and cross-border rail; measures to incentivise the purchase of electric vehicles and accelerate the deployment of recharging and refuelling infrastructure; reforms to adjust taxation to better reflect environmental and climate concerns.

European Commission’s assessment of the final NECP of Malta

2019 Recommendations and Assessment of the final NECP by the Commission

Here following a summarized table, including the 2019 Recommendation from the Commission and the evaluation of the implementation of those recommendation within the final version of the NECP together with the assessment of the final NECP.

	NECP	Related Recommendation and evaluation on its implementation	Assessment
Renewable Energy	contribution of 11.5% to the EU renewable energy target for 2030. The indicative trajectory to reach the 2030 share satisfies the reference points: theshare of renewables is expected to reach 10.3%, 11.0% and 11.6%, respectively in 2022, 2025 and 2027. Solar PV is expected to contribute to 42% of the total renewable energy share in 2030. Electricity generation from waste-to-energy plants is estimated to contribute only a relatively small share to the trajectory for renewable electricity. The final NECP includes a comprehensive list of policies and measures – both ongoing and under development - across all sectors. They predominantly focus on solar PV, renewable heating technologies and biofuels	Significantly increase the level of ambition for 2030 to a renewable energy share of at least 21% as Malta’s contribution to the Union’s 2030 target for renewable energy ➔ Not Addressed	Remains unambitious and below the share of 21% that results from the Governance Regulation.
		Include an indicative trajectory in the final integrated national energy and climate plan that reaches all the reference points pursuant to Article 4(a)(2) of Regulation (EU) 2018/1999 in accordance with that share ➔ Fully addressed	Malta provided the indicative trajectory to reach the 2030 shares set out in the final plan in a way that satisfies the reference points: RES share is expected to reach 10.3%, 11.0% and 11.6%, respectively in 2022, 2025 and 2027.

		Put forward detailed and quantified policies and measures ➔ Fully addressed	The final NECP includes a comprehensive list of policies and measures – both in place and under development - across all sectors. The planned policy measures appear to be consistent to reach the 20 level of ambition of the contribution and the first interim point in 2022.
	Heating and cooling: The updated trajectory increases the baseline of 2020 to 22.06% and presents one scenario including only heating. The updated trajectory rises to 25.71% by 2030.	Increase the level of ambition in the heating and cooling sector to meet the indicative target included in Article 23 of Directive (EU) 2018/2001. ➔ Partially addressed	Remains less ambitious than the ones presented in the draft plan and does not comply with the indicative objective of a 1.1 percentage point increase, so as to reach the indicative 1.1% target. The heating and cooling trajectory may need to be updated once renewable cooling is included in the calculation.
	Malta intends to reach its renewable transport objective via the implementation of an obligation on fuel suppliers to blend biofuels with diesel. The ambition level on the blend of biofuels is retained (14% in 2030).	Provide more detailed measures to meet the transport target in Article 25 of Directive (EU) 2018/2001. ➔ Partially addressed	Calculation of the transport target is not entirely elaborated but the disaggregation of the biofuels by type and the contribution of electric vehicles are included. No detail on the role of food-based biofuels is provided. Some information is also provided on biomass supply and its source of origin.
		Provide more details on the enabling frameworks for renewable self-consumption and renewable energy communities. ➔ Fully addressed	Malta supports self-consumption, assuring that systems prioritising self-consumption do not face additional charges and consumers can offset their consumption of electricity from the grid in real time. On the contrary, in view of the structure of the Maltese electricity system with only one electricity supplier, Malta does not foresee the development of renewable energy communities.
Energy efficiency	Malta's national contribution for energy efficiency, set at a primary energy intensity level of 0.07 toe/EUR in 2030, translates into 1.1 Mtoe for primary energy and 0.8 Mtoe for final energy consumption. The plan describes policies and measures beyond 2020 for all sectors, with buildings remaining the least addressed sector and transport the sector with the biggest potential for further savings.	Substantially increase the ambition towards reducing final and primary energy consumption in 2030 in view of the need to increase the level of efforts to reach the Union's 2030 energy efficiency target. ➔ Partially addressed	The final plan proposes a slight increase in ambition, while referring to several country-specific factors preventing a bigger increase. Malta's ambition remains at a very low level compared to the EU 2030 targets. According to Malta, a more ambitious proposal is not possible because of a steep increase in population and GDP and corresponding growing demand in the housing market and tourist arrivals.

	new measures to address energy efficiency in transport (electrification of transport and a possible cut-off date for importing and registering internal combustion engine cars) and in industry and services. On buildings, the final plan does not provide specific targets or indicative milestones.	Propose more ambitious policies and measures that would deliver additional energy savings by 2030. Concrete additional energy efficiency measures particular for the building and transport are needed in order to meet to be proposed for the 2021-2030 period. ➔ Partially addressed	Given the limited and vague description of these measures, they cannot be considered as sufficiently developed to promote energy renovations of the existing building stock
Energy Security	Malta sets an objective of having a 11% share of renewable electricity and increasing its share of domestic renewable energy. On risks, the plan takes into account the specific situation of isolated territories such as islands.	Specify the measures supporting the energy security objectives on diversification and reduction of energy dependency, including measures ensuring flexibility and possibly the increased role of demand response in the electricity sector. ➔ Partially addressed	the plan does not envisage significant measures to increase the flexibility of the system or to increase the role of demand response in the electricity sector. On strategies to diversify sources and routes and to build new infrastructure projects, long-term decarbonisation goals do not appear to have not been fully considered: The plan does not consider possible alternative solutions to the construction of a new gas pipeline. The plan does not envisage significant further measures and investment in energy storage and network infrastructure. The planned policies and measures are considered insufficient in relation to the achievement of the objectives. Information on future electricity generation adequacy, including on demand response and storage remains limited
Internal Energy Market	The final plan states that Malta has achieved an electricity interconnectivity level of 24%	Further improve the level of detail of the objectives and policies and measures of the final integrated national energy and climate plan ➔ Partially addressed	This is well above the EU electricity interconnection target of 15% for 2030. However, the improvement goal is not addressed in a structured way and significant measures to increase flexibility remain absent. The plan does not explain how the projects of petroleum exploration are in line with longer-term decarbonisation goals.

	The final plan includes an extensive list of current and planned policy objectives and measures on consumer protection, covering issues like smart meters, smart grids and energy poverty. Regarding energy poverty, Malta reports a very low number of households affected. The percentage has fallen from its peak of 23.4% in 2013 to 6.6% in 2017, placing Malta below the EU average.	➔	The described current and planned policies and measures appear satisfactory in relation to the achievement of even the more ambitious targets on fighting energy poverty in Malta
Research, Innovation and Competitiveness	The final plan does not include any quantified research, innovation and competitiveness objectives and funding targets for 2030. The final NECP also states that Malta does not have 2050 objectives for the promotion of clean energy technologies.	Further elaborate national objectives and funding targets in research, innovation and competitiveness, specifically related to the Energy Union, to be achieved between now and 2030 ➔ Partially addressed	The information provided by the final NECP on national objectives and funding targets remains generic and largely incomplete. Given the limited amount of information provided and the lack of precise targets, it is not possible to assess whether policy measures are realistic and consistent with the objectives.
	The plan does not mention any contribution to the Strategic Energy Technology (SET) Plan actions for 2021-2030 and there is no explanation on how the SET Plan contributes to meeting the national energy and climate objectives.	Underpin such objectives with specific and adequate policies and measures including those to be developed in cooperation with other Member States, such as the Strategic Energy Technology Plan. ➔ Partially addressed	In light of the limited amount of information provided and of the lack of precise targets, at this stage it is not possible to assess whether policy measures are realistic and consistent with the objectives. The cooperation with the SET Plan is missing.
Investments	The plan provides an overview and a quantification of investment needs and expenditures, funding sources, market risks and barriers. It aggregates the total undiscounted cost borne by the Maltese government which amounts to approximately EUR 1.66 billion for 2018-2030.	Complement the mainly qualitative references to some of the projected investment needs, expenditures and funding sources, with further quantification in order to obtain a comprehensive assessment of overall investment needs to achieve the objectives, as well as information on the national and Union financial sources to be mobilised. ➔ Partially addressed	The full scope of the planned actions and measures taken into account remains unclear. Nevertheless, the methodology for calculating the investment needs appears to be satisfactory overall. The national budget is the implied source of the vast majority of funding, with scope for EU funding if needed, without further information regarding the share of investment needs that might be covered with the EU-level funding programmes

Guidance on the implementation of the NECP and the link to the recovery from the Covid-19 crisis

Main points:

- Despite the country' geographical constraints, Malta is encouraged to explore and assess further renewable energy options across all sectors that heavily rely on fossil fuels in order to provide for a sustainable energy future that would allow the comprehensive decarbonisation of the whole economy. Identify further opportunities to attract private investment and public support under the Innovation Fund programme, CEF or other programmes, and implement pilot projects which could prove beneficial in the longer-term such as floating offshore solar or wind technologies.
- On energy efficiency, considering the very low level of ambition, Malta would benefit from adopting and implementing additional policies and measures that would deliver additional energy savings by 2030. Malta is also invited to properly implement the 'energy efficiency first' principle in energy-related policy and investment decisions.
- Improving energy efficiency in buildings has much potential for speeding up energy savings and contributing to the recovery of the economy after the COVID-19 pandemic. (Renovation Wave initiative).
- On energy security, given the rising share of renewable energy in the electricity system, Malta would benefit from developing the different sources of flexibility, including storage, together with measures to increase the role of demand response in the electricity sector to better ensure variable renewable electricity generation.
- Malta would benefit from defining clear indicators to track the achievement of its research and innovation and competitiveness objectives. The timely completion of the national strategy for R&I in energy and water for 2021-2030, planned in 2020, will enable Malta to define key thematic priority areas to target R&I support. he strategy will also help Malta identify the strategic energy technology (SET) plan actions for 2021-2030 that may help it overcome challenges in meeting its national energy and climate objectives while bolstering national competitiveness and growth.
- While the final plan includes a breakdown of funding sources, Malta would benefit from further analysing the share of investment needs that might be covered with EU-level funding programmes.
- Malta is invited to continue ongoing efforts on regional cooperation with a view to intensifying exchanges and initiatives that will facilitate the implementation of its national energy and climate plan, in particular as regards the Clean Energy for EU Islands initiative and the multilevel climate and energy dialogues.
- Malta is encouraged to consult the Commission Recommendation of 14 October 2020 on energy poverty and its accompanying staff working document providing guidance on the definition and quantification of the number of households in energy poverty and on the EU-

level support available to Member States' energy poverty policies and measures. Energy poverty could be, among other measures, addressed through specific support to socially innovative solutions and social enterprises that work on addressing this challenge.

- Malta is invited to make the best possible use of the various funding sources available, combining scaled-up public financing at all levels (national and local, as well as EU funding) and leveraging and crowding in private financing.

Key areas indicated by the Commission to be considered when developing the national recovery and resilience plan:

1. Measures to promote sustainable mobility, in particular through tax reforms and phasingout of fossil fuels subsidies, and through investments in sustainable modes of transport;
2. Measures to create an energy-efficient building stock; measures to improve waste and water management;
3. Measures to tap into the large renewable energy potential, including innovative projects and further deployment of renewable solutions for electricity and heat generation.

European Commission's assessment of the final NECP of the Netherlands

STRUCTURE

45. Consideration by the Commission on the implementation of the recommendation from 2019

The October 2020 assessment document includes a general overview of the implementation of the Commission recommendations from 2019 in the final NECPs.

46. Assessment of the final NECP (objectives, contributions, measures, impact, investments)

This section consists in a general summary of the planned measures, divided by areas (Decarbonisation, Renewable energy, Energy efficiency, Energy security, Internal energy market. Research innovation and competitiveness..), with an evaluation on the basis of targets, implementation and Impact. The document focuses on the trajectories outlined to achieve the described targets, however never going into too much detail technology-wise. It is and update of the 2019 Report.

47. Guidance on the implementation of the NECP linked to the recovery plans from the Covid-19 crisis

This section addresses the link between the final plan and the recovery efforts from after the COVID-19 crisis by pointing at possible priority climate and energy policy measures the Netherlands could consider when developing its national recovery and resilience plan in the context of the Recovery and Resilience Facility.

48. Annexes:

- I: Potential funding from EU sources to Netherlands, 2021 – 2027
- II: Detailed assessment of how Commission recommendation have been addressed

CONTENT

2019 Recommendations and Assessment of the final NECP by the Commission

Here following a summarized table, including the 2019 Recommendation from the Commission and the evaluation of the implementation of those recommendation within the final version of the NECP together with the assessment of the final NECP.

	NECP	Related Recommendation and evaluation on its implementation	Assessment
Renewable Energy	The national contribution to the 2030 EU renewable energy target is specified in the plan, with the **renewable share** set at 27-32% of national gross final energy consumption in 2030.	The draft NECP does not set a clear national contribution to the Union's binding target of at least 32% renewable energy in 2030. ➔ Partially addressed	The renewable energy contribution put forward in the plan is 27% of national gross final energy consumption in 2030. The plan simply applies the indicative trajectory on the pathway from 14% in 2020 to 27% in 2030.

		The indicative trajectory to reach the Dutch contribution in 2030 reaching the reference points of 18% by 2022, 43% by 2025 and 65% by 2027 is not yet included in the draft NECP. ➔ Partially addressed	It does provide the 2030 renewable shares for electricity (73%), heating and cooling (13%) and transport (33%), but without an adequate breakdown of technologies or fuels. Offshore wind is the only technology where a detailed outline is provided.
	In the **electricity** sector, the Netherlands aims to use renewable energy sources to cover 73% of its consumption by 2030. However, planned capacities are not provided for the electricity sector and are not split between new power and re-powering. The increase in renewable electricity is expected to be achieved through dedicated tenders for offshore wind (49 TWh), a competitive support scheme for primarily solar photovoltaic and onshore wind (35 TWh in total) and support for small-scale renewables (10 TWh).	As regards the policies and measures, only a general description of existing measures is provided. ➔ Partially addressed	The final plan provides an overview of the main policy and measures that have been put (or are considered to have been put) in place, the intended objective and target group, the responsible government ministry, status and timeline.
	For **heating and cooling**, the plan refers to a renewables share penetration of 13% in 2030 and to several main actions under the Climate Agreement in several sectors.	For heating and cooling, the ambitions, trajectories and measures are still being developed. ➔ Partially addressed	The Netherlands offers some additional information on how to increase the renewable energy share in heating and cooling, such as an increase in heat pumps, geothermal projects, deep geothermal and the use of biogas.
	For the **transport** target in the final plan, the contribution of all eligible fuels amounts to 32%.	On the transport target, the draft plan mentions that the use of electric vehicles will increase. ➔ Largely addressed	Confirmation of the 32% reduction ambition.
Energy efficiency	The Netherlands' national contribution to **energy efficiency** in 2030 amounts to 46.6 Mtoe of primary energy consumption, which translates into 43.9 Mtoe of final energy consumption.	Review its final energy consumption contribution in view of the need to increase the level of efforts to reach the Union's 2030 energy efficiency target. ➔ Largely addressed	Final energy consumption is slightly lower and still assessed as modest in ambition. Primary energy consumption is unchanged but sufficient in ambition.

	The policies and measures are considered credible in relation to the achievement of the target, a complete estimate of the impacts on energy consumption is absent. According to the data reported in the plan, the Netherlands will not be able to achieve the national contribution.	List additional policies and measures to the ones already in place for the purposes of achieving the Netherlands' 2030 energy efficiency targets. ➔ Largely addressed	New policies were identified, in particular the Climate Agreement, which provides the basis for new policy measures that should help fill the gap identified in the first assessment.
	On **energy efficiency in buildings**, the Netherlands has provided more information, details and more energy efficiency policies and measures than the draft plan, which would go some way in terms of meeting the potential for energy efficiency savings in the sector. It intends to apply an indicative milestone of 15.2 Mt of CO2 in 2030 and a 95% reduction in GHG emissions in the Dutch built environment in 2050 compared to 1990.		
Energy Security	Maintaining a high level of **security of supply** is a priority in the ongoing transformation of the energy system, with the objective being a 73% **renewable electricity system**.	Specify the measures supporting the energy security objectives on diversification and reduction of energy dependency, including measures ensuring flexibility and electricity generation adequacy in light of the ambitious renewables target. ➔ Partially addressed	This recommendation was only partially addressed.
	The objective of the policies here are primarily based on the principle of well-functioning energy markets.		
	The plan only includes considerations on **cybersecurity** in the context of innovation objectives and fails to address it further.		

Internal Energy Market	The plan states that the Netherlands has set an **electricity interconnectivity** level of 37%, which is above the 15% EU target for 2030. The country's key stakeholders actively participated in the North Sea renewables interconnections group. Given the electricity sector target of 73% **renewable electricity** in 2030, the final plan provides an overview of the development of the different sources of **flexibility** needed to integrate the growing share of renewable energy into the electricity system.	No recommendation (n.a.)	
Research, Innovation and Competitiveness	The plan identifies relevant areas where **research and innovation** efforts are being developed under the mission-driven Knowledge and Innovation Agenda. The Netherlands aims to spend 2.5% of GDP on research and development.	Clarify the national objectives and funding targets research, innovation and competitiveness, specifically related to the Energy Union, to be achieved between 2021 and 2030, so that they are readily measurable and fit for purpose to support the implementation of targets in the other dimensions of the integrated national energy and climate plan. ➔ Largely addressed	The plan does a very good job in identifying relevant areas where research & innovation efforts are needed for the timeframes of 2030 and 2050. It also defines the set-up of relevant missions (programmes) for their implementation.
	The Netherlands has a strong ambition to become a leader in the deployment of **hydrogen** and expresses it in the target to install electrolyser capacity of 3-4 GW in 2030. The Netherlands is active in many research projects and is currently investing in hydrogen research and in pilot & demonstration projects like the possible use of the Rotterdam harbour for hydrogen trade. It is also leading bilateral and EU projects on hydrogen development.		

	Cooperation on the **strategic energy technology (SET) plan** is well described. The plan provides an accurate link between the Dutch multiannual mission-driven innovation **programmes** and the SET Plan Implementation Working Groups, including ERA-NETs (funding for transnational research and innovation), mission innovation challenges and technology collaboration programmes when appropriated.	Underpin such objectives with specific and adequate policies and measures, including those to be developed in cooperation with other Member States, such as the Strategic Energy Technology Plan. ➔ Largely addressed	The plan includes yearly estimates of private investments in energy-related R&D (between EUR 100 million and EUR 150 million since 2012). Cooperation with the SET Plan is very well defined.
Investments	The plan contains a fairly complete assessment of the **investment needs** to meet the total national 2030 objectives (i.e. a 49% reduction compared to 1990). The investment needs are divided into subsector or policy measures. The plan includes cumulative **investment** estimates over 2019-2030 following implementation of the draft Climate Agreement (and not the final one), ranging from EUR 56-75 billion, i.e. roughly 10% of current GDP. A large share of projected **investment** amounts is linked to renewable electricity generation and improved energy efficiency in key sectors (especially buildings), besides the overall objective of reducing net GHG emissions.	Provide a general overview of the investment needs to achieve the climate and energy objectives, and a general assessment of the sources of that investment, including appropriate financing at national and regional level. ➔ Largely addressed	The plan contains a fairly complete assessment of the investment needs to meet the total overall national 2030 objectives as well as of the costs.
Regional cooperation		Intensify the already excellent regional cooperation arrangements within the Pentalateral Energy Forum based on the political declaration of 4 March 2019 to extend this regional cooperation to specifically include the	In the context of the Pentalateral Energy Forum, further development of the political declaration and greater regional cooperation on the national energy and climate plans will be taken up during the Dutch presidency of the Benelux in 2020.

		development and monitoring of the national energy and climate plans in particular as regards relevant issues for cross border cooperation. ➔ Fully addressed	

Guidance on the implementation of the NECP and the link to the recovery from the Covid-19 crisis

Main points:

- On **renewables**, the Netherlands is committed to an overall renewable energy target of 27% by 2030, and is expected to exceed the share at national level. However, it still lags behind its 2020 target of 14%, and will require significant investments in renewable energy to ensure that it remains above its baseline and achieves its trajectory for 2023. The development of renewable hydrogen, including the associated renewable power generation required, is important area that can contribute to the Dutch ambition of raising its renewable energy share.
- On **energy efficiency,** the Netherlands would benefit from adopting and implementing additional policies and measures that would deliver additional final energy savings by 2030. To ensure it achieves its ambitions, a sufficient set of policies and measures needs to be proposed.
- On **energy security**, given the importance of the Netherlands to the EU in the nuclear fuel cycle with its uranium enrichment and nuclear fuel fabrication facilities (and high-level technology), it is important to maintain this capacity in the country. This is also to ensure the EU's continued technological leadership in the nuclear domain and to be competitive on the world market.
- The Netherlands would benefit from defining clear indicators to track the achievement of milestones towards its objectives on **research and innovation and competitiveness**. Over time, the gathering of granular research, innovation and competitiveness data will be useful to strengthen this process. The Netherlands would need to ensure the link with the undertaken SET Plan activities.
- On **regional cooperation**, the Netherlands has been fairly pro-active, notably as part of the Pentalateral Energy Forum and the North Seas Energy Cooperation. It is invited to continue ongoing efforts with a view to intensifying exchanges and initiatives that will facilitate the implementation of its national energy and climate plan, in particular as regards relevant cross-border issues.
- The final plan constitutes a strong basis for the Netherlands to design climate and energy-related aspects of its national recovery and resilience plan and to deliver on broader European Green Deal objectives.

Key areas indicated by the Commission to be considered when developing the national recovery and resilience plan:

1. Measures accelerating investments in energy-saving renovations and renewable energy in buildings;
2. **Measures** developing **smart energy infrastructure**, including in offshore and on-shore wind, as well as smart grids;
3. **Measures financing innovative deep decarbonisation projects in industry**, including hydrogen-related projects; measures promoting sustainable transport, including fleet renewal.

European Commission’s assessment of the final NECP of Poland

STRUCTURE

49. Consideration by the Commission on the implementation of the recommendation from 2019

The October 2020 assessment document includes a general overview of the implementation of the Commission recommendations from 2019 in the final NECPs.

50. Assessment of the final NECP (objectives, contributions, measures, impact, investments)

This section consists in a general summary of the planned measures, divided by areas (Decarbonisation, Renewable energy, Energy efficiency, Energy security, Internal energy market. Research innovation and competitiveness...), with an evaluation on the basis of targets, implementation and Impact. The document focuses on the trajectories outlined to achieve the described targets, however never going into too much detail technology-wise. It is and update of the 2019 Report.

51. Guidance on the implementation of the NECP linked to the recovery plans from the Covid-19 crisis

This section addresses the link between the final plan and the recovery efforts from after the COVID-19 crisis by pointing at possible priority climate and energy policy measures Poland could consider when developing its national recovery and resilience plan in the context of the Recovery and Resilience Facility.

52. Annexes:

- I: Potential funding from EU sources to Poland 2021 – 2027
- II: Detailed assessment of how Commission recommendation have been addressed

CONTENT

2019 Recommendations and Assessment of the final NECP by the Commission

Here following a summarized table, including the 2019 Recommendation from the Commission and the evaluation of the implementation of those recommendation within the final version of the NECP together with the assessment of the final NECP.

	NECP	Related Recommendation and evaluation on its implementation	Assessment
Renewable Energy	The national contribution to the 2030 EU **renewable energy target** is specified in the plan and the renewables share is set at 21-23% in gross final consumption of energy by 2030. The plan includes **year-on-year pathways for the three sectors** (electricity, transport and heating/cooling) on how to achieve the final contribution, but not for the individual technologies in these sectors. For individual technologies, values are only provided for the years 2020, 2025 and 2030.	Increase the level of ambition for 2030 to a renewable energy share of at least 25% as Poland's contribution to the Union's 2030 target, as indicated by the formula in Annex II under Regulation (EU) 2018/1999. ➔ Partially addressed	This is **still considered unambitious**, as it is below the share of 25% by 2030 based on the formula in Annex II of the Governance Regulation. In some instances, the plan **lacks detail as regards the planned policies and measures** that will allow the contribution to be achieved. Poland's final NECP includes an explicit contribution to the EU renewables target for 2030, but it is in the range of 21-23%, "with a 23% RES target possible, subject to additional EU funding being granted to Poland, including for a just transition". **This would be unambitious**, as an increase of 2 percentage points compared to the 21% put forward in the draft plan and would still be 2 percentage points below the 25% calculated using the formula in Annex II of the Governance Regulation.

			The explanation of why 25% would have been too ambitious remains rather general, quoting 'national circumstances, forecasts of economic development and specific sectors, the potential for the development of individual technologies, as well as the evolutionary process of a just energy transition and its socio-economic dimension'. Poland also refers to the low level achieved in 2018 (11%).
		Include an indicative trajectory in the final integrated national energy and climate plan that reaches all the reference points pursuant to Article 4(a)(2) of Regulation (EU) 2018/1999 in accordance with that share, in view of the need to increase the level of efforts for reaching this target collectively. ➔ Fully addressed	The final plan provided an indicative trajectory for reaching the 2030 shares that is exactly in line with the reference points, based on a 2030 contribution of 23%. RES share is expected to reach 16.4%, 18.4% and 20.2%, respectively in 2022, 2025 and 2027.
		Put forward detailed and quantified policies and measures that are in line with the obligations laid down in Directive (EU) 2018/2001 of the European Parliament and Council, to enable a timely and cost-effective achievement of this contribution. ➔ Partially addressed	The plan includes detailed pathways year-on-year on how to achieve the final contribution for the three sectors, but sometimes **lacks detail on the planned policies and measures for achieving this contribution.** For specific technologies within these sectors, only values for 2020, 2025 and 2030 are provided.
		Ensure that the renewable energy target for 2020 set out in Annex I of Directive 2009/28/EC of the European Parliament and of the Council is fully met and maintained as a baseline from 2021 onwards, and explain how such a baseline share will be met and maintained. ➔ Fully addressed	The plan indicates that Poland will meet the 15% renewables target by 2020 and remain above this level throughout 2021-2030. The overall percentage is underpinned by yearly percentages, broken down by electricity, heating & cooling and transport. The plan lays out the measures for increasing the share from 11% in 2018 to 15% in 2020, including:

			- the additional auctions for onshore wind carried out in 2019 and 2020 (volume of over 3 400 MW, but not all to be operational by 2020) - new measures to support prosumers (PLN 1 billion for PV production, with 200,000 expected beneficiaries), energy cooperatives and renewables in district heating and agriculture. These policies and measures are expected to substantially increase the share of renewables by 2020, but there are **doubts about whether they will be sufficient to reach to the 15% target**.
		Provide additional details and measures on simplification of administrative procedures, on the enabling frameworks for renewable self-consumption and renewable energy communities, in line with Articles 21 and 22 of Directive (EU) 2018/2001. ➔ Partially addressed	The plan does not provide information on how administrative procedures will be simplified. Regarding enabling frameworks for renewable **self-consumption**, the plan only lays out the intention to adopt a prosumer-friendly legal framework, without much detail. On **energy communities**, the plan underlines their importance and that legislative measures have been taken in the Renewable Energy Sources Act (2016, 2017, 2019) to support them, without going into details. However, Poland also focusses on **'energy clusters'**, which have elements of energy communities, but are broader. It is estimated that in 2030, there will be around 300 local energy sustainable areas.
	Electricity sector: Poland aims to cover 32% of its electricity consumption from renewable sources by 2030. This will be achieved by support provided by auctions, feed-in tariffs and feed-in premiums. Support will be based on the type of source and its size. The plan indicated that the Renewable Energy Act will remain the main legislative tool. For 2030 the plan envisages photovoltaic (PV) capacity increasing to around 7.3 GW, offshore wind farms		These policies and measures are only considered sufficient to achieve part of the intended increase in renewables.

	to 3.8 GW and onshore wind energy remaining around its current level of 9.6 GW. Hydropower potential is to be increased, as well as biomass and biogas, but without providing specific policy measures.		
	Heating and cooling: solid biomass will remain very dominant (with increases in absolute terms). However, there will also be steep increases, from a low starting point, for geothermal, solar thermal, biogas, municipal renewable waste and especially heat pumps (increasing compared to 2015 by almost 30x). Poland estimates the increase in the share of renewables in heating and cooling to be 1.1 percentage points per year, moving from 17.4% in 2020 to 28.4% in 2030.	Increase the level of ambition in the heating and cooling sector to meet the indicative target included in Article 23 of Directive (EU) 2018/2001 ➔ Partially addressed	These policies and measures **are considered insufficient** for achieving the target. Poland estimates the increase in the share of renewables in heating and cooling to be 1.1 percentage points per year, moving from 17.4% in 2020 to 28.4% in 2030. But there **is no information on the planned increase in the renewables share in district heating, nor on the role of waste heat**. As support measures, the plan mentions funding in the form of grants, repayable instruments and guarantee funds, but does not give more details.
	Transport: Poland has set a 2030 target of 14%, incl. 7% conventional biofuels. The key policies and measures to achieve this are the 2018 Law on electro-mobility and a Low Emission Fund (2018-2027), with PLN 6.7 billion of financing. Further legislation will follow, to reach 1 million electric vehicles by 2025. However, with only 32% renewable electricity share planned for 2030, less than a third of the electricity use in transport can be counted as renewable.	Put forward measures to meet the transport target in Article 25 of Directive (EU) 2018/2001. ➔ Partially addressed	These policies and measures are considered **insufficient for achieving the target**. The plan provides further information on existing and planned measures. However, **the specific status of the measures is not clear**. The plan lacks quantifiable indicators for transport. Poland expects to achieve a 14% share of renewables by 2030. Some measures are detailed (i.e., supporting investment related to the production of bio-components, liquid biofuels and other renewable fuels), but **do not provide precise figures** on the use of biofuels and gas fuels in transport by 2030. Despite the level of increased commitment, the proposed forms of support are only **vaguely described**.

Energy efficiency	The plan indicates Poland's national contribution for **energy efficiency in 2030** as 91.3 Mtoe for primary energy and 67.1 Mtoe for final energy consumption.	Review its contributions. ➔ Not addressed	The contributions **have not been revised compared to the draft plan and remain of modest ambition** compared to the level of efforts needed at the EU level. However, compared to the 2020 target, the 2030 effort has clearly increased.
	The plan provides **descriptive information on policies and measures beyond 2020** targeting all sectors. The main focus is on the supply side, transport and buildings. Poland presents the cumulative savings to be achieved under Article 7 of Energy Efficiency Directive15 as 69.741 Mtoe. This will be achieved mainly by an energy obligation scheme, accompanied by financial support for upgraded thermal insulation of buildings and expanding public transport in cities.	Identify additional policies and measures that could deliver further energy savings in view of the need to increase the level of efforts to reach the Union's 2030 energy efficiency target. ➔ Partially addressed	These policies and measures **are considered sufficient for achieving the targe**t, because they address various sectors and are reflected in the scenario used to define the contributions. However, their credibility is more difficult to assess, given that no clear estimates of impacts and related budgets are provided. These policies and measures are considered sufficient for achieving the target, but it remains uncertain whether Poland will be able to deliver the estimated savings through the energy efficiency obligation scheme. Some additional policies and measures have been presented, but given that the level of ambition remains unchanged, their impact is not significant. The information provided on renovating building stock is much improved, with additional policy measures. More details will be presented in the long-term renovation strategy, not yet submitted.
	Energy efficiency in buildings: the NECP includes useful information. The majority of measures are a continuation of existing ones. Poland has estimated the expected savings from the building measures for the period 2021-2030. The plan outlines a number of specific measures, with a quantitative objective to increase the share of thermally insulated residential buildings to 70% in 2030 (as compared with 58.8% in 2015), to decrease the number of people living in sub-standard conditions due to overpopulation, poor technical conditions or absence of technical facilities to 3.3 million in 2030 (from 5.36 million		The listed measures are often still generic and lacking in detail. Financing mechanisms for building renovation in line with Article 2a of the Energy Performance of Buildings Directive are broadly outlined in the NECP, but lack the specific information and figures (e.g. m2 of buildings, energy savings/m2, investment) that would enable a comprehensive evaluation.

	in 2011). The long-term renovation strategy has not been submitted yet.		
		The proposed level of ambition towards reducing the final contribution should be better justified and backed by adequate and quantified savings from polices and measures. ➔ Partially addressed	It is explained that contributions are based on the analysis of their impacts (especially on GDP) and energy savings potential, but this analysis is not presented in the plan.
		Support policies and measures with an impact assessment and deliver more detailed information on the scale and timeframe of implementation. Further explore policies and measures in transport considering the expected increase in the sector's energy demand in the future. ➔ Largely addressed	Policies are better described. Some measures in transport are proposed and the impacts in terms of savings are estimated for Article 7 measures. However, details for other measures are still missing. Multiple measures are presented to increase energy efficiency in transport. They include promoting new forms of transport and implementing low-emission zones (LEZ), developing inter-modal freight transport, constructing Personal Rapid Transport (PRT) systems and using new technologies, procedures and systems for railway transport (ERTMS, SDIP, CBRK) and aviation (SESAR)
Energy Security	The plan contains a **well-structured description of measures on security of supply, in particular for electricity**. Maintaining a high level of supply security is a priority in the ongoing transformation of the electricity system. In general the plan recognises that, with a growing share of renewables (from 14% now to 32% in 2030) and the closure of coal power plants, new capacity (mostly gas) will be necessary to provide secure supplies in times of unfavourable weather conditions. For this purpose, a capacity mechanism has been adopted.	Specify the measures supporting the energy security objectives on diversification and reduction of energy dependency, including measures ensuring flexibility. ➔ Largely addressed	The plan recognises gradual change in Poland's energy mix, as well as diversification projects for oil and gas infrastructure. A decrease in the coal-based electricity generation share to 57-60% in 2030, and further in the longer term, will be supplemented by the growing share of renewables (from 14% now to 32% in 2030), gas-based generation and after 2030 also nuclear (the first unit of 1-1.5 GW in 2033, followed by another 5 units over a 10-year period) and a growing share of alternative gases (e.g. syngas, biogas, hydrogen).

	On **electricity**, the implementation of nuclear electricity in Poland is indicated in the national plan as important for ensuring a stable and zero-emission electricity supply, as well as diversifying energy sources.		This would require a fuel procurement policy – to enable secure, diversified deliveries of nuclear materials and the licensing of at least two alternative fuel assembly producers.
	To **diversify sources of gas**, the plan points out investment in LNG and new pipelines sourcing gas from other sources than the East, the maintenance of domestic gas production, investment in the Baltic gas pipeline and LNG terminals and the promotion of alternative transport fuels. Decarbonised gases such as biogas and renewable hydrogen are not mentioned in this context. Poland plans to increase crude oil storage capacity (by 2024, 90 days' supply in above-ground tanks and 90 days in underground tanks).		The plan **does not make adequate links** with the emergency plans for gas, electricity and oil set out in the sectoral rules, nor does it address the incompliance of the security of supply measures (storage obligations) with both Regulation (EU) 2017/1938 on security of gas supply and the emergency plan. The planned policies and measures are **considered insufficient** for achieving the objectives.
Internal Energy Market	The NECP assesses Poland's current and intended levels of **electricity interconnectivity** for 2030 as 4% and 8.7%, respectively. It also addresses the need to reach 70% available capacity in interconnectors. The NECP reports on specific projects that will help achieve this objective. It refers to a number of gas Projects of Common Interest to strengthen the country's security of supply and diversify resources. The plan recognises a gradual change in **the country's energy mix**, as well as diversification projects related to oil and gas infrastructure. A cut in the coal-based share of electricity generation to 57-60% in 2030, and more in the longer term, will be supplemented by a growing share of renewables (from 14% now to 32% in 2030), gas-based generation and (after 2030) nuclear (the first unit of 1-1.5 GW in 2033, followed by another 5 units over a 10-year period) and a growing share of alternative gases (e.g. syngas, biogas, hydrogen).	Define forward-looking objectives and targets concerning market integration, in particular measures to assess the impact of public service obligations, in particular gas storage and price regulation on market functioning and clarify how negative consequences will be mitigated. Outline a strategy and timeline for progressing towards fully market based prices. ➔ Partially addressed	Some aspects have been improved. Poland defines forward-looking objectives and targets for **market integration** related to implementing existing internal market legislation. However, it has not addressed the key aspect of the recommendation, namely to assess how public service obligations, in particular gas storage and price regulation, will affect market functioning, and how any negative consequences will be mitigated. In broad terms the final plan refers to **liberalising gas market prices, but it leaves open the issue of liberalisation for electricity prices**. However the measures are insufficient for achieving the outlined objectives. The plan further defines forward-looking objectives and targets concerning **market integration**, related to implementing existing internal market legislation, although not always specifying the targeted date. For example, Poland plans to introduce flow-based capacity allocation (no

	The plan includes further policy objectives and measures related to the **internal electricity market**, e.g. measures to ensure the non-discriminatory participation of new market participants and different flexibility sources in all time dimensions of the electricity markets, which aim to help integrate new renewable sources e.g. electricity from off-shore wind.		target year) and intraday market coupling (no target year), remove price caps in the balancing market from 2019, and introduce marginal price-based pricing in the balancing market from 2021. Despite these descriptions, the plan **does not contain a concrete assessment of impacts**, so we cannot assess the contribution of these measures and their consistency with the changes in the energy mix. Poland should ensure the removal of export and import restrictions as soon as possible, and in any event no later than the beginning of 2021, when it will introduce the new balancing capacity procurement process. Congestion management in Central Europe needs a solution at regional level that facilitates cross-border electricity flows, while ensuring system security. Poland's plan does not address the key aspect of the recommendation on the **internal energy market dimension** – namely to assess the impact of public service obligations, in particular gas storage and price regulation, on market functioning, and to clarify how negative consequences will be mitigated. Given the electricity sector target of 32% from renewables by 2030, the plan **does provide an overview of the envisaged development of the different sources of flexibility needed** to integrate this rising share of renewables into Poland's electricity system.
Research, Innovation and Competitiveness	The plan identifies relevant areas where **research and innovation efforts aim to increase the competitiveness of economy**. These efforts are considered partially credible for achieving the target. This needs to be complemented by a timeframe, the sources of funding and	Clarify the national objectives and funding targets in research, innovation and competitiveness, specifically related to the Energy Union, to be achieved between now and 2030, so that they are readily measurable and fit for purpose to support the implementation of	The plan **does not provide clear quantitative objectives for 2021-2030**, although information on research, innovation and competitiveness was provided. The main objective is to reduce the gap between Poland and more prosperous Member States and to improve the quality of life in Polish society. Poland plans to increase the competitiveness of the economy by making better use of

	the main instruments to adopt, and fine-tuned by additional measures, in order to deliver results.	targets in the other dimensions of the integrated national energy and climate plan. Underpin such objectives with specific and adequate policies and measures, including those to be developed in cooperation with other Member States, such as the Strategic Energy Technology Plan. ➔ Partially addressed	social and regional resources, increasing renewable resources, and through automation and digitalisation of industry. Although the plan indicates Poland's ambition to gradually increase its share of renewables, promote advanced biofuels, hydrogen and micro-renewable installations, there is no explicit objective in the document for promoting or deploying low-carbon technologies. The **policy frame for energy and climate related R&I** is defined (Directions for Energy Innovation Development – DEID) and objectives set (for 2030 compared to 2018), as well as the means for achieving them, and the programmes involved (although not always for the period up to 2030). However, the plan **needs to complement this information** with a timeframe, sources of funding and the main instruments to adopt, as well as the detailed additional measures needed to deliver results. The competitiveness objectives need to be complemented by specific measures, mentioned throughout the plan.
	The NECP highlights Poland's great potential in the **hydrogen economy** and refers to the upcoming Hydrogen Technology Development Programme, where hydrogen generation, transport, storage, distribution and end-use are addressed. Poland is interested in injecting hydrogen produced from electricity into the natural gas network, to produce synthetic methane. According to its NECP, Poland will support national research on clean coal technologies and will promote the use hydrogen as an alternative fuel in the transport sector.		

	The plan mentions the **Strategic Energy Technology (SET) Plan** and provides a complete and consistent overview of its participation in the different working groups, which are (1) energy efficiency in industry and (2) nuclear safety. However, there is no allocation of national funds or activities and no information on how SET Plan contributes to achieving Poland's energy and climate objectives.		While Poland has joined two **SET plan working groups** ('Energy efficiency in industry' and 'Nuclear'), the draft plan does not specify how this participation will be implemented/supported.
	While funding targets for general research and innovation are set (1.7% of GDP in 2020 and 2.5% in 2030), there is **no specific target for Energy Union-related research and innovation**.		The NECP does not include specific national objectives for 2050, such as **promoting clean energy technologies**.
Investments	**Investment needs:** the plan forecasts the necessary capital expenditure in the energy supply sector (electricity, heat, gas, mining and liquid fuels) up to 2040 to be EUR 245.5 billion (around 4% of current GDP annually) – of which some 60% will be in 2016-2030. Investment needs in the electricity generation sector in 2021-2030 are detailed, and estimated at EUR 23.9 billion (around 0.4% of GDP annually), of which 17.6 billion for renewable sources, 2.2 billion for coal and 3.1 billion for gas. High expenditure after 2030 is related to the planned investment in nuclear energy.		The NECP identifies **priority investment areas and the funding sources**, but provides limited information on market barriers and risks. Concerning cohesion policy, the plan does not provide a comprehensive analysis of potential areas to be supported in the next programming period. Some national and other EU funding sources are mentioned e.g. the Modernisation Fund, the EU's Framework Programme for Research and Innovation and free allowances from the EU ETS. The identified investment needs set out in annex II are generally also not matched with a funding analysis. In particular, the funding analysis for additional public financial support is not sufficiently detailed.
Regional cooperation		Continue and broaden the consultation of neighbouring Member States and regional cooperation in the context of the Visegrad Group (Czechia, Hungary, Poland and Slovakia) and in the respective high-level groups. ➔ Fully addressed	Poland added information about consulting neighbouring Member States in its final plan, compared to the draft one. The final plan shows that consultations were carried out on the NECP. Requests for written comments on the draft NECP were sent to 8 countries, including the Visegrad countries, countries with a common border (Germany, Sweden, and Lithuania) and Denmark and Romania. The NECP was also discussed in 2019 by the BEMIP High Level Group, of which Poland is a member. Poland

			describes cooperation within the Visegrad group, highlighting that countries aim to create a regional gas market, cooperating on energy and nuclear energy, with the goal of ensuring energy security.
		The focus of the regional exchanges could be on further integration in the internal energy market, assessing system adequacy in light of the planned continuation of a capacity market, just transition issues, decarbonisation and renewables deployment and the impact on the energy system and cross-border electricity trade. ➔ Largely addressed	The **necessity for regional cooperation**, to further integrate the internal energy market, is well understood by Poland. It describes existing and planned cooperation on electricity infrastructure (increasing the transmission capacities of cross-border interconnections) and energy transmission networks (integrating the networks of the Baltic states and the North-South Corridor projects). Statistical transfer to/from other EU Member States and joint energy projects are also mentioned, but are still just ideas, with no concrete detail. Poland gives a very detailed account of the planned impact of its policies and measures on neighbouring Member States (chapter 5.4). Cooperation on decarbonisation, renewable energy deployment and just transition could have been addressed in more detail.

Guidance on the implementation of the NECP and the link to the recovery from the Covid-19 crisis

Main points:

- On **renewables**, Poland committed to **achieve 21-23% share of renewables** in its final energy consumption by 2030. Additional policies and measures are needed to ensure the renewables target will be achieved, especially when it comes to **heating/cooling and transport**. Given the reduction of costs in renewable technologies, Poland could assess the option of further increasing the share of renewables in its power mix. Its implementation capacities would be strengthened by exploring the right enabling frameworks for **renewable self-consumption and energy communities**, simplifying administrative and regulatory frameworks and promoting market-based direct contracts (PPAs). Strengthening the **independence of the energy market regulator** would promote stable regulatory and investment conditions, which will promote private finance for investments in renewable energy infrastructure. Renewables use in the heating sector could be increased by focusing more on the link between **modernising district heating networks**, maximising waste heat and renovating buildings, as well as by harnessing domestic renewable sources other than those based on biomass.

- On **energy efficiency,** Poland would benefit from adopting and implementing additional policies and measures to deliver **steeper energy savings** by 2030. To ensure effective implementation and progress towards the energy saving obligation under Article 7 of the Energy Efficiency Directive, it would be useful for the plan to **include a detailed assessment of the impacts of the proposed measures** and a detailed description of all the aspects required by Annex III of the Governance Regulation. Also important for delivering the expected savings would be allocating sufficient resources to monitoring and verifying the energy savings under the obligation scheme, and making sure that available funding is well allocated and leads to implementation of the identified measures. **Significant investments** would need to be directed to the replacement of around 3 million boilers for heating, which are behind a sizeable part of pollution in cities, as well as to establish financial instruments for energy efficiency in the residential sector and single-family dwellings. The plan would **need to clearly state milestones** for the implementation of these measures. Poland is also invited to implement the '**energy efficiency first'** principle across the whole value chain of its energy system, taking into account co-benefits of energy saving measures. Building on the momentum of the **Renovation Wave initiative**, there is scope for Poland to intensify efforts to improve the energy performance of the existing building stock with specific measures and targets, while giving due attention to **energy poverty**. Further support for renovating public and private buildings could be provided through increased public funding and by leveraging EU and national budgets with private money, combining grants, lending, guarantees and loan subsidies. Poland is expected to provide a robust and comprehensive **long-term renovation strategy**, in accordance with Article 2a of the Energy Performance of Buildings Directive. The long-term renovation strategy is required to set out a roadmap for decarbonisation by 2050 with ambitious milestones for 2030 and 2040 and 2050, measurable progress indicators, expected energy and wider benefits, measures to renovate the building stock, and a solid finance component with mechanisms for mobilising public and private investment.
- On **energy security** Poland is invited to modify its requirements for **gas storage**, to comply with Regulation 2017/1938, to allow **more diversification** of suppliers and domestic production of bio methane. Regarding the plan for **new nuclear capacity**, Poland would benefit from implementing a fuel procurement policy, to enable secure, diversified deliveries of nuclear fuels from alternative fuel assembly producers.
- Concerning the **internal energy market**, Poland is encouraged to take **steps to move away from regulated prices in gas and electricity**, since market price signals are an important driver for EU energy policy objectives. Poland is also encouraged to streamline the use of and market access for renewable sources in heating and cooling and in district heating, and to facilitate the injection of bio methane into its transmission and distribution networks for gas.

- Poland would benefit from defining clear indicators to track the achievement of milestones towards its **research and innovation and competitiveness** objectives. Over time, this process would be helped by gathering more granular data on innovation and competitiveness. Poland needs to ensure there is a link with the activities it has undertaken under its strategic energy technology plan. Poland would also benefit from further strengthening the link between the competitiveness objective and the policies and measures to put in place for the different sectors by 2030.
- On **regional cooperation**, Poland has been rather pro-active, notably in the context of the Baltic Energy Market Interconnection Plan (BEMIP) High Level Group. Poland is invited to continue these ongoing efforts to intensify exchanges and initiatives that will facilitate the implementation of its national energy and climate plan, in particular as regards relevant cross-border issues. Poland is also invited to better exploit the potential of the multilevel climate and energy dialogues to actively engage with regional and local authorities, social partners, civil society organisations, business community, investors and other relevant stakeholders, and to discuss with them the different scenarios envisaged for its energy and climate policies.
- The final plan constitutes a strong basis for Poland to design climate and energy-related aspects of its national recovery and resilience plan, and to deliver on broader European Green Deal objectives.

Key areas indicated by the Commission to be considered when developing the national recovery and resilience plan:

1. Measures supporting investments in renewable energy to reduce dependency on coal, and in energy efficiency in buildings and industry;
2. Measures enhancing energy system integration and promoting the decarbonisation of gas consumption, including by developing the market for storage technologies and clean hydrogen;
3. Measures fostering sustainable transport, including developing and modernising the public transport infrastructure, promoting intermodal transport networks and electromobility.

European Commission’s assessment of the final NECP of Portugal

STRUCTURE

53. Consideration by the Commission on the implementation of the recommendation from 2019

The October 2020 assessment document includes a general overview of the implementation of the Commission recommendations from 2019 in the final NECPs.

54. Assessment of the final NECP (objectives, contributions, measures, impact, investments)

This section consists in a general summary of the planned measures, divided by areas (Decarbonisation, Renewable energy, Energy efficiency, Energy security, Internal energy market. Research innovation and competitiveness..), with an evaluation on the basis of targets, implementation and Impact. The document focuses on the trajectories outlined to achieve the described targets, however never going into too much detail technology-wise. It is and update of the 2019 Report.

55. Guidance on the implementation of the NECP linked to the recovery plans from the Covid-19 crisis

This section addresses the link between the final plan and the recovery efforts from after the COVID-19 crisis by pointing at possible priority climate and energy policy measures XX could consider when developing its national recovery and resilience plan in the context of the Recovery and Resilience Facility.

56. Annexes:

- I: Potential funding from EU sources to XXX.. 2021 – 2027
- II: Detailed assessment of how Commission recommendation have been addressed

CONTENT

2019 Recommendations and Assessment of the final NECP by the Commission

Here following a summarized table, including the 2019 Recommendation from the Commission and the evaluation of the implementation of those recommendation within the final version of the NECP together with the assessment of the final NECP.

	NECP	Related Recommendation and evaluation on its implementation	Assessment
GHG emissions		Provide quantifiable information on policies and measures for different dimensions (WEM and WAM) to support results. ➔ Partially addressed	The final plan provides information on policies and measures, but annual projections for 2021-2030 are not provided. It is also not explained whether Portugal intends to use cost-efficient overachievements for possible transfers to other Member States.
Renewable Energy	Portugal's renewable energy contribution to the EU level 2030 target is 47% of gross final energy consumption in 2030. This contribution is above the 42% resulting from the formula in Annex II of the Governance Regulation.	Underpin the level of ambition of a 47% renewable energy share for 2030 as Portugal's contribution to the Union's 2030 target for renewable energy by detailed and quantified policies and measures, in line with Directive (EU) 2018/2001 of the European Parliament and Council, in a way that enables a timely and cost-effective achievement of this contribution. ➔ Largely addressed	The plan includes significant additional information on the policies and measures to achieve the underlying goals, particularly for the electricity sector, although many remain generic and difficult to assess.
	The projected share of renewable energy in final energy consumption in heating and cooling sector for the 2030 is 38% and in transport sector, 20%. In the Heating and Cooling sector, the role of fuel consumption will reduce as energy efficiency measures and the electrification of consumption is reinforced. After the analysis carried out while preparing NECP, Portugal is one of the countries of the European Union where it may not be possible to increase the share of RES by 1.3% or 1.1% per year, as set out in Directive (EU) 2018/2001. It will be possible to increase the percentage of renewable energy through the greater use of biomass and renewable	Increase the level of ambition of renewables in the heating and cooling sector to meet the indicative target included in Article 23 of Directive (EU) 2018/2001. ➔ Not Addressed	The plan did not address the recommendation to raise the ambition in the heating and cooling sectors, indicating this aspect will be revised in the updated version of NECP that will be submitted in 2024.

	gases. A more in-depth analysis of the potential of renewable gases in Portugal will take place over 2020-2021.		
	The projected share of RE in final energy consumption for the 2030 is transport sector, 20%. Increasing the incorporation of renewable energy in the transport sector and thus ensuring compliance with the goal for this sector will include use of electric mobility, advanced biofuels and hydrogen.	Put forward measures and details to meet the increased transport target in Article 25 of Directive (EU) 2018/2001, including further details on contributions of eligible fuels. ➔ Partially addressed	The final NECP provides an ambitious objective (20%) and a better description on the pathways for its achievement, including measures to electrify transport, develop advanced biofuels and reduce first generation biofuels. However, it does not include detailed information in their projections on the application of the rules to calculate the transport target (e.g. use of multipliers, and shares of advanced biofuels and first generation biofuels).
		Reduce the complexity and regulatory uncertainty, further detail how it will address the simplification and optimisation of the framework related to licensing and permitting using one-stop-shops, provide additional details on the enabling frameworks for renewable self-consumption and renewable energy communities, facilitating access to finance, and details on promoting power purchasing agreements. ➔ Fully addressed	The plan presents substantial progress on measures for simplifying administrative procedures and on promotion of self-consumption and renewables communities.
Energy efficiency	Final energy consumption is set at a 35% reduction in energy consumption in 2030 compared to the 2007 PRIMES Reference Scenario projections.	Substantially increase ambition for final energy consumption contribution, in view of the need to increase the level of efforts to reach the Union's 2030 energy efficiency target and identify additional policies and measures that could deliver further energy savings by 2030.	Portugal did not raise the overall level of ambition in energy efficiency. However, it presented slightly more reduced levels for final energy consumption and provided further information on measures and policies to be put in place targeting energy efficiency. The NECP provides some information on the renovation of the building stock, but further details on the indicative

		➔ Partially addressed	milestones and relevant policies and measures will be determined in the long-term renovation strategy, which has not been submitted yet.
		Provide a proper quantification of the energy savings expected from the planned policies and measures as part of a more detailed impact assessment and indicate how they would contribute to the national energy efficiency contributions. ➔ Partially addressed	There is more information on the with additional measures (WAM) and with existing measures (WEM) scenarios, but there is no connection between individual measures (or umbrella actions) with the targets. NECP still lacks information on the quantitative impact of the policies and measures.
		Adequately reflect the envisaged updates and improvements to existing support schemes in the final integrated national energy and climate plan and in the following progress reports. Scale them up significantly to allow for the achievement of the indicated energy savings goals. ➔ Partially addressed	The annex including information on methodologies and policies and measures for achieving the energy savings requirement in accordance with Article 7 of Directive 2012/27/EU was not provided. Work is ongoing on this front.
Energy Security	Portugal has set the objective of reducing energy import dependency to 65% by 2030. At present it is 79%.	No recommendation	n.a.
Internal Energy Market	The planned interconnection level by 2030 is 15% (10% in 2020), with a focus on implementing key infrastructure projects, notably projects of common interest and several grid reinforcement projects to accommodate further renewables capacity.	Define forward-looking objectives and targets concerning market integration, in particular measures to develop more competitive electricity and gas markets, including progressing towards fully market based prices. ➔ Partially addressed	The recommendations regarding the internal markets were partially followed, but do not include new forward-looking objectives for market integration. No measures are provided which explicitly focus on progressing towards fully market-based prices. Measures allowing self-consumption and energy communities should lead to increased competition on the markets through new market entrants.

Research, Innovation and Competitiveness	Portugal has set a target to invest 1.8% of its GDP in research and innovation by 2020 and 3% by 2030. It has also established sub-targets for energy R&D investments of 0.2% of GDP, and water and climate R&D investments of 0.2% of GDP by 2030.	Further clarify the national objectives and funding targets in research, innovation and competitiveness, specifically related to the Energy Union, to be achieved between 2021 and 2030, so that they are readily measurable and fit for purpose to support the implementation of targets in the other dimensions of the integrated national energy and climate plan. ➔ Largely addressed	The plan is a substantial improvement and now includes specific relevant targets for investment in research and innovation related to energy and climate objectives, including additional information on patents and researchers. These efforts are considered sufficient in relation to achieving the set objectives. The main means of implementation remain EU financing instruments. As regards competitiveness, specific objectives are hardly mentioned.
		Underpin such objectives with specific and adequate policies and measures, including those to be developed in cooperation with other Member States, such as the Strategic Energy Technology Plan. ➔ Partially addressed	Cooperation with the strategic energy technology (SET) plan is only mentioned generally.
Investments	The overall additional investments required for the decade 2021-2030 to achieve carbon neutrality by 2050 are estimated at EUR 11-15 billion (1 billion per year).	Provide a general overview on the investment needed to modernise its economy by reaching its energy and climate objectives, articulated with its national investment plan. ➔ Largely addressed	The plan includes detailed calculations of investment needs of the various sectors over the period 2021-2030 to achieve carbon neutrality by 2050. However, the plan does not provide details on the methodology to arrive at these estimates.
		Provide a general assessment of the sources of that investment, including appropriate financing at national, regional and Union level. ➔ Largely addressed	The plan includes an overview of EU and national programmes, and the private sector. Portugal is committed to redirecting financial flows to promote decarbonisation and energy transition, fostering the development of a favourable framework for sustainable financing and greater involvement of the financial system in these areas in the coming decade. However, no information on sources from regional budgets is provided. In addition, an indicative source of financing is

			provided for each of the policy measures, often mentioning a combination of EU and national funding.
Regional cooperation	On regional cooperation,	Intensify the existing good regional cooperation with Spain and France. The focus of the regional exchanges should be on internal energy market and energy security areas, in particular cross-border and cross regional interconnections. Fully addressed	Portugal discussed its NECPs in a regional setting with France and Spain. The plan highlights the high relevance of regional cooperation between those countries through the high-level group for South Western Europe for further developing interconnections and promoting market integration.

Guidance on the implementation of the NECP and the link to the recovery from the Covid-19 crisis

Main points:

- On **renewables**, Portugal committed to achieve 47% renewable energy in gross energy consumption. Portugal would benefit from a swift implementation of the measures, which would be well complemented by further assessment of an increased role of renewables in the heating and cooling sector.
- On **energy efficiency,** Portugal would benefit from adopting and implementing additional policies and measures that would deliver additional energy savings by 2030. Proper assessment of expected impacts of the proposed measures and a detailed elaboration of all the elements required by Annex III of the Governance Regulation would be beneficial for ensuring achievement of the **energy saving obligation** under Article 7 of the Energy Efficiency Directive. In particular, details and targets for measures to promote information for consumers, the roll-out of smart meters, and electric mobility would help ensure their effective implementation and monitoring. **Improving energy efficiency in buildings** has much potential for speeding up energy savings and contributing to the recovery of the economy after the COVID-19 pandemic. As regards energy poverty, Portugal is encouraged to consult the Commission Recommendation of 14 October 2020 on energy poverty.
- Concerning the **internal energy market**, Portugal is invited to set forward-looking objectives for market integration.

- Portugal would benefit from defining clear indicators to track achievement of milestones towards its **research and innovation and competitiveness** objectives. Over time, the gathering of granular research, innovation and competitiveness data will be useful to strengthen this process. Portugal needs to ensure the link with the SET plan activities undertaken. Portugal would also benefit from further strengthening the link between the competitiveness objective and the policies and measures to put in place for the different sectors by 2030.
- Identifying investment needs and securing adequate funding will be key to delivering on Portugal's ambitious climate and energy objectives. The front-loading of such public investment projects supporting the green transition can have an important role in fostering the economic recovery.
- Portugal is invited to continue ongoing efforts on regional cooperation with a view to intensifying exchanges and initiatives that will facilitate the implementation of its national energy and climate plan, in particular as regards relevant cross-border issues20. Involvement in the **TEN-E** High-Level Group for South-West Europe would enable Portugal to continue developing interconnections in the future. Portugal is also invited to better exploit the potential of the **multilevel climate and energy dialogues** to actively engage with regional and local authorities, social partners, non-governmental organisations, the business community, investors and other relevant stakeholders
- The final plan constitutes a strong basis for Portugal to design climate and energy-related aspects of its national recovery and resilience plan, and to deliver on broader European Green Deal objectives.

Key areas indicated by the Commission to be considered when developing the national recovery and resilience plan:

1. **Measures** fostering **sustainable transport**, including through the **electrification of the transport sector** and ensuring better train interoperability and integration of ports and railway infrastructure;
2. Measures to enhance the **energy efficiency of buildings**, to diversify **renewable energy generation** and deploy **smart grids**; measures aimed at strengthening and expanding the transmission and distribution lines including electricity interconnections with neighbouring countries;
3. Measures targeted at **climate change adaptation**, including improved water management, risk prevention and preparedness.

European Commission’s assessment of the final NECP of Romania

STRUCTURE

57. Consideration by the Commission on the implementation of the recommendation from 2019

The October 2020 assessment document includes a general overview of the implementation of the Commission recommendations from 2019 in the final NECPs.

58. Assessment of the final NECP (objectives, contributions, measures, impact, investments)

This section consists in a general summary of the planned measures, divided by areas (Decarbonisation, Renewable energy, Energy efficiency, Energy security, Internal energy market. Research innovation and competitiveness..), with an evaluation on the basis of targets, implementation and Impact. The document focuses on the trajectories outlined to achieve the described targets, however never going into too much detail technology-wise. It is and update of the 2019 Report.

59. Guidance on the implementation of the NECP linked to the recovery plans from the Covid-19 crisis

This section addresses the link between the final plan and the recovery efforts from after the COVID-19 crisis by pointing at possible priority climate and energy policy measures Romania could consider when developing its national recovery and resilience plan in the context of the Recovery and Resilience Facility.

60. Annexes:

- I: Potential funding from EU sources to Romania 2021 – 2027
- II: Detailed assessment of how Commission recommendation have been addressed

CONTENT

2019 Recommendations and Assessment of the final NECP by the Commission

Here following a summarized table, including the 2019 Recommendation from the Commission and the evaluation of the implementation of those recommendation within the final version of the NECP together with the assessment of the final NECP.

	NECP	Related Recommendation and evaluation on its implementation	Assessment
Renewable Energy	Romania's **share of energy from renewable sources** in gross final consumption of energy set for 2030 has gone up from 27.9% to 30.7%.	Significantly raise the level of ambition for 2030 to a renewable share of at least 34% as Romania's contribution to the Union's 2030 target for renewable energy, as indicated by the formula in Annex II under Regulation (EU) 2018/1999. ➔ Partially addressed	Romania's share of energy from renewable sources in gross final consumption of energy set for 2030 has gone up from 27.9% to 30.7%, but **this is still below the 34% renewable share** resulting from the formula in Annex II to the Governance Regulation. Romania's final contribution is still a conservative figure awaiting: (i) ongoing development strategies and analysis of financial resources needed to back up concrete policies and measures; and (ii) potential adjustment of the overall renewable energy share in 2030.
		Include an indicative trajectory in the final integrated national energy and climate plan that reaches all the reference points pursuant to Article 4(a)(2) of Regulation (EU) 2018/1999 in accordance with that share, in view of the need to increase the level of efforts for reaching this target collectively. ➔ Partially addressed	Although Romania expects to reach 24.4% of renewable energy in gross final energy consumption, this is considered a baseline. The indicative trajectory to reach the 30.7% contribution reaches all the reference points of 18%, 43% and 65% of the total projected increase over the 2021-2030 period.
		Put forward detailed and quantified policies and measures that are in line with the obligations laid down in Directive (EU) 2018/2001 of the European Parliament and Council, to enable a timely and cost-effective achievement of this contribution.	The **main policies and measures addressed by Romania in reaching the 30.7% target for renewable energy in 2030** will focus on adapting the primary and secondary legislative framework. The plan lists a series of policies and measures to achieve the RES target, some set in legislation but others not, and some dependent on being able to use ETS funding or EU structural funds. On alternative fuels for road transport, these are quite detailed and seem realistic, for example, how charging points for electric cars will be built and

		➔ Partially addressed	financed. Measures to promote the use of biofuels are vague and still need to be developed concretely, as are those aimed at replacing existing fossil fuel power plants with new renewable energy capacities. In the heating and cooling sectors, renewables will be promoted through amendment of Law No 372/2005, which will aim to increase primary energy consumption from RES to 30%. Further policies and measures are included in the long-term renovation strategy, albeit with limited detail included on the renovation packages to promote other renewable technologies such as solar panels, solar thermal and heat pumps.
		Put in place measures to simplify the licensing and permitting procedures and provide additional details on the enabling frameworks for renewable self-consumption and renewable energy communities, in line with Articles 21 and 22 of Directive (EU) 2018/2001. ➔ Partially addressed	Law No 184/2018 on promoting the production of energy from renewable energy resources also regulates the situation of prosumers in Romania, e.g. prosumers are exempt from the payment of excise duties on the amount of electricity produced from renewable sources for own consumption, as well as on the surplus sold to suppliers. They also have the right to sell electricity to suppliers at a protected price. However, there is a lack of clarity on licensing and permitting. Further measures are set out in the draft long-term renovation strategy (e.g. which new buildings are required to meet the 30% renewable energy consumption from on-site or nearby renewable resources from 1 January 2021). Smart metering will be developed but no timetable is given.
	Electricity sector: Romania aims to cover a 50% share of its electricity consumption from renewable energy sources by 2030. This will be achieved by hydro, wind, solar and other sources. Described policies and measures are considered sufficient in relation to the achievement of the target, because hydro is expected to remain stable throughout the 2020-2030 period, while wind production will nearly double and solar generation is expected to increase nearly fourfold in absolute generation.		

	Heating and cooling: the existing renewable share comes primarily from the use of biomass in boilers and a strong increase in the use of heat pumps (due to an estimated 25% cost reduction in deployment) and in the use of solar panels on roofs. The 33% renewable energy heating and cooling share projected in 2030 has been updated compared to the draft plan	Increase the level of ambition in the heating and cooling sector to meet the indicative target included in Article 23 of Directive (EU) 2018/2001 and put in place adequate measures to meet the transport target set in its integrated national energy and climate plan and in line with Article 25 of Directive (EU) 2018/2001. ➔ Partially addressed	The trajectory does not indicate that the 1.1 percentage point increase in renewables laid down in the new Renewable Energy Directive will be achieved. Romania relies heavily on biomass for its renewable contribution in this sector, with the use of biomass generally found in rural areas. The fact that the true potential of biomass is not clear at national level (due to lack of data and an unclear legal framework) makes it highly questionable whether the overall renewable energy contribution can be achieved and sustained. The plan does not provide information on the role of waste heat and on how Romania will achieve the 1 pp. renewable energy share increase for district heating and cooling, calculated according to the new Renewable Energy Directive. Nor does the plan indicate any accompanying measures in this area. **For H&C**: The 33% renewable energy heating and cooling share projected for 2030 has been updated compared to the draft plan. However, the final plan does not indicate that the 1.1 percentage point renewable increase will be achieved, as provided for in the Recast Renewable Energy Directive. In addition, the plan does not provide any information on the role of waste heat or on how Romania will implement the 1 pp. renewable energy share increase for district heating and cooling, calculated according to the Recast Renewable Energy Directive and accompanying measures.
		Provide additional details on the specific measures to ensure sustainability for biomass supply and use in the energy sector, given the important contribution of biomass to Romania across the energy mix, especially in heating and cooling. ➔ Partially addressed	Reliable national data on biomass and a clear legal framework are needed. The system of certificates of origin for biomass from agriculture and from forestry needs to be linked to LULUCF and must include sustainability criteria. For forest biomass in particular, a full assessment of its source and impact on the LULUCF sink is still required.
	Transport: When setting the transport target in the final plan, as required in Articles 25-27 of Directive 2018/200111, the contributions of all eligible fuels does not exceed the 7% cap. Renewable electricity in transport is set to increase substancially compared to 2020, with		These policies and measures are considered sufficient in relation to the achievement of the target. **For transport**: Road and rail energy consumption and the split between Annex IX part A and part B feedstocks was not provided, which makes it difficult to assess whether the advanced biofuel sub-target will be fulfilled.

	around 700,000 private electric cars (including hybrid) and approximately 650,000 charging points (approximately 40,000 of which will provide fast and semi-fast charging) expected to be in circulation in 2030. The key policies and measures to achieve this are the rollout of electric vehicles and further uptake of advanced biofuels.		
Energy efficiency	**Romania's national contribution for energy efficiency** in 2030 is 32.3 Mtoe for primary energy and 25.7 Mtoe for final energy. Targets and indicative trajectories are provided for both primary and final energy production. The primary energy target is more ambitious than in the draft plan, as it has been revised from 36.7 Mtoe to 32.3 Mtoe for 2030 (-45.1% compared to the PRIMES 2007 projections).	Substantially increase the ambition for reducing both final and primary energy consumption in 2030 in view of the need to increase the level of efforts to reach the Union's 2030 energy efficiency target. ➔ Partially addressed	Although the final energy target (25.7 Mtoe for 2030) is 40.4% below the PRIMES 2007 projections, **it cannot necessarily be regarded as ambitious because** it is above the level observed in recent years (average of 22.9 Mtoe in 2016-2018). The primary energy target was lowered from 36.7 to 32.3 Mtoe. No information was given for the final energy target in the draft plan so no comparison can be made. Despite the final plan having lower values than in the draft plan, the **ambition remains low** in relation to the WEM projections as final energy consumption under WAM (i.e. the target value) is higher by 8.5% than final energy consumption under WEM projections.
	The plan provides descriptive information **on policies and measures** beyond 2020 targeting the building sector, but some policies and measures also target transport, industry and the supply sectors.	Propose more ambitious policies and measures that would deliver additional energy savings by 2030. Provide more clarity on existing policies and measures and provide more detailed information on the planned policies and measures for the whole 2021 to 2030 period, in particular on their expected savings and impacts as well as timeline for implementation. ➔ Partially addressed	**It remains unclear if the policies and measures can be considered sufficient and credible** in relation to the achievement of the target, because Romania does not give any detailed descriptions of their policies and measures, in particular regarding policies and measures beyond 2020, for which the information provided is even more limited, with only general actions rather than concrete and well-defined measures. The contribution of policies and measures in terms of energy savings is not covered in the final plan. The Romanian NECP presents a list of 12 current and 40 planned policies and measures (PaMs). Planned PaMs include building renovation passports, restrictions on the sale or lease of buildings in the lowest energy performance classes, energy or CO2 taxes and transport fleet renewal programmes. Many

			of the planned PaMs focus on the building sector, but some measures also target transport, industry and the supply sector. The NECP does not give any detailed descriptions of PaMs (e.g. type of policy, sector, implementation period, status, description, etc.). In terms of future PaMs, the information is even more limited, with only general actions rather than concrete and well-defined measures. The PaMs' contribution to energy savings is not covered in the NECP. The information provided in the final plan is much improved and useful. The long-term renovation strategy has not been submitted yet.
	Energy efficiency in buildings: the plan indicates that three scenarios have been analysed to support the long-term renovation strategy, which has not been submitted yet13. Romania indicates intentions for going beyond a 3-4% renovation rate (the baseline is 0.5%). The scenario preferred at this stage by the Romanian authorities would lead to a reduction of 0.83 Mtoe in final consumption in 2030 and 3.38 Mtoe in 2050, a 66% reduction compared to the same year in the baseline scenario and a reduction in CO2 emissions of 2.34 million tonnes by 2030. To implement that scenario, investments of EUR 12.8 billion will be needed. EUR 3 billion is envisaged to come from grants from the state budget or from EU funds, while between EUR 6 billion and 8 billion would be financed through repayable financial mechanisms including repayable grants, and 1.8 billion would be secured by the owners of buildings to be refurbished under a co-financing regime.		

Energy Security	**Concerning gas supplies**, Romania envisages developing its national gas transport system as part of the Bulgaria-Romania-Hungary-Austria corridor and the Romanian section of the Southern transport corridor, to carry natural gas from the Black Sea. Legislation is being amended to facilitate investments in the Black Sea in line with the Commission's recommendations. Measures are planned to make sure that climate impacts are taken into account in **risk prevention and management**. The final plan also explores the possibility of **using LNG** from different supply routes. The role of gas for energy security is better explained in the final plan, and the use of hydrogen and of the current networks for injecting bio-methane are also considered.	Specify the measures supporting the energy security objectives on diversification and reduction of energy dependency, in particular measures ensuring flexibility and a robust gas diversification strategy including relevant underlying infrastructure projects and the elimination of the undue restrictions to investments in gas production considering the regional potential of the reserves in the Black Sea. ➔ Largely addressed	**Information is lacking** on adaptation co-benefits and trade-offs for energy efficiency, such as in the thermal management of buildings. The measures are not described in detail. Romania **increased the ambition** in the final plan from 77% to 68% energy dependency in 2030. Clearer objectives are also set for diversification of sources, i.e. renewable energy and energy efficiency targets, and the transition from coal to cleaner sources (including nuclear) was addressed. The final plan covers investment priorities for nuclear, natural gas, hydropower, wind and photovoltaic sources, and provides information on specific infrastructure projects.
	On **electricity**, the final plan addresses the production of nuclear energy. It contains measures for the long-term supply of nuclear materials and fuels and information on how to maintain its domestic capabilities in the fuel cycle. It mentions that the development of new nuclear and storage capacities will contribute to the stability of the national energy system considering that by the end of 2030 some end-of-life coal-fired power plants will be withdrawn from operation. The new generation capacity will thus contribute to the diversification	Detail the strategy to ensure the long-term supply of nuclear materials and fuel in view of the enlargement of the nuclear generation capacity and detail information concerning the strategy to maintain its domestic capabilities in the fuel cycle. ➔ Partially addressed	The strategy identifies the need to ensure long-terms supply of nuclear, gives details about the life-cycle of the two existing reactors and mentions the construction of two new reactors. However, the time horizon is not known yet. Romania should diversify uranium supply sources in the form of uranium octoxide qualified for production of nuclear fuel for CANDU reactors.

	of electricity supply sources. Romania also envisages replacing several coal-fired power stations with combined cycle units powered by natural gas, retrofitting two nuclear units (unit 1 by December 2028 and unit 2 as of 2037), and constructing at least one new nuclear unit by 2030.		
	To increase the **flexibility** of the national energy system, the plan indicates the need for additional electricity storage capacities. The plan recommends the integration of battery energy storage systems. However, it refers to a study only, and there is no objective or target for additional storage capacity.		
Internal Energy Market	The plan envisages an **interconnectivity** level of 15.4% for 2030. The plan lists current projects of common interest which will increase interconnectivity, and includes analysis of how the rising electricity demand affects the level of electricity interconnectivity and the need for infrastruture. For the electricity sector target of 15.4% renewable electricity in 2030, the plan reviews the different sources of flexibility needed to integrate the rising share of renewable energy into the electricity system. The final plan includes further policy objectives and measures related to the **internal energy market** (e.g. measures	Define forward-looking objectives and targets concerning market integration, in particular measures to develop liquid and competitive wholesale and retail markets, both by fostering competition within the country and by eliminating barriers to cross-border trade, including export restrictions. ➔ Largely addressed	This is in accordance with the target set at EU level. The final plan better outlines the reform of the electricity and gas markets. The final plan also promotes the participation of all resources, better integration of renewables, and favours the active role and the protection of prosumers and consumers. Targets were also introduced (e.g. for deregulation, for market integration and coupling and for smart grids). Specific deregulation measures at national level and planned measures at regional level were also added.
		Address the negative impact of wholesale price regulation and provide a clear outlook to ensure compliance of national legislation with Union law with respect to open and liberalised markets and free price formation by including a strategy and timeline for progress towards fully market-based prices, while including targeted measures to protect vulnerable customers.	The plan indicates a phase-out of price regulation on both the gas and electricity markets (30 June 2020 for gas and 31 December 2020 for electricity). However, the legislation is still to be implemented. The final plan provides several measures to address energy poverty, notably by developing the legal framework needed to protect vulnerable consumers.

	to ensure the non-discriminatory participation of new market participants and flexibility sources in all energy markets). Those measures are considered important in relation to the achievement of the objectives.	➔ Largely addressed	
Research, Innovation and Competitiveness	Romania **does not indicate national objectives and funding targets in research, innovation and competitiveness** for the period beyond 2020. For 2020 to 2027, the plan identifies areas where research and innovation (R&I) efforts are needed. As the 2021-2027 National Strategy for Intelligent Specialisation is under preparation, it remains to be seen whether the R&I efforts identified in the plan will be fully aligned with the Strategy. A specific timeline, quantified targets, and concrete policies and measures beyond 2020 are not provided.	Clarify the national objectives and funding targets in research, innovation and competitiveness, specifically related to the Energy Union, to be achieved between 2020 and 2030, so that they are readily measurable and fit for purpose to support the implementation of targets in the other dimensions of the integrated national energy and climate plan. ➔ Not addressed	Romania does not yet have energy and climate-related national objectives and funding targets for research, innovation and competitiveness for any period beyond 2020, or any concrete policy or measures beyond 2020. As regards competitiveness, no specific or measurable objectives have been laid down, apart from a qualitative target to replace natural gas by hydrogen and stimulate investment in the development of the equipment manufacturing industry for RES and electromobility. The revised document takes the recommendation into consideration only to a very limited extent.
		Underpin such objectives with specific and adequate policies and measures, including those to be developed in cooperation with other Member States, such as the Strategic Energy Technology Plan. ➔ Not addressed	Cooperation with the SET Plan is mentioned, but with no reference to adequate policies or measures to be developed in this context.
Investments		Extend its analysis of investment needs and risks provided for its Energy strategy objectives, to a general overview of investment needs to reach the objectives of its integrated national energy and climate plan. ➔ Partially addressed	The plan contains a **partial assessment of investment needs** and expenditures, funding sources and other relevant information. Total investment needs to achieve the objectives of the Romanian energy strategy are estimated at EUR 150 billion for 2021 to 2030 (annually around 7% of current GDP) and the main risks are listed. EUR 127 billion of the investment needs relate to energy demand in the industry, tertiary, residential and transport sectors, EUR 12 billion for power and heat supply, and EUR 9 billion for grids.

		Provide a general assessment of the sources of that investment, including appropriate financing at national, regional and Union level. ➔ Partially addressed	The information is **significantly more comprehensive than in the draft plan**, but there are still some gaps. It is stated in the plan that Romania could transfer part of its annual emission allocations under Regulation (EU) 2018/842, but no information is provided on possible investments that would help generate such transfers. The plan provides specific information per dimension and per policy and measure, as well as investment sources broken down by fund.
		Consider also the cost-effective generation of transfers to other Member States under Regulation (EU) 2018/842 of the European Parliament and Council as funding source. ➔ Partially addressed	It is stated in the plan that Romania could transfer part of its annual emission allocations under Regulation (EU) 2018/842, but no information is provided on possible investments that would help generate such transfers.
Regional cooperation		Intensify regional cooperation with neighbouring Member States and within established regional cooperation frameworks such as the Central and South-Eastern Europe Energy Connectivity (CESEC) High-Level Group including in gas and electricity infrastructure, renewables, energy efficiency and research, innovation and competitiveness, and taking into account common challenges and shared objectives. ➔ Partially addressed	**Regional cooperation is mentioned**, and contacts with the neighbouring countries took place, but there is a lack of clear action or indication on how specifically to address existing issues at borders, i.e. interconnections. The information on **regional cooperation** with other Member States on renewable energy and energy security including via CESEC remains largely unchanged from the draft plan.
		There is significant potential to further cooperate with a view to achieving the planned developments in the electricity sector, including the need to accommodate higher shares of renewables and clean transport, which could impact electricity interconnections and trading in the region. ➔ Partially addressed	The plan refers to the statistical transfer mechanism that provides for the transfer of a surplus of RES produced in one EU country to other Member States, as laid down in Directive 2009/28/EC. These instruments (statistical transfer or co-financing by two or more Member States of RES production projects) may represent an opportunity to increase the RES installed capacity in Romania provided that the statistical transfer in question is not at the expense of meeting national RES targets and that there is no negative impact on the safe operation of the energy system. Romania also proposes measures to reduce red tape through transparency, digitalisation and the introduction of a ‘one-stop shop’.

Guidance on the implementation of the NECP and the link to the recovery from the Covid-19 crisis

Main points:

- On **renewables**, Romania committed to increasing the share of renewables in gross final energy consumption to **30.7% in 2030**. In this context, Romania would benefit by developing further policies and measures. **Finalising ongoing development strategies** would help investment certainty. Particular attention would need to be paid to: (i) improving accounting of bioenergy to ensure its sustainability, especially given the current high use of bioenergy; and (ii) diversifying the energy mix in heating and cooling away from forest biomass. Illegal logging is indeed an issue to be addressed.
- On **energy efficiency,** Romania would benefit from the introduction of **additional policies and measures** that would deliver additional energy savings by 2030. More detailed policies and measures would help ensure effective implementation and monitoring of the proposed measures, in particular with regard to **energy savings** and requirements on central government. Romania is also invited to ensure that the ‘**energy efficiency first’** principle is properly implemented in energy-related policy and investment decisions. Building on the momentum of the ‘**Renovation Wave’** initiative, there is scope for Romania to intensify efforts to improve the energy performance of the existing building stock with specific measures, targets and actions, while giving due attention to **energy poverty**. Further support for the renovation of public and private buildings, including the residential sector with a focus on affordable and social housing, could be provided through increased public funding and by leveraging EU and national budgets with private money, combining grants, lending, guarantees and loan subsidies.
- On **energy security,** concrete actions are recommended to address **cooperation with neighbouring countries** at EU and regional level to ensure the diversification of sources and routes. This could harness Romania’s solar, wind and hydropower potential. On the protection of critical infrastructure against physical, computer-related and other disasters, Romania could benefit by providing specific details of the envisaged measures. Finally, Romania would gain from taking concrete measures on the flexibility of the national energy system, including setting a target for additional storage.
- On the **internal energy market**, Romania is encouraged, after recently adopting legislation in this field, to take further steps towards market-based prices and a competitive retail market. Romania is encouraged to envisage supporting the development of the retail electricity market by developing policy measures on storage and smart grids, and present detailed measures on system flexibility, real-time price signals, demand response and aggregation, prosumers and energy communities. Consumer protection measures could also be strengthened further.

- Romania would benefit from setting clear indicators to track achievement of milestones towards its **research and innovation and competitiveness** objectives. Over time, the gathering of granular research, innovation and competitiveness data will strengthen this process. Equally important is the strengthening of Romania's institutional capacity and governance for designing, implementing and monitoring research, innovation and competitiveness policies in support of energy and climate objectives. Romania would need to ensure the **link with SET Plan activities**, and would benefit from further strengthening the link between the competitiveness objective and the policies and measures to put in place for the different sectors by 2030.
- Romania is invited to continue ongoing efforts on **regional cooperation with** a view to intensifying exchanges and initiatives that will facilitate the implementation of its national energy and climate plan. This applies in particular to relevant cross-border issues, including those in the context of the Central and South-Eastern Europe Energy Connectivity (CESEC) High-Level Group16. Romania is also invited to better exploit the potential of the multilevel climate and energy dialogues to actively engage with regional and local authorities, social partners, civil society organisations, business community, investors and other relevant stakeholders and to discuss with them the different scenarios envisaged for its energy and climate policies.
- The final plan constitutes a strong basis for Romania to design climate and energy-related aspects of its national recovery and resilience plan, and to deliver on broader European Green Deal objectives.

Key areas indicated by the Commission to be considered when developing the national recovery and resilience plan:

1. Measures boosting renewable energy generation; measures aimed at fostering the renovation of buildings and the energy efficiency of district heating networks;
2. Measures improving transport infrastructure and sustainable mobility, including reforming the transport agencies and supporting the deployment of recharging and refuelling infrastructure;
3. Measures supporting the phase-in of green taxation and green budgeting.

European Commission's assessment of the final NECP of Slovakia

STRUCTURE

61. Consideration by the Commission on the implementation of the recommendation from 2019

The October 2020 assessment document includes a general overview of the implementation of the Commission recommendations from 2019 in the final NECPs.

62. Assessment of the final NECP (objectives, contributions, measures, impact, investments)

This section consists in a general summary of the planned measures, divided by areas (Decarbonisation, Renewable energy, Energy efficiency, Energy security, Internal energy market. Research innovation and competitiveness..), with an evaluation on the basis of targets, implementation and Impact. The document focuses on the trajectories outlined to achieve the described targets, however never going into too much detail technology-wise. It is and update of the 2019 Report.

63. Guidance on the implementation of the NECP linked to the recovery plans from the Covid-19 crisis

This section addresses the link between the final plan and the recovery efforts from after the COVID-19 crisis by pointing at possible priority climate and energy policy measures XX could consider when developing its national recovery and resilience plan in the context of the Recovery and Resilience Facility.

64. Annexes:

- I: Potential funding from EU sources to XXX.. 2021 – 2027
- II: Detailed assessment of how Commission recommendation have been addressed

CONTENT

2019 Recommendations and Assessment of the final NECP by the Commission

Here following a summarized table, including the 2019 Recommendation from the Commission and the evaluation of the implementation of those recommendation within the final version of the NECP together with the assessment of the final NECP.

	NECP	Related Recommendation and evaluation on its implementation	Assessment
GHG emissions	Slovakia has increased its ambition for emissions reductions under the Effort Sharing Regulation (ESR) for sectors outside the EU Emissions Trading System (non-ETS sectors) from -12% (binding target set at EU level) to -20% by 2030 set nationally compared to 2005. In the plan, Slovakia has endorsed climate neutrality.	No recommendation	n/a
Renewable Energy	"The Slovak Republic proposes a target of 19.2% in 2030, which is an increase of 5.2 percentage points compared to the target set for 2020.	Significantly raise the level of ambition for 2030 to a renewable share of at least 24% as Slovakia's contribution to the Union's 2030 target for renewable energy, as indicated by the formula in Annex II under Regulation (EU) 2018/1999 and after due consideration of relevant circumstances and national constraints. ➔ Partially addressed	Slovakia proposes a 19.2% renewable share in gross final consumption of energy for 2030 as opposed to the 14% target for 2020. The overall contribution remains below the estimate of a 24% renewable share in 2030 for Slovakia. Following up on the Commission recommendation to provide explanations for the low ambitions, the final plan refers to the PRIMES modelling producing a 19% share for SK and indicates that 5 departments of the SK government opposed a higher ambition of 20%. SK does not consider RES cooperation mechanisms to use the 'better potential elsewhere in EU.

	Based on the requirements in Article 4(2) of the Regulation, the reference points in the indicative trajectory for 2022, 2025 and 2027 are set at 14.94%, 16.24% and 17.38% for the 19.2% target."	Include an indicative trajectory in the final integrated national energy and climate plan that reaches all the reference points pursuant to Article 4(a)(2) of Regulation (EU) 2018/1999 in accordance with that share, in view of the need to increase the level of efforts for reaching this target collectively. ➔ Fully addressed	The indicative trajectory to reach the 19.2% contribution in 2030 is included and satisfies the reference points in 2022, in 2025 and 2027.
		Put forward detailed and quantified policies and measures that are in line with the obligations laid down in Directive 2018/2001. ➔ Partially addressed	The final plan includes an overview on existing and planned policies and measures for RES, which was not the case for the draft. Basis is a reformed RES law that entered into force in 2019 as well as some other measures that seem to be included in the transposition of the RES Directive, for which not much more detail is provided. Measures are described briefly; for some measures, the plan also indicated how long they will be in force. However, the impact of the measures is not quantified and, for example, the plan does not describe how capping for own consumption is in line with the RES target. It is also not clear which measures were added or increased to provide the additional 1.2% in the final plan. The plan also does not explain how in the short term a turnaround in trend can be achieved (stagnation for 5 years at around 11%), when for example all of 2019 did not see an auction for big-scale RES, unlike what was originally planned. Regarding the heating and cooling sector, the final NECP includes some policy measures to achieve the objective of increasing renewable energy in heating and cooling; however these measures remain insufficient to deliver the required increase. For transport, the main measure is fuel obligation and future support for biomethane and advanced fuels, although it is not specified. Measures on self-consumption included, but not for RES communities PPA repowering.

	In the electricity sector, the final plan proposes a renewable energy share target of 27.3%. The use of renewable energy in heating and cooling is planned to increase from the expected 13% in 2020 to 19% in 2030, an increase of 1.4% compared to the draft NECP (compared to 10.60% in 2020). The NECP recognises the need to invest in new district heating and cooling infrastructure.	Increase the level of ambition in the heating and cooling sector to meet the indicative target included in Articles 23 of Directive (EU) 2018/2001 and put in place adequate measures to meet the transport target in Article 25 of Directive (EU) 2018/2001. ➔ Partially addressed	The use of renewable energy in heating and cooling is set to increase from the expected 13% in 2020 to 19% in 2030 and increase by 1.4% compared to the draft NECP (the current share is only 10.60%). The annual average increase for 2020-2025 is 0.68 percentage points per annum, while for 2025-2030, the increase is 0.58 percentage points per annum, hence not in line with the 1.3 percentage points per annum enshrined in the Directive. A brief description of the amount of additional renewable heat production and demand needed to reach the 1.3% is given. For district heating and cooling, a mandatory 1 percentage point per annum will be set as of 2021, with the NECP basically repeating obligations from the Renewable Energy Directive for transposition. The NECP states that there is a need to build new DH and DC infrastructure but does not quantify it or address it. The plan mentions single measures such as VAT reduction, but does not put forward a comprehensive strategy for the sector. Slovakia expects biomass/biomethane to account for 75% of renewable heat in 2030, with the remaining renewable heat coming from solar thermal, ambient energy from heat pumps and geothermal energy.
	The final plan includes a sectoral share of renewable energy in transport of 14% in 2030 (compared to 8.9% in 2020) with close to 90% based on biofuels.		The final plan includes a sectoral share of renewable energy in transport of 14% in 2030 (vs a baseline of 8.9% in 2020) vs the current share of 6.96%, thus reaching the minimal obligation. Close to 90% is bioenergy-based in 2030, with low levels of electricity penetration, especially in road transport. The role of advanced biofuels will increase in 2030 (and the final NECP announces a blending obligation for fuel suppliers as of 2019 and mentions measures for second generation with no details about the type of support and scope nor about the entry into force). Although a breakdown of the renewable energy contribution by fuels in the transport sector is included, Slovakia does not provide the detailed calculation of the transport target as required in the Renewable

			Energy Directive. The final NECP announced measures as of 2019/2020 on alternative fuel infrastructure and support for e-vehicles purchase, with no information on overall amount and duration or expected economic impact.
Energy efficiency	National indicative energy efficiency targets and contributions to the European energy efficiency target: Primary energy consumption in WAM scenario, 2030: 15.7 Mtoe / 182 623GWh, Final energy consumption in WAM scenario, 2030: 10.27Mtoe / 119 457 GWh National indicative contributions to the EU target in 2030: 30.32%	Increase its ambition regarding both final and primary energy consumption in view of the need to increase the level of efforts to reach the Union's 2030 energy efficiency target. ➔ Partially addressed	The NECP indicates a slightly higher level of ambition compared to the draft, but this is still low for PEC and modest for FEC. Slovakia claims its contributions are ambitious already.
		Support it with policies and measures that would deliver additional energy savings by 2030. Provide a proper quantification of the energy savings expected from the planned policies and measures as part of a more detailed impact assessment. ➔ Partially addressed	While there are new measures added to the final NECP (e.g. regional energy centres), it seems that overall the policies and measures build on the basis set out in the draft NECP. The measures under Article 7 are described in a much higher level of detail, but not all policy measures are set out, and details about energy savings are missing - currently quantified impacts reach about 53% of targeted energy savings. The information provided on the renovation of the building stock remains limited in the absence of the long-term renovation strategy.
		Specify the measures supporting the energy security objectives on diversification and reduction of energy dependency, including measures ensuring flexibility and the long-term supply of nuclear materials and fuel in view of the development of the nuclear generation capacity. ➔ Partially addressed	On energy security, Slovakia received a recommendation to specify the measures supporting the energy security objectives on diversification and reduction of energy dependency, including measures ensuring flexibility and the long-term supply of nuclear materials and fuel in view of the development of nuclear generation capacity. This recommendation was partially addressed. The plan

			refers to discussions on alternative nuclear fuel supplies, however, without providing concrete details.
Energy Security	Maintaining a high level of security of supply is a priority for Slovakia due to the high dependency on energy imports.	➔	The plan outlines energy security policies and measures, which are considered sufficient; however, the contribution of these policies and measures to the overall decarbonisation objectives needs to be elaborated further.
Internal Energy Market	The electricity interconnectivity level of Slovakia of 43% in 2017 is well above the EU cross-border transmission capacity interconnection target of 15% by 2030.	Define forward-looking objectives and targets concerning market integration, in particular measures to enhance competition in the wholesale and retail markets, including progressing towards fully market based prices. Partially addressed	The plan improves the outline of concrete objectives for further electricity market integration. Slovakia also received a recommendation to set clear objectives, milestones and timelines related to sources of flexibility and smart meters. Such a recommendation was partially addressed. Nevertheless, the description stays generic. As for objectives and measures, the plan often makes reference to the new Electricity Directive 2019/944 stating that its transposition into Slovak law will address the issue.
	In view of the target for electricity of having 27.3% renewables for 2030, the plan has provided an overview of the development of the different sources of flexibility needed to integrate the rising share of renewable energy into the electricity system.		The overview of current market conditions for gas and electricity is not sufficiently detailed, in particular when it comes to levels of competition and liquidity of markets. The NECP includes concrete objectives for further electricity market integration, but lacks timeframes and concrete steps for reaching them. The plan does not provide clear timing for the steps to implement the market design elements of the clean energy package. Congestion management in Central Europe needs a solution at regional level that facilitates cross-border electricity flows while ensuring system security.

	“The Slovak Republic has exceeded its plan to eliminate the risk of poverty or social exclusion. The EU SILC 2017 survey showed that it has rescued 255,000 people from the risk of poverty or social exclusion. The measures adopted have had a major impact on the achievement of this objective, in particular in the employment policy, social policy and economic policy measures of the State.” in 2016 regulatory policy, “A major difference from the previous regulatory policy is the emphasis on vulnerable customers in the electricity, gas and heating sectors, and also on the energy poverty issue.” “As regards legislation, there are several generally binding legal norms in force in Slovakia that create the conditions to address energy poverty: “Act No 321/2014 on energy efficiency and on amendments to certain Acts, set out measures to promote and improve energy efficiency and contribute towards reducing energy poverty; Act No 443/2010 on subsidies for the development of housing and on social housing, providing subsidies for the elimination of systemic defects in apartment buildings; Act No 150/2013 on the State Housing Development Fund, which provides loans for the insulation of existing apartment buildings. etc.	➔ The final NECP and assessment are contradicting. Policies to tackle energy poverty both through energy sector and other policy sectors date before the NECP.	“Slovakia did not include any policies and measures targeted specifically at fighting energy poverty, as it cannot be addressed through energy policy but only through social policy.” This could a quote for Sweden.

Research, Innovation and Competitiveness	The plan identifies the key areas and funding needs for research and development for 2019-2023 with an outlook to 2028. National budgets dedicated to research are also identified; however, there are no specific targets for research and innovation.	Clarify the national objectives and funding targets in research, innovation and competitiveness, specifically related to the Energy Union, to be achieved between 2023 and 2030, so that they are readily measurable and fit for purpose to support the implementation of targets in the other dimensions of the integrated national energy and climate plan. Underpin such objectives with specific and adequate policies and measures, including those to be developed in cooperation with other Member States, such as the Strategic Energy Technology Plan. ➔ Partially addressed	There are no specific targets for research and innovation. The plan includes relevant areas where research and innovation efforts are identified for 2019-2023 with an outlook to 2028. National budgets dedicated to research are also tentatively identified and there is an indication of possible private investments. However, these efforts may be insufficient in relation to the achievement objectives with specific and adequate policies and measures, including those to be developed in cooperation with other Member States, such as the Strategic Energy Technology Plan.
Investments		Extend its analysis of investment needs and sources, including appropriate financing at national, regional and Union level, which is currently provided only for energy efficiency and research, to a general overview of investment needs to reach its energy and climate objectives. Consider also the cost-effective generation of transfers to other Member States under Regulation (EU) 2018/842 of the European Parliament and Council as funding source. ➔ Largely addressed	The extension of the analysis of investment needs and sources has been fully addressed. Slovakia provided quantified information on investment needs for energy efficiency, as well as for individual sectors, and selected policies and measures. However, the identified investment needs are not matched with potential funding sources in a comprehensive manner. The consideration of cost-effective generation of transfers to other Member States as a funding source has been partially addressed. Slovakia has not directly responded to this part of the recommendation, but it mentions that it may apply flexibility instruments (borrowing, banking and transferring allocated emission allowances to other Member States as an option), without further detail.
Regional cooperation		Continue the consultation of neighbouring Member States and regional cooperation in the context of the Visegrad Group involving Czechia, Hungary, Poland and Slovakia, and of the Central and South-Eastern Europe Energy Connectivity (CESEC) High Level Group, as well as bilateral cooperation, such as with	Slovakia has continued its exchanges with other countries in the relevant regional fora. A ministerial-level declaration of support for the implementation of the ACON (Again COnnected Networks) project aimed at fostering the integration of the Czech and the Slovak electricity markets was signed between the two countries in

		Czechia on electricity distribution systems. The focus of regional exchanges could be on further integration in the internal energy market, assessing system adequacy, just transition issues and decarbonisation and renewables deployment and its impacts on the energy system. ➔ Largely addressed	June 2019. There is also additional information on a similar InGrid project between Slovakia and Hungary.

Guidance on the implementation of the NECP and the link to the recovery from the Covid-19 crisis

Main points:

- **Decarbonisation**: In 2019 Slovakia committed to achieve **carbon neutrality** by 2050.
- On **renewables**, Slovakia committed to increase the share of renewables in gross final energy consumption to 19.2% in 2030. Achieving a higher share of renewables in gross final energy consumption for 2030 would necessitate additional policies and measures to reinstate investor certainty, based on more specific and detailed planning of the sources for generation of renewable energy. Currently, the main source is bioenergy, while the potential of the electricity and transport sectors remains untapped.
- On **energy efficiency,** Slovakia would benefit from adopting and implementing additional policies and measures that would deliver additional energy savings by 2030. Proper implementation of the numerous measures proposed will be key for the delivery of the expected energy savings. **Improving energy efficiency in buildings** has much potential for speeding up energy savings and contributing to the recovery of the economy after the COVID-19 pandemic.
- On **energy security** Slovakia would benefit if it clarified measures on electricity security of supply, in particular a) on the implementation steps of the clean energy package provisions, including electricity system adequacy and b) on storage and production capacity as well as timing of main steps of the planned construction of a new pumped storage power plant. Moreover, Slovakia is invited to include in the NECP specific measures to preserve and strengthen cybersecurity in the energy sector. Finally, in view of the greater role that nuclear energy production is to have, Slovakia would benefit if it implemented a long-term strategy for diversification of the supply of nuclear fuels.
- XX would benefit from … defining clear indicators to track achievement of milestones towards its **research and innovation and competitiveness** … The start of mature public investment projects supporting the green transition can have an important role to play in contributing to the economic recovery after the Covid-19 crisis.

- Concerning the **internal energy market**, Slovakia would benefit from measures to **increase competition in the wholesale and retail markets**, including progressing towards fully market-based prices and reforms that reduce the relative price of electrictiy compared to gas (due to the G-charge component). Slovakia would need to ensure consistency between internal energy market measures and the overall decarbonisation objectives, with particular regard to the planned extension of fossil fuel production and consumption.
- Slovakia would benefit from defining clear indicators to track achievement of milestones towards its research and innovation and competitiveness objectives. Over time, the gathering of granular research, innovation and competitiveness data will be useful to strengthen this process.
- Slovakia will need to **invest** EUR 4.3 billion over 10 years to achieve its **renewable energy contribution**, while for the other dimensions Slovakia provides only selected investment needs for certain policies and measures. Slovakia would benefit from finalisation of the quantification of its investment needs and from complementing it with a comprehensive assessment of overall investment needs to achieve the objectives of the final NECP. Slovakia's approach to investment in the green transition is focused on renewable energy, energy efficiency and transport.
- Slovakia is invited to continue ongoing efforts on **regional cooperation** with a view to intensifying exchanges and initiatives that will facilitate the implementation of its national energy and climate plan, in particular as regards relevant **cross-border issues**, including those in the context of the **Central and South-Eastern Europe Energy Connectivity** (CESEC) High Level Group. Slovakia is also invited to better exploit the potential of the multilevel climate and energy dialogues to actively engage with regional and local authorities, social partners, non-governmental organisations, the business community, investors and other relevant stakeholders and to discuss with them the different scenarios envisaged for its energy and climate policies.
- In the context of the Recovery and Resilience Facility, the final plan constitutes a strong basis for Slovakia to design **climate and energy-related aspects** of its **national recovery and resilience plan**, and to deliver on broader European Green Deal objectives.

Key areas indicated by the Commission to be considered when developing the national recovery and resilience plan:

1. Measures fostering **energy efficiency in buildings**, in particular by investing in the renovation of buildings and the replacement of domestic heating systems, and by reforming the social housing investment framework;
2. Measures to promote the development of **renewable energy**, invest in **energy infrastructure**, and advance the coal phase out by speeding up the implementation of the action plan for the transformation of Horná Nitra and other regions in transition;
3. Measures modernising the mobility system, including by fostering investments in **sustainable mobility infrastructure** and urban transport.

European Commission’s assessment of the final NECP of Slovenia

2019 Recommendations and Assessment of the final NECP by the Commission

Here following a summarized table, including the 2019 Recommendation from the Commission and the evaluation of the implementation of those recommendation within the final version of the NECP together with the assessment of the final NECP.

	NECP	Related Recommendation and evaluation on its implementation	Assessment
Renewable Energy	The national contribution to the 2030 EU renewable energy target is specified in the plan and the renewables share is set at 27% of gross final energy consumption by 2030. Slovenia describes difficulties in increasing its share of renewable energy power generation because of environmental constraints	Significantly raise the level of ambition for 2030 to a renewable share of at least 37% as Slovenia's contribution to the Union's 2030 target for renewable energy. ➔ Partially addressed	This ambition is low, as it remains below the share of 37% that has been calculated using the formula in Annex II of the Governance Regulation. The assessment of the impact of the policies and measures put forward in the plan shows that these measures are still insufficient for attaining the target set for the share of renewables.
		Include an indicative trajectory in the final integrated NECP that reaches all the reference points ➔ Largely addressed	The indicative trajectory to reach the 27% contribution in 2030 is included and reaches the reference points in 2022, 2025 and 2027.
		Put forward detailed and quantified policies and measures ➔ Partially addressed	The plan includes financial incentives, legislative, technical and regulatory measures that support the electricity and heating and cooling sectors and aim to achieve the level of contributions put forward. However, Slovenia does not quantify the necessary policies and measures, nor does it specify the related economic impacts. For the transport sector, the final plan does not include specific policy measures to support further electrification and biofuel production and use.

		Ensure that the renewable energy target for 2020 ➔ Partially addressed	The plan takes the 2020 target of 25% as the baseline, maintaining this level from 2021 onwards. The plan specifically mentions that, with the exception of the heat and cooling sector, Slovenia lags behind the indicative sectoral targets in both the transport and the electricity sectors.
	In the electricity sector, Slovenia aims to cover 43% of its electricity consumption from renewable energy sources by 2030. This new target will be achieved mainly through contributions from hydropower, followed by solar energy and some wood biomass from combined heat and power (CHP) and co-incinerators; wind and biogas are still expected to remain marginal (about 3% or lower).		This new target significantly reduces the ambitions presented in the draft plan (which envisaged a 47.4% share by 2030, up from 38.6% in 2020) without providing a satisfactory reason. The policies and measures are considered insufficient in relation to Slovenia's potential in terms of renewable energy sources. In particular, hydropower, solar- and wind power would remain largely underexploited.
	The use of renewable energy in **heating and cooling** is planned to increase from the expected 36.4% in 2020 to 41.4% in 2030	Increase the level of ambition in the heating and cooling sector to meet the indicative target included in Articles 23 of Directive (EU) 2018/2001 and the transport target in Article 25 of Directive (EU) 2018/2001 ➔ Partially addressed	this is insufficient to achieve the indicative 1.3 and 1 percentage points as an annual average. The final plan includes policies and measures to increase the share of renewable energy in heating and cooling, but these are insufficient to deliver the envisaged result. Not enough information was included to justify the increase of renewable energy in the heating and cooling sector, both as a baseline and as a target, including the role of renewable energy in district heating systems.
	When setting the **transport** target in the final plan, as requested in Articles 25-27 of Directive 2018/2001[17] , Slovenia intends to focus on the development, production and use of advanced sustainable biofuels (expecting advanced biofuels to contribute up to		The targeted sectoral share of renewables in transport is expected to amount to 20.1% in 2030, a significant increase compared to the figures in the draft plan. the final plan does not include specific policy measures to support further electrification and production or the use of biofuels.

	42% of the overall renewables used in transport).		
Energy efficiency	Slovenia’s national contribution to energy efficiency in 2030 is of modest ambition for primary energy consumption, with 6.4 Mtoe, and of low ambition for final energy consumption, with 4.7 Mtoe.	Substantially increase the ambition towards reducing primary energy consumption in 2030 in view of the need to increase the level of efforts to reach the Union's 2030 energy efficiency target. ➔ Partially addressed	The new target is more ambitious compared with the draft plan.
	Slovenia´s final national energy and climate plan mostly builds on existing measures to promote energy efficiency. These essentially combine financial and fiscal incentives and regulatory and further support measures. In the transport sector, financial incentives aim to support modal shifts, upgrades in the railway network, and the use of more efficient vehicles, combined with regulatory measures and eco-driving	Propose more ambitious policies and measures that would deliver additional energy savings by 2030. Indicate policies and measures for the whole 2021-2030 period including their impact, in terms of energy savings expected, and timeline for implementation ➔ Partially addressed	Slovenia has not quantified the expected impact of the measures in its final national energy and climate plan. Furthermore, the plan does not provide thorough descriptions on policies and measures beyond 2020. Information on the level of ambition related to implementing additional measures and the energy consumption target set in the energy-efficiency-with-additional-measures scenario is therefore insufficient. The final plan does not include the information required by Annex III of the Governance Regulation as regards the energy savings obligation. Thus, it remains unclear if Slovenia will meet its energy savings target by 2030. The voluntary guiding template from the Commission has not been used.

	Regarding **energy efficiency in buildings**, the plan indicates that Slovenia intends to reduce final energy consumption in buildings by 20% and to reduce greenhouse gas emissions from buildings by at least 70% by 2030 compared with 2005.		the energy efficiency target for buildings implies a lower level of ambition than in the draft national energy and climate plan. Slovenia's final national energy and climate plan presents a comprehensive outline of measures in the building sector, considering relevant aspects in an integrated and structured manner. However, it lacks specific information and figures, for example on the surface of renovated buidings, energy savings, and investments, which would make it easier to evaluate the level of ambition and the feasibility and effectiveness of the measures.
Energy Security	Maintaining a high level of security of supply is a priority in the ongoing transformation of the energy system set in the national energy and climate plan, with an objective of a 43% renewable electricity system and a 27% share of domestic renewable energy.	Specify the measures supporting the energy security objectives on diversification and reduction of energy dependency, including measures ensuring flexibility. ➔ Largely addressed	Slovenia has now indicated objectives for energy security and, in particular, to ensure at least 75% of electricity supply from its own sources by 2030, and maintain at least the existing level of supply security. When considering risks, the plan does not take into account the plans of the other neighbouring Member States. As regards the diversification of sources and routes, the plan does not provide measures or objectives to increase the diversification of energy sources and supply from non-EU countries.
	The national energy and climate plan provides an indicative target of a 10% share of methane and hydrogen of renewable origin in the transmission and distribution network by 2030.	➔	
Internal Energy Market	The national energy and climate plan states that Slovenia's interconnectivity level stood at 83.6% in 2017	Define forward-looking objectives and targets concerning market integration, in particular measures to develop more competitive wholesale and retail markets. ➔ Not addressed	This target overachieves the EU 2030 target of 15%. Hence, the plan does not set any further explicit interconnectivity target for 2030. The plan would benefit from more qualitative descriptions, as well as specific indicators upon which future objectives can be benchmarked, particularly in the following areas: real-time price signals; increase of system flexibility; demand response and aggregation; storage; distributed generation.

		➔	
Research, Innovation and Competitiveness	Slovenia's final national energy and climate plan provides a concise and clear overview of specific objectives and targets on research and innovation.	Clarify the national objectives and funding targets in research, innovation and competitiveness, specifically related to the Energy Union, to be achieved between 2023 and 2030, so that they are readily measurable and fit for purpose to support the implementation of targets in the other dimensions of the integrated national energy and climate plan. ➔ Partially addressed	the plan does not systematically set policies and measures to achieve these objectives. Investment figures and the timeline to reach the targets are not provided either. The lack of a vision for 2050 is also a weak point.
	The plan presents research and innovation measures on the circular economy, with the use of waste heat considered a priority.		these efforts are not accompanied by investment figures or related specific and measurable milestones and deadlines.
	Slovenia is considering decarbonising its gas supply by blending renewable hydrogen into its natural gas network. According to its final plan, renewable hydrogen is considered as an alternative to conventional fossil fuels; Slovenia estimates that by 2040 around 7% of its		

	fuel consumption could be provided by hydrogen, especially in the transport sector.		
	The final plan mentions cooperation in the framework of the SET plan.	Underpin the objectives with specific and adequate policies and measures, including those to be developed in cooperation with other Member States, such as the SET Plan ➔ Partially addressed	It does not commit to any specific implementation working group, including the one on nuclear safety, in which Slovenia participates. National funds are not allocated under each innovation platform, and the plan does not explain how the strategic energy technology plan would contribute to the achievement of Slovenia's energy and climate objectives
Investments	The plan estimates that EUR 22 billion will be invested in implementing the measures from 2021 to 2030 (excluding transport), of which EUR 4 billion would come on top of the investment required by existing measures. Overall, EUR 12.6 billion are allocated to the energy component across sectors, with buildings receiving around EUR 9.5 billion.	Provide a general overview on the investment needed to modernise its economy by reaching its energy and climate objectives, and a general assessment of the sources of that investment, including appropriate financing at national, regional and Union level. ➔ Partially addressed	The plan is not clear which investment needs will be covered by the national budget and what will be covered by other financing sources such as from international financial institutions. Neither does the plan describe the methodology applied to calculate the investment needs
	Taking into account transport infrastructure and sustainable mobility, the overall investment needs reach EUR 28 billion.		
Regional cooperation		Carry out a fully-fledged consultation procedure with neighbouring countries and other Member States in order to promote the achievement of the objectives of the Energy Union in a cost-optimal manner.	In July 2019, Slovenia organised a regional consultation with neighbouring countries on the preparation of the final plan. The purpose of the consultation was the exchange of good practices and cooperation in the field of alternative fuels, in particular synthetic gases, and in the areas of joint transport management, renewables projects and energy efficiency, smart grids, cross-

		➔ Partially addressed	border infrastructure projects, soft education and awareness measures, efficient integration of electricity markets and governance and energy poverty.
		Explore further the cross-border potential and the macroregional aspects of a coordinated energy and climate policy notably in the Adriatic with the aim of reducing the region's carbon footprint and implementing an ecosystem approach ➔ Partially addressed	Slovenia does not mention cooperation in the Adriatic and Ionian Macro-region. The potential for a more integrated climate policy with neighbouring countries is not explored in the final plan.

Guidance on the implementation of the NECP and the link to the recovery from the Covid-19 crisis

Main points:

- On **renewables**, Slovenia committed to increasing the share of renewables in gross final energy consumption to 27% by 2030, which would necessitate additional policies and measures. n light of its environmental restrictions, further exploration and targeted studies will help Slovenia to further exploit renewable energy while assuring minimal environmental impact. It is in Slovenia's interest to identify further opportunities to attract private investment and public support under different programmes, such as the Innovation Fund programme or Connecting Europe Facility (CEF).
- On **energy efficiency**, Slovenia would benefit from adopting and implementing additional policies and measures that would deliver additional energy savings by 2030. Slovenia would further benefit from specifying the expected impact of the proposed policies and measures. The policy framework would benefit from better consideration and application of the 'energy-efficiency first' principle.
- Improving energy efficiency in buildings has much potential for speeding up energy savings and contributing to the recovery of the economy after the COVID-19 pandemic (Renovation Wave). Further support for the renovation of public and private buildings could be provided through increased public funding and by leveraging EU and national budgets with private money, combining grants, lending, guarantees and loan subsidies.
- On **energy security**, Slovenia would benefit from further developing key performance indicators to improve security of supply and diversification of resources, as well as further reducing energy dependency on non-EU countries.

- On the **internal energy market**, Slovenia would benefit from defining forward-looking objectives and targets for market integration and in particular measures to accelerate the digitalisation of the electricity distribution grid.
- Strong links between **research, innovation and competitiveness**, specific investment figures, related specific and measurable targets and deadlines would help make the way forward more concrete, especially with a view to the 2030 and 2050 time horizons.
- Starting mature public investment projects supporting the green transition as soon as possible can play an important role in fostering the economic recovery. Forward-looking stable policy frameworks are important to guide business and household investment decisions and incentivise prioritising investment also in the private sector.
- Slovenia is invited to continue ongoing efforts on regional cooperation with a view to intensifying exchanges and initiatives that will facilitate the implementation of its national energy and climate plan, in particular as regards relevant macro-regional and cross-border issues, including those in the context of the CESEC High Level Group. Slovenia would notably benefit from promoting renewable and sustainable projects across the Adriatic. Slovenia is also invited to better exploit the potential of the multilevel climate and energy dialogues.
- Slovenia is encouraged to consult the Commission Recommendation of 14 October 2020 on energy poverty and its accompanying staff working document providing guidance on the definition and quantification of the number of households in energy poverty and on the EU-level support available to Member States' energy poverty policies and measures.

Key areas indicated by the Commission to be considered when developing the national recovery and resilience plan:

1. Measures to promote renewable energy, including by removing administrative barriers and improving the regulatory framework;
2. Measures to support energy efficiency, especially through building renovation and in industrial processes;
3. Measures to support sustainable transport, including.

European Commission's assessment of the final NECP of Spain

2019 Recommendations and Assessment of the final NECP by the Commission

Here following a summarized table, including the 2019 Recommendation from the Commission and the evaluation of the implementation of those recommendation within the final version of the NECP together with the assessment of the final NECP.

	NECP	Related Recommendation and evaluation on its implementation	Assessment
Renewable Energy	The national contribution to the 2030 EU renewable energy target is specified in the plan and the renewable share is set at 42% in gross final consumption of energy.	Underpin the welcome level of ambition by detailed and quantified policies and measures ➔ Fully addressed	This target is sufficiently ambitious and above the share of 32% that results from the formula in Annex II of the Governance Regulation. However, the target level set in the Spanish draft law on climate change and energy transition is 35%.
		Include an indicative trajectory that reaches all the reference points under Article 4(a)(2) of Regulation (EU) 2018/1999 ➔ Partially addressed	For the indicative trajectories, the plan adds reference points for 2022 (24%), 2025 (30%) and 2027 (34%) towards the overall 42% target in 2030. These reference points comply with the requirements of the Governance Regulation (at least 18% of the total increase in the renewables share for 2030 by 2022, at least 43% by 2025, and at least 65% by 2027). Interim points for 2022 and 2027 have been included in the trajectory for the overall share of renewables, but not for the sectoral shares.
		Provide further details on measures to reduce administrative burden and on the enabling frameworks for renewable self-consumption and renewable energy communities ➔ Fully addressed	The plan sets a framework to boost self-consumption and proposes measures to facilitate the development of renewable energy communities.

	The renewables share in the **electricity sector** has increased from 74% to 86%, but the 31% renewables share in **heating and cooling** is lower (34% in the draft plan). The renewables share in the transport sector is expected to reach 28%, which is higher than the 22% indicated in the draft plan. In addition, the plan has raised the share of **advanced biofuels** and biogas to a 3.7% in 2030, in order to comply with the minimum 3.5% set out in the Recast of the Renewables Directive		Regarding the values relevant to calculate the transport target, even if the final plan includes absolute values for renewable energy in transport, it does not provide absolute values for each type of relevant renewable source, does not explain the effect of multipliers, and does not reflect the phase out of the contribution of high indirect land-use change risk biofuels, bioliquids as well as biomass fuels produced from food and feed crops.
	In the electricity sector, it is envisaged to install 59 GW from 2021 to 2030 mainly through the organisation of auctions (3,000 MW every year), together with measures to facilitate the penetration of renewables in the grid such as increasing storage capacity by 6 GW and facilitating response demand through demand aggregators.		
	For heating and cooling, the final plan includes measures to promote the use of renewable heating and cooling systems, including the revision of the technical code for buildings, the use of guarantees of origin and the use of support schemes.		The plan does not reflect the phase out of the contribution of high indirect land-use change risk biofuels, bioliquids as well as biomass fuels produced from food and feed crops.
Energy efficiency	Spain's national contribution for energy efficiency in 2030 is 98.5 Mtoe for primary energy and 73. 6 Mtoe for final energy consumption.	Explore further on how the current measures would need to be additionally developed to achieve their ambition towards the expected energy savings, and to address potential in the building stock. ➔ Partially addressed	Both contributions are considered as sufficient. The plan provides descriptive information on policies and measures beyond 2020 targeting all sectors. These policies and measures are considered sufficient in relation to the achievement of the national contribution. However, further clarification on their impact on annual energy consumption is needed.

	Spain presents the cumulative savings to be achieved under Article 7 of the Energy Efficiency Directive with a cumulative amount of 36 809 ktoe		The target calculation was not carried out in line with Article 7(1) (b) of that Directive – the proper baseline was not used. The target was calculated based on national statistics and it is unclear how these differ from the Eurostat data. However, the difference between the two values is relatively small. The cumulative energy savings target will be achieved mostly through a combination of the Energy Efficiency Obligation Scheme and policy measures, spanning across all sectors. These policies and measures are considered sufficient in relation to the achievement of the target. However, the calculation of the estimated energy savings is not provided and the fact that the total amount of estimated energy savings is equal to the target raises uncertainty.
	On energy efficiency in buildings, the plan includes a number of specific actions as well as a quantitative objective to renovate 1,200,000 residential buildings by 2030. It also includes renovating heating and cooling technical building systems of on average 300,000 residential buildings per year. For buildings owned and occupied by central government, the intention is to go beyond the 3% annual renovation target enshrined in EU legislation.		the information remains generic and lacks detail. While the financing mechanisms for building renovation in line with Article 2a of the Energy Performance Building Directive are outlined, specific data are missing which would enable a comprehensive evaluation of the ambition, effectiveness and feasibility of the measures.
Energy Security	While Spain's import dependency for oil and gas is higher than the EU average source, diversification is one the highest in the EU. Following the measures envisaged in 2021-2030, Spain's import dependency would go from 73% in 2017 to 61% in 2030. The plan envisages significant further measures and investments in energy storage and network infrastructure and mentions energy efficiency technologies and the use of domestic renewable sources as key technologies to improve security of energy supply.	Further develop measures supporting the energy security objectives on diversification and reduction of energy dependency, including measures ensuring flexibility, as well as information on phase-out from nuclear ➔ Fully addressed	When considering risks, the plan does take into account the plans of the other connected Member States, as well as specific risks of non-peninsular territories such as the Canary and Balearic islands and the autonomous cities of Ceuta and Melilla. The planned policies and measures are considered sufficient in relation to the achievement of the objectives, because of the combination of measures and technologies, based on the socioeconomic assessment.

Internal Energy Market	Spain sets an interconnection level of 15% for 2030, which corresponds to the target set at EU level. The plan lists current projects of common interest, which will increase interconnectivity. An analysis on how the rising electricity demand affect the level of electricity interconnectivity and the need for infrastructure is included.	➔	
	The plan provides a sufficient overview of current market conditions for gas and electricity, in particular regarding levels of competition and liquidity of markets.	Define forward-looking objectives and targets concerning market integration, in particular measures to address the projected evolution of the tariff deficits in the electricity and gas sectors and potential impact from the measures envisaged. Outline a strategy and timeline for progressing towards fully market-based prices. ➔ Largely addressed	The final plan includes policy objectives and measures related to the internal energy market that are are considered as sufficient in relation to the achievement of the objectives. The final NECP sufficiently outlines the electricity market reform and provides for the cancellation of the historical deficit of the energy system by 2028. Information on specific targets and instruments.
	On energy poverty, the NECP reports the number of households affected and provides a summary of the objectives and measures envisaged in the 2019-2024 strategy against energy poverty. Spain has the objective of halving the share of households in situation of “hidden energy poverty.” This indicator is defined as households whose total expenditure on energy is less than a half of the national median.		It is an ambitious plan to tackle energy poverty, and the Spanish government has already started to implement it. These policies and measures are considered sufficiently credible in relation to the achievement of the target.
Research, Innovation and Competitiveness	Spain aims to increase the weight of research and innovation in national economic activity. From the respective investment, **a significant share – yet to be determined – will be dedicated to energy and climate.**	Further clarify national objectives and funding targets in research, innovation and competitiveness, specifically related to the Energy Union, to be achieved between now and 2030. Underpin such objectives with specific and suitable policies and measures, including those to be developed in cooperation with other Member States, such as the SET Plan.	Although the objectives are not accompanied by specific timelines or quantified targets, the policies and measures go in the right direction. While Spain does not provide a precise allocation of the national funds, the description allows an understanding of how the SET plan contributes to the achievement of their national energy and climate objectives.

		➔ Partially addressed	
	The plan refers to its **renewable hydrogen roadmap** (RH2), where Spain considers renewable hydrogen as a key technology to increase the production of renewable electricity and renewable gases, targeting 4 GW of hydrogen electrolysis capacity in 2030		
	industrial development plan will be drawn up to analyse the countries potential and map existing technological, industrial and knowledge capabilities for the energy transition.		
Investments	The final plan mentions the transition to a “resource efficient, circular and low-carbon economy.” It acknowledges the complementarity between the circular economy and decarbonisation, in line with the circular economy strategy approved in 2019.		However, while describing several policies and practices that relate to circular approaches, the actual analysis and integration between decarbonisation and the circular economy will be part of the announced long-term strategy.
	The NECP assesses investment needs by sector. The total investments to achieve the plan’s objectives amount to EUR 241 412 million between 2021 and 2030, including EUR 196,000 million of additional investments compared to the trend scenario (without additional policies). The main sectors are: energy efficiency: 35% (EUR 83 540 million), renewables: 38% (EUR 91 765 million), and networks and electrification: 24% (EUR 58 579 million).		It is not clear how these amounts have been calculated: most (80%) is private investment and 20% is public investment in energy saving and efficiency measures, in the electrification of the economy and in actions associated with the promotion of sustainable mobility and modal shift. Part of the public investment is planned to come from European funding. As for public funding, not many details are given except for the energy renovation of houses (around EUR 1.2 million) and the electricity

			interconnections with France, with EUR 5.5 billion and EUR 800 million of European funding respectively.
Regional cooperation		Intensify the existing good regional cooperation with France and Portugal to address the internal energy market and energy security areas, in particular cross-border and cross-regional interconnections. ➔ Largely addressed	The final NECP is more detailed on the measures envisaged to carry out the cross-regional and cross-border projects with France and Portugal. • On energy security: one measure mentioned in the NECP is to improve coordination with France and Portugal by organising regular meetings to address energy security issues. • On the energy internal market: the NECP provides complementary information on how the projects with France and Portugal will be planned. It refers explicitly to the 2021-2026 transport network plan.
		Consider strengthening measures related to regional cooperation in renewable energy and energy efficiency. ➔ Not addressed	When mentioning regional cooperation energy projects or measures, there is no specific focus on renewable energy or energy efficiency.

Guidance on the implementation of the NECP and the link to the recovery from the Covid-19 crisis

Main points:

- Spain’s plan still leaves scope to further develop and strengthen policies and measures on both renewables and energy efficiency in order to contribute more to the EU climate and energy targets and strengthen the green transition.
- **Renewable energy**: Full implementation of the detailed policies and measures indicated in the NECP should allow Spain to achieve a substantial increase in renewables.

- **Energy efficiency:** a detailed elaboration of all the elements laid down in Annex III of the Governance Regulation would be beneficial for ensuring the achievement of the energy saving obligations. In addition, the policy framework would benefit from implementing the energy efficiency first principle in related policy areas, by fully taking into account co-benefits of energy efficiency measures when considering them for reaching other objectives.
- The improvement of **energy efficiency in buildings** has much potential for speeding up energy savings and contributing to the recovery of the economy after the COVID-19 pandemic. Building on the momentum of the Renovation Wave initiative19, there is scope for Spain to intensify efforts to improve the energy performance of the existing building stock.
- On **energy security**, Spain would benefit from developing measures supporting the energy security objectives, including measures ensuring system resilience and flexibility, focusing on the deployment of renewable energy in the non-peninsular territories.
- On the **internal energy market**, Spain is encouraged to further develop specific measures and clear and measurable milestones to deliver on the objectives contained in the final plan concerning the full integration of the electricity and gas markets and the development of new energy technologies, and by guaranteeing non-discriminatory access to new market entrants.
- Spain would benefit from defining clear indicators to track the achievement of milestones towards its **research and innovation and competitiveness objectives.** Spain would need to ensure the link with the SET plan.
- Spain is invited to continue ongoing efforts on **regional cooperation** with a view to intensifying exchanges and initiatives that will facilitate the implementation of its national energy and climate plan, in particular as regards relevant cross-border issues. Spain is also invited to better exploit the potential of the multilevel climate and energy dialogues.
- Spain is invited to make the best possible use of the various funding sources available, combining scaled-up public financing at all levels (national and local, as well as EU funding) and leveraging and crowding in private financing.

Key areas indicated by the Commission to be considered when developing the national recovery and resilience plan:

1. Measures supporting building renovation and developing renewable energy, especially in heating and cooling and transport; measures aimed at strengthening and expanding the transmission and distribution lines including electricity interconnections with neighbouring countries.
2. Measures promoting sustainable transport, including improving e-mobility infrastructure and shifting freight from road to rail.
3. Measures promoting the circular economy, water management, flood prevention and wastewater treatment.

European Commission’s assessment of the final NECP of Sweden

STRUCTURE

65. Consideration by the Commission on the implementation of the recommendation from 2019

The October 2020 assessment document includes a general overview of the implementation of the Commission recommendations from 2019 in the final NECPs.

66. Assessment of the final NECP (objectives, contributions, measures, impact, investments)

This section consists in a general summary of the planned measures, divided by areas (Decarbonisation, Renewable energy, Energy efficiency, Energy security, Internal energy market. Research innovation and competitiveness..), with an evaluation on the basis of targets, implementation and Impact. The document focuses on the trajectories outlined to achieve the described targets, however never going into too much detail technology-wise. It is and update of the 2019 Report.

67. Guidance on the implementation of the NECP linked to the recovery plans from the Covid-19 crisis

This section addresses the link between the final plan and the recovery efforts from after the COVID-19 crisis by pointing at possible priority climate and energy policy measures XX could consider when developing its national recovery and resilience plan in the context of the Recovery and Resilience Facility.

68. Annexes:

- I: Potential funding from EU sources to XXX.. 2021 – 2027
- II: Detailed assessment of how Commission recommendation have been addressed

CONTENT

2019 Recommendations and Assessment of the final NECP by the Commission

Here following a summarized table, including the 2019 Recommendation from the Commission and the evaluation of the implementation of those recommendation within the final version of the NECP together with the assessment of the final NECP.

	NECP	Related Recommendation and evaluation on its implementation	Assessment
GHG emissions	The Swedish NECP confirms the commitment made in the Climate Act, which states that the country will achieve net-zero emissions of greenhouse gases by 2045 (with domestic emissions at least 85% below the 1990 level); and negative emissions thereafter.	Develop its strategy for achieving the commitment under Regulation (EU) 2018/841 of the European Parliament and of the Council (8) that land use, land use change and forestry (LULUCF) emissions do not exceed removals, based on the underpinning accounting rules. Pay particular attention to assessing the impact of policies and measures on emissions trading system, effort sharing and LULUCF sectors. • Partially implemented	The NECP does not contain sufficient analyses of emissions and removals from the LULUCF sector on a) its contribution to the 2030 GHG-related targets or on b) how the sector emissions will be affected by measures to promote the use of biomass in Sweden. For the ETS sectors, the NECP lists a number of policies (e.g. carbon and energy tax on cogeneration and heat generation, the Industry Leap) designed to promote technical advances and reduce emissions from installations in Sweden's energy system. It notes that these measures complement the EU ETS and may increase the number of allowances in the Market Stability Reserve. The NECP does not state whether Sweden expects to meet its ESR target in 2030 with existing policies and measures. The plan lacks an impact analysis of these measures and a breakdown of forecast data into ETS, ESR and LULUCF sectors.

Renewable Energy		Confirm the level of ambition of a 65% renewable energy share for 2030 referred, to in the draft integrated national energy and climate plan, as Sweden's contribution to the Union's 2030 target for renewable energy. - Fully addressed	The final NECP states that Sweden will have "a national contribution of 65% share of renewable energy in gross final consumption in 2030," which is based on the Swedish Energy Agency's 2016 reference scenario and confirmed by the Swedish government.
	With regard to the electricity sector, Sweden has a target of 100% renewable electricity by 2040 and a projected contribution of 83% share of its electricity consumption from renewable energy sources by 2030. Heating and cooling in Sweden is already largely electrified, with an electrification share of 69%, expected to stabilise at around this level, rising just slightly to 72% in 2030.	This contribution should be underpinned by detailed and quantified policies and measures that are in line with the obligations laid down in Directive (EU) 2018/2001 in a way that enables a timely and cost-effective. - Partially implemented	The final plan provides very few additional policies and measures targeted to RES compared to the draft plan. The initial assessment suggests that the policies and measures reflected in the plan are not sufficient to meet the targets.
Energy efficiency	Sweden's national contribution to energy efficiency policy in 2030 is to be 50% more energy efficient than in 2005, which translates into 40.16 Mtoe for primary energy and 29.67 Mtoe for final energy16. The plan provides information on policies and measures beyond 2020 in areas such as buildings, transport and industry. The main policy driving energy efficiency in Sweden is the tax on energy and carbon, which provides strong financial incentives to reduce energy consumption.	Increase the level of efforts towards reducing final energy consumption in view of the need to collectively reach the Union's 2030 energy efficiency target, and support it with policies and measures that would deliver additional energy savings by 2030. - Partially addressed	Sweden increased its level of ambition on energy efficiency modestly. It included some new information on policies and measures in the final plan, but for many measures, the expected savings are not quantified. New modelling was carried out for the final plan. Depending on the assumption for GDP growth, the contribution can be considered as more or less ambitious, but overall the target contribution set for energy intensity can be deemed to be higher than it was in the draft plan. The NECP provides some information on the renovation of the building stock but further details on the indicative milestones and relevant policies and measures will be given in the long-term renovation strategy.
Energy Security	Besides the requirements and criteria in European Union legislation, there are no national targets for reducing dependence on importing energy from third countries. Instead, the energy supply is secured by properly functioning energy markets, where energy is traded freely	Specify the measures supporting the energy security objectives on diversification and reduction of energy dependency, including measures ensuring flexibility and electricity	Sweden has included additional information on system resilience in view of the renewable energy target, including measures on regional cooperation between the Nordic countries. There could be more detail provided regarding policies and measures to ensure system flexibility.

	as far as possible, both within Sweden and between Sweden and other countries.	generation adequacy in light of the ambitious renewables target. • Largely addressed	
Internal Energy Market	Sweden has not set a target for interconnection in 2030. However, the Energy Agreement includes an ambition to increase Sweden’s network connections with other countries. At the beginning of 2019, Sweden’s interconnectivity level was 27%, which already exceeds the EU’s target for 2030.	No recommendation	n/a
Research, Innovation and Competitiveness		Clarify the national objectives and funding targets in research, innovation and competitiveness, specifically related to the Energy Union, to be achieved between 2023 and 2030, so that they are readily measurable and fit for purpose to support the implementation of targets in the other dimensions of the integrated national energy and climate plan. Underpin such objectives with specific and adequate policies and measures, including those to be developed in cooperation with other Member States, such as the Strategic Energy Technology Plan. • Partially addressed	The plan identifies relevant areas where R&I action is needed. However, the objectives lack a specific timeline and quantified targets. For a substantial part of the objectives, specific policies and measures are presented only up to 2027. For that reason, the action planned on research and innovation is considered sufficient. As regards competitiveness, the objectives are barely mentioned. By contrast, the plan clearly covers cooperation with the Strategic Energy Technology (SET) plan.

Investments		Provide a general overview of the investment needs to achieve the climate and energy objectives, and a general assessment of the sources of that investment, including appropriate financing at national and regional level. • Partially addressed	Except for electricity production capacity and distribution infrastructure, the NECP does not contain an assessment of the investment needs or funding sources targeted to achieve Sweden's climate and energy objectives.
		Intensify the already good regional cooperation arrangements between Nordic countries (Denmark, Finland, Iceland, Norway and Sweden), extending them to new areas and broadening the geographic reach to include the Baltic States (Estonia, Latvia and Lithuania). The focus of the regional exchanges should be on internal energy market and energy security areas, in view to the changes in the electricity systems accommodating higher shares of renewable electricity, which will increase electricity import and export and enhance the need for system flexibility. • Fully addressed	In terms of regional cooperation in preparing the plan, emphasis was given to engagement with the Nordic Council of ministers, under which an ad hoc group was set up as a forum for cooperation on the NECPs. It also made reference to the discussions on cooperation in the context of BEMIP and the North Seas Energy Cooperation (NSEC). Regional cooperation is still ongoing in multiple areas. Sweden shared its final plan with the Nordic countries for comments. Since the draft NECP, the Nordic countries have signed a declaration on carbon neutrality and formulated a 2030 vision for the Nordic electricity market, described in the final NECP.
Regional cooperation	On regional cooperation,	Sweden **fully addressed** the recommendation to boost regional cooperation, which is ongoing in different areas.	
Just and fair transition		Sweden has **not addressed** the recommendation to better integrate just and fair transition aspects.	

Main points:

- On **renewables**, Sweden committed to increase the share of renewables in gross final energy consumption to 65% in 2030.
- On **energy efficiency,** Sweden would benefit from taking further action on energy efficiency and from adopting and implementing additional policies and measures that would deliver additional energy savings by 2030. Improving energy efficiency in buildings has much potential for speeding up energy savings and contributing to the recovery of the economy after the COVID-19 pandemic. Building on the momentum of the 'Renovation Wave' initiative21, there is scope for Sweden to take further action to improve the energy performance of its existing building stock with specific measures, targets and action.
- On **energy security,** bringing in and implementing measures on cyber security will improve the resilience and flexibility of the energy sector.
- Regarding the **internal energy market**, Sweden is encouraged to set more detailed targets and objectives to improve system flexibility. Setting milestones and objectives for the retail market, including for smart grid implementation, aggregation and storage participation on the market, should improve overall system flexibility by integrating renewable electricity and new market participants into the system.
- Sweden would benefit from having clear indicators to track progress on the milestones towards its **research and innovation and competitiveness** objectives. Over time, collecting granular research, innovation and competitiveness data will be useful to strengthen this process. Sweden would need to link this to the action taken under the SET Plan.
- Identifying **investment needs** and securing adequate funding will be key to delivering on Sweden's ambitious climate and energy objectives. The industry roadmaps for fossil free competitiveness are examples of good practice, which will help identify investment needs in the different sectors. Sweden would also need to support the decarbonisation of the economy through ambitious policies to promote innovation and competitiveness.
- On regional cooperation, Sweden is invited to continue ongoing work to step up exchanges and initiatives facilitating implementation of its national energy and climate plan, in particular as regards relevant cross-border issues. Sweden is also invited to maximise the potential of **multilevel climate and energy dialogues** to actively engage with regional and local authorities, social partners, civil society organisations, the business community, investors and other stakeholders and to discuss with them the different scenarios envisaged for its energy and climate policies.
- The final plan constitutes a strong basis for Sweden to design climate and energy-related aspects of its national recovery and resilience plan, and to deliver on broader European Green Deal objectives.

Key areas indicated by the Commission to be considered when developing the national recovery and resilience plan:

1. **Measures supporting investment** in **energy efficiency**, including by investing in the renovation of buildings;
2. Measures supporting new infrastructure for the electrification of road transport, in particular recharging infrastructure for electric vehicles and investment in **research and innovation** related to green technologies;
3. Measures to continue the **phase-out of fossil fuels subsidies** against a clearly defined schedule.

Summary on the European Commission's Assessment Key areas:

	Key areas indicated for the national recovery and resilience plan & energy-related investment and reform measures
Austria	Measures to significantly reduce greenhouse gas emissions in view of Austria's shift to climate neutrality, including reforms of energy and transport taxation, and measures to promote sustainable mobility, including e-vehicles;
	Measures to develop renewable energy sources, including the generation of **renewable methane** from biomass and **renewable hydrogen**, and **upgrading the energy infrastructure**;
	Measures to increase energy efficiency in buildings, in particular through large-scale renovations and investments
Belgium	Measures to front-load mature public investment projects and to address regulatory barriers to investment in clean energy production and use;
	Measures to **ramp up the renovation of buildings**, including reforms of **energy taxes and flanking social measures**, to address the current shortage of workers with the requested **skills in the construction sector**, and to simplify the procedure for **building permits** to improve renovation rates;
	Measures supporting sustainable mobility, including on railways, electric and hydrogen vehicles and recharging points; review of energy taxes and of infrastructure pricing to reflect congestion and externalities; measures to gradually phase-out the favourable tax treatment of company cars
Bulgaria	Measures supporting a **coal phase-out strategy** with a clear timeframe commitment and ensuring a **just transition of coal and lignite-reliant areas**, accompanied by a clear strategy for promoting renewable energy; measures to **reform the energy market**;
	Measures promoting investments in buildings renovation, focusing as a matter of priority on worst-performing residential buildings;
	Measures improving sustainable transport infrastructure and boosting sustainable mobility.
Croatia	Measures supporting investments in renewables, in particular through a stable legislative framework including a functioning and competitive electricity market;

	Measures to support **sustainable transport** including through reforms to develop sustainable **urban and inter-urban mobility** and investments to promote a modal **shift from road to rail**;
	Measures supporting investments in energy efficiency, in particular building renovation with focus on schools, hospitals and social housing, targeting households at risk of energy poverty.
Cyprus	Measures introducing a **green tax reform** coupled with measures to promote **sustainable mobility**, including **greening public transport** and creating appropriate infrastructure;
	Measures **opening up the electricity market** to facilitate the increase of the production and use of **renewable energy**, notably in transport and energy production;
	Measures improving **energy efficiency of all sectors** of the economy, including **buildings**, and covering both urban and rural households.
Czechia	Measures to **promote renewables and energy efficiency** to **reduce dependency on coal** and improve the **flexibility of the grid**, including by reducing administrative burdens to speed up building renovation;
	Measures increasing the **roll-out of electric and hydrogen vehicles** by developing **charging infrastructure** and alternative fuels, and tax reforms;
	Measures to promote sustainable transport infrastructure, in particular by investing into the backbone railway infrastructure and improving suburban transport networks.
Denmark	Measures to promote a **green tax reform** while ensuring a **just transition** for the most affected households and companies;
	Measures to promote sustainable energy production, including clean hydrogen;
	Measures to promote increased energy efficiency through building renovation, notably in the residential sector and primarily in social housing, as well as renovating heating and cooling technical building systems.
Estonia	Measures for reforms and investment into the expansion of renewable sources of energy in view of supporting the phase-out of oil shale from electricity production, including accompanying investments into the electricity grid and into storage solutions;
	Measures supporting the renovation of buildings, including integration of renewables, and continue the phase-out of carbon-intensive heating technologies;
	Measures for reforms and investment into **sustainable transport modes**, including the completion of Rail Baltica and **increased rail electrification**.
Finland	Measures to promote a carbon neutral economy and ensure more consistent price signals to foster energy sector integration, energy efficiency and renewable energy;

	Measures and investments to promote energy efficiency in buildings, including automation and digitalisation, as well as the decarbonisation of heating systems;
	Measures and investments to promote the **electrification and capacity of railways**
France	Measures, including reforms, to increase the **energy efficiency of buildings** (including **social housing**);
	Measures to promote renewable energy, in particular by simplifying administrative procedures to support investment; measures aimed at strengthening and expanding the transmission and distribution lines, including electricity interconnections with neighbouring countries; a review of economic incentives to support the energy transition;
	Measures to promote sustainable mobility by accelerating the electrification of transport and the use of alternative fuels including hydrogen; measures to invest in green mobility infrastructures.
Germany	Measures to promote investments in sustainable mobility projects and infrastructure, backed by investments in greener energy infrastructure and R&D on clean technologies;
	Measures to reform green taxation, phase out fossil fuel subsidies and address inconsistent price signals;
	Measures addressing **investment bottlenecks related to electricity networks**, **offshore wind** and **sustainable transport** by simplifying administrative procedures and building capacity in the public sector.
Greece	Measures to continue the implementation of the energy reform agenda, to promote renewables, energy efficiency improvements in particular in buildings, island and energy connections; measures to facilitate the phase-out of lignite-fired power plants while taking into account a just transition to accommodate their decommissioning;
	Measures promoting electric vehicles and the electro-mobility infrastructure, as well as the further development of city and rail public transport;
	Measures addressing vulnerability to the impacts of climate change, including investments in climate proofing infrastructure and the inclusion of adaptation considerations in environmental and planning legislation.
Hungary	Measures supporting investments in energy efficiency in residential housing and public buildings;
	Measures in **sustainable public transport** and **alternative transport modes**, both in the capital region and across the country;
	Measures to promote renewables in the electricity and heating sectors, including measures to boost electricity production with solar photovoltaics, and measures to upgrade existing infrastructure, storage capacity and smart grids.
Ireland	Measures to improve the energy efficiency of the built environment through the deep retrofitting of buildings as well as social housing; measures to support investments in renewable energy generation and to promote the uptake of heating systems based on renewable energies; measures aimed at strengthening and expanding the transmission and distribution lines, including electricity interconnections with neighbouring countries;

	Measures to support the shift towards sustainable modes of transport, including decarbonised public transport in urban areas;
	Reforms to put in place the new planned **governance framework and long-term objectives** for climate policy.
Italy	Measures and investments to promote energy efficiency of buildings; measures and investments to decarbonise the power sector, in particular by boosting renewable electricity production, reducing the role of natural gas and increasing the role of renewable gas, as outlined in the NECP, while continuing the planned phase out of coal by 2025, and upgrading energy infrastructures; measures and investment to support circular economy; reviewing taxes and subsidies to make them consistent with the green transition, while taking into account redistributive aspects;
	Measures and investments to develop **sustainable transport**, including **infrastructure**;
	Measures promoting climate change adaptation, including ensuring the climate-proofing of existing and future infrastructures.
Latvia	Measures accelerating the deep renovation of buildings and improving energy efficiency in the industry as well as in the heating and cooling sectors;
	Measures improving **energy efficiency and renewable energy use in transport**, including by developing the **infrastructure for electric mobility**, and supporting a **modal shift**; measures to complete Rail Baltica;
	Measures supporting the further **deployment and integration of renewable energy**, including promoting the use of **renewables in buildings**; measures to **phase out fossil fuel tax advantages**, and aligning heating tariffs and car taxation with **emission intensity**; in cooperation with other concerned Member States, investments and related measures required for the **synchronisation with the European continental grid** by 2025.
Lithuania	Measures addressing **energy efficiency and renewable energy in buildings**, in particular through the **modernisation of heating systems**; measures addressing **energy efficiency in industry**; measures supporting the implementation of the renewable targets; in cooperation with other concerned Member States, investments and related measures required for the **synchronisation with the** European continental grid by 2025;
	Measures promoting **sustainable transport**, including public transport at local, regional and national levels, through investments in e-mobility, the deployment of **recharging infrastructure** and **alternative fuels**; measures aimed at the completion of Rail Baltica;
	Measures promoting a **green tax reform**, by increasing **environmental taxes** and **cancelling tax exemptions**, while taking into account distributional effects.
Luxembourg	Measures supporting energy efficiency in buildings and in businesses' production systems; measures to support the supply of energy-efficient affordable housing;
	Measures to support **investments in renewables**, in particular to support systems based on **renewable** technologies in **buildings and industry**;
	Measures to support investments in **sustainable mobility**, in particular related to **urban public transport** and **cross-border rail**; measures to incentivise the **purchase of electric vehicles** and accelerate the deployment of **recharging and refuelling infrastructure**; reforms to **adjust taxation** to better reflect environmental and climate concerns.

Malta	Measures to promote sustainable mobility, in particular through tax reforms and phasing-out of fossil fuels subsidies, and through investments in sustainable modes of transport;
	Measures to create an energy-efficient building stock; measures to improve waste and water management;
	Measures to **tap into the large renewable energy potential**, including innovative projects and further deployment of **renewable** solutions for **electricity and heat generation**.
Netherlands	Measures accelerating investments in energy-saving renovations and renewable energy in buildings;
	Measures developing **smart energy infrastructure**, including in **offshore and on-shore wind**, as well as measures developing smart energy infrastructure, including in **offshore and on-shore wind**, as well as **smart grids**;
	Measures financing innovative deep decarbonisation projects in industry, including hydrogen-related projects; measures promoting sustainable transport, including fleet renewal.
Poland	Measures supporting investments in renewable energy to reduce dependency on coal, and in energy efficiency in buildings and industry;
	Measures enhancing energy system integration and promoting the decarbonisation of gas consumption, including by developing the market for storage technologies and clean hydrogen;
	Measures fostering sustainable transport, including developing and modernising the public transport infrastructure, promoting intermodal transport networks and electromobility
Portugal	Measures fostering sustainable transport, including through the electrification of the transport sector and ensuring better train interoperability and integration of ports and railway infrastructure;
	Measures to enhance the energy efficiency of buildings, to diversify renewable energy generation and deploy smart grids;
	Measures aimed at strengthening and expanding the transmission and distribution lines including electricity interconnections with neighbouring countries
Romania	Measures boosting renewable energy generation; measures aimed at fostering the renovation of buildings and the energy efficiency of district heating networks;
	Measures improving transport infrastructure and sustainable mobility, including reforming the transport agencies and supporting the deployment of recharging and refuelling infrastructure;
	Measures supporting the phase-in of **green taxation and green budgeting**.
Slovakia	Measures fostering energy efficiency in buildings, in particular by investing in the renovation of buildings and the replacement of domestic heating systems, and by reforming the social housing investment framework;

	Measures to promote the development of **renewable energy**, invest in **energy infrastructure**, and advance the **coal phase out** by speeding up the implementation of the **action plan for** the transformation of Horná Nitra and other **regions in transition**;
	Measures modernising the mobility system, including fostering investments in sustainable mobility infrastructure and urban transport.
Slovenia	Measures to promote renewable energy, including by removing administrative barriers and improving the regulatory framework;
	Measures to support energy efficiency, especially through building renovation and in industrial processes;
	Measures to support sustainable transport, including urban and inter-urban mobility, transfers from road to rail and railway infrastructure.
Spain	Measures supporting **building renovation** and developing **renewable energy**, especially in **heating and cooling** and **transport**; measures aimed at strengthening and expanding the **transmission and distribution lines** including **electricity interconnections** with neighbouring countries;
	Measures promoting sustainable transport, including improving e-mobility infrastructure and shifting freight from road to rail;
	Measures promoting the circular economy, water management, flood prevention and waste water treatment.
Sweden	Measures supporting investment in **energy efficiency**, including by investing in the **renovation of buildings**
	Measures supporting new infrastructure for the electrification of road transport, in particular recharging infrastructure for electric vehicles and investment in research and innovation related to green technologies
	Measures to continue the **phase-out of fossil fuels** subsidies against a clearly defined schedule.