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Final report on the state of play of the SET Plan IPs and mapping of R&I activities (Revamp of the SET Plan)

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AUTHORS' NAMES AND AFFILIATIONS	Maude BAUMAN, CEA; Ivan MATEJAK, EERA aisbl ; Spyridon PANTELIS, EERA aisbl
REVIEWERS' NAMES AND AFFILIATIONS	Vasile IOSUB, CEA; Ivan MATEJAK, EERA aisbl.
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EXECUTIVE SUMMARY

This report *D1.3. – Final report on the state of play of the SET Plan IPs and mapping of R&I activities* relates to Task 1.1 – *State of play: mapping of identified SET Plan IPs activities* of the SUPEERA project. It was preceded by two annual interim reports, both approved by the European Commission in March 2021 and in September 2022 respectively, and is presented here in its final version.

The present report is structured in six main chapters and relates specifically to the revamp process of the SET Plan.

Nearly two years and a half after the launch of the SUPEERA project and reaching the task's conclusion, this report in Chapter I sets the scene and introduces its objectives and methodology, both of which have been redefined in February 2022, subsequent to the kick-off of the SET Plan revamp process put in place by the European Commission. Indeed, as set up by SUPEERA's Grant Agreement, T1.1 shall be adjusted each year to further its added value: to work in a complementary manner with SETIS based on its own annual monitoring of the SET Plan implementation progress, and to better reflect new priorities/targets originated at the EU level (EGD, Next Generation EU, REPowerEU, etc.). In that respect, this third and final report on the state of play of the SET Plan IPs and mapping of R&I activities aims at delivering the contribution of EERA JPs', ETIPs' and other stakeholders to the revamp of the SET Plan, taking stock of its expertise and of its long-lasting experience as the SET Plan research pillar.

Subsequently, leaning on a set of surveys and workshops conducted with EERA's JPs and the ETIPs, Chapter II and Chapter IV of this report provide an overview of EERA JPs' and ETIPs' feedback respectively and recommendations on the future, rearranged, SET Plan: identified obstacles and barriers for the SET Plan to play its role in the energy transition, and new ideas to make the SET Plan more impactful, mission-oriented, and politically visible.

In the face of the recent geopolitical developments in Europe and the subsequent REPowerEU communication by the EC, Chapter III is dedicated to the timely response of the EERA JPs to address the associated long-term R&I challenges that will have impact the energy system in the years to come.

Given the EERA commitment to address the revamp of the SET Plan in a way that will allow for a fast-track implementation of the CET in the new political context, Chapter V puts forward in a concise manner, two sets of recommendations: high level (focused on SET Plan content and governance structure at higher level) and operational (relevant to the execution of the Plan at the IWG level).

The conclusion (Chapter VI) of the present report aims at providing guidance from the EERA community to build the SET Plan of the future. For sake of convergency, the title of this report has been amended to reflect all above-mentioned actions regarding the revamp process.

LIST OF ACRONYMS

AC(s)	Associated Countrie(s)
AMPEA	Advanced Materials and Processes for Energy Applications
CCUS	Carbon Capture (Use) and Storage
CET	Clean Energy Transition
CSP	Concentrated Solar Power
DoE	Digitalisation of Energy
E3S	Economic, Environmental and Social impacts of the Energy transition
EC	European Commission
EE	Energy Efficiency
EEIP	Energy Efficiency for Industrial Processes
EERA	European Energy Research Alliance
EGD	European Green Deal
ES	Energy Storage
ESI	Energy System Integration
ETIP(s)	European Technology and Innovation Platform(s)
EU	European Union
IP(s)	Implementation Plan(s)
IWG(s)	Implementation Working Group(s)
MS(s)	Member State(s)
NM	Nuclear Materials
PV	Photovoltaics
R&I	Research and Innovation
RCH	Renewable Heating & Cooling
SC	Smart Cities
SETIS	Strategic Energy Technologies Information System
SET Plan	Strategy Energy Technology Plan
SFC	Solar Fuels and Chemicals
SG	Smart Grids
SI(s)	Supporting Initiative(s)
SRIA(s)	Strategic Research and Innovation Agenda(s)
SSH	Social Sciences and Humanities
SUPEERA	Support to the coordination of national research and innovation programmes in areas of activities of the European Energy Research Alliance
WP(s)	Work Package(s)

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I PRELIMINARY CONSIDERATIONS

1.1 SUPEERA in a few words

In 2007, the EC announced the creation of its SET Plan, as an instrument to boost R&I in the field of low carbon technologies for energy. Following the SET Plan's 10 priorities, 14 IPs were drafted in order to cover all the Energy Union R&I priority areas, and IWGs, put in charge of executing the R&I activities listed under the IPs. The SET Plan is supported by the open-access SET Plan Information System (SETIS – JRC, EC) that provides up-to-date information on its activities covering all R&I priorities of the Energy Union.

Within this context, the SUPEERA project - SUPport to the coordination of national research and innovation programmes in areas of activities of the European Energy Research Alliance was launched on January 1st 2020, and aims at reaching four high-level objectives:

1) Facilitating the coordination of the research community in support of the execution of the SET Plan towards the CET;
2) Accelerating innovation and uptake by industry;
3) Providing recommendations on R&I priorities and policy frameworks through the development and analysis of the energy and macroeconomic indicators;
4) Supporting and promoting the connection of the SET Plan and the CET with all stakeholders.

In an effort to realise the first high objective, the project aims at facilitating the implementation of the SET Plan IPs by assisting the energy research organisations involved in the SET Plan itself. In specific, SUPEERA focuses on the identification, mobilisation and optimisation of primary EERA members' resources that can be engaged in the execution of the IPs. Within its Work Package 1, SUPEERA also aims at enhancing the exchange of information between the IWGs and at making recommendations for joint actions concerning crosscutting and interdisciplinary activities.

1.2 Monitoring the SET Plan progress: SETIS report for 2021

In order to provide the EC with accurate information on the implementation of the SET Plan, SETIS yearly assesses the progress from the IWGs on their respective activities and publishes the results of its work in a report: "*Progress from the Implementation working groups*". This report, *inter alia*, offers a concrete and up-to-date assessment of the implementation of the SET Plan IPs, and displays where additional efforts for their execution would be needed. In its yearly report, SETIS also assesses the relevance of the IPs according to current technological and political priorities, collects potential needs of revision of their targets and activities, displays a list of ongoing exemplary R&I project and their funding sources, and analyses ongoing collaborations or potential synergies between IPs and IWGs.

The 2021 SETIS' report[1] , rather than analysing single IPs actions, has emphasized on the general progress of the SET Plan, putting into perspective its aim of coordinating clean energy technologies-related R&I with EC current challenging policy landscape when it comes to the energy transition and to the fight against climate change (EGD, Fit for 55, etc.). SETIS' 2021 report thus focuses on the political relevance of the SET Plan, its main developments and efforts towards more synergies with EU policies, and displays each working group's achievements in that respect. Overall, the SETIS' report for 2021 concludes on the good adaptation of the Working Groups to current political and market evolutions, building on increasing collaboration between the different working groups, and on a strengthened monitoring of their R&I priorities, allowing for greater funding coordination at national level as well. In preparation for the SET Plan annual conference in 2020, IWGs have indeed all conducted a general assessment of their IPs' activities and targets relevance, underlining the need to add, remove, or adapt them in certain areas, and to better collaborate in other areas deemed "crosscutting", such as digitalisation, or the supply in strategic raw materials. Still, according to SETIS' assessment, more efforts are needed to ensure the alignment between national and European programmes and priorities, and SETIS' report mentions the NECP EU-wide assessment conducted by the EC in 2021, which has concluded on the huge potential in making more connections between national strategies and ambitions, and EU MS(s)' participation within the SET Plan framework. Looking more specifically at R&I funding, the report draws attention to the difficulties experienced by certain SET Plan countries in monitoring R&I spending at national level, making it therefore quite difficult to ensure its coherence with existing EU funding schemes. Eventually, SETIS' 2021 report calls for further involvement from the public and private sectors as well as from all EU MS(s) into the SET Plan framework.

Against this backdrop, the SETIS 2021 report officially signed the beginning of the revision of the SET Plan ("revamp"), which will better align the Plan and its stakeholders (including the EERA community) in support of EU political, energetic and industrial priorities,

Since SUPEERA's first Work Package (WP1) aims at facilitating the execution of the SET Plan IPs by providing a clear and consolidated analysis of their state of progress, and while doing so, an overview of energy research cooperation in the EU, SETIS' report is key to complete these objectives. However, for this task 1.1's final report, a structural reorientation of both its objectives and strategy has been agreed on, in accordance with the EC. Indeed, in the context of the SET Plan revamp expected in 2022, the present report takes advantage of the SUPEERA framework to formalise and provide the EC with a detailed feedback and contribution from the biggest low-carbon R&I community in Europe on the future of the SET Plan.

[1] *SET Plan progress report 2021: Contributing to the EU Green Deal and the path forward to a Green Recovery*, 24 November 2021, Joint Research Centre (JRC) – European Commission https://setis.ec.europa.eu/set-plan-progress-report-2021_en

1.3 Amended actions and revised methodology: capitalising on D1.1, D1.2 and contributing to the SET Plan revamp

The present report was preceded by two interim reports:

- *D1.1. – Interim report on the state of play of the SET Plan IPs and mapping of R&I activities*, which aimed at both displaying the first mapping of all open and covered IP actions and assessing their respective progress towards achieving the targets of the SET Plan. D1.1 relied, on one hand, on the data made available by the SETIS 2019 progress report, and on the other, on a set of interviews conducted by SUPEERA partners with EERA members present in different IWGs, which aimed at furthering the project's qualitative analysis of the progress made by each IWG. In order to add value to the study already published by SETIS in its yearly report, D1.1 attempted to further its analysis, by identifying the facilitating practices related to the internal organisation of the IWGs, the role of the MS and AC and, finally, the potential benefits of the SET Plan environment.
- *D1.2. – Second interim report on the state of play of the SET Plan IPs and mapping of R&I activities,* which builds on the conclusions of D1.1., attempts to take advantage of the opportunities and to overcome the difficulties identified in the making-process of T1.1.'s first interim report (fast-changing environment, difficulty to gather relevant information in order to add value to SETIS' yearly assessment, overlapping of reporting activities of supporting initiatives). In that perspective, the EC, EERA aisbl and SUPEERA partners have agreed on a new methodology for this specific task: the type and number of IPs activities under the focus are to be defined on a yearly basis, in order to deepen the complementarity with SETIS' annual progress report, to direct its analysis towards the EU's political priorities, and to provide concrete and up-to-date information on the needs for additional efforts in the implementation of the SET Plan. D1.2. has therefore laid the focus on providing an overview of the barriers of the IPs activities that in SETIS' 2020 report were labelled as "orange" and "red", which are impeding those actions to progress (and to turn "green"). D1.2. has both relied on SETIS' collected data in 2020, and on a set of interviews and surveys conducted with the supporting initiatives of the IWGs.

Eventually, the present report is the final deliverable of this task. Apart from the fact that this report is intended to draw the final conclusions of two years and a half of monitoring the IWGs' and EERA JPs' progress towards the full implementation of the SET Plan, it also needs to be put in the broader context of an expected SET Plan revision, which should be completed by the end of 2022 by the EC. As to provide the EC with useful, proactive feedback from EERA community, and as agreed on during SUPEERA's yearly meeting with the EC in January 2022, D1.3. aims at formalising EERA JPs' contribution to the definition of the SET Plan's role to accelerate the CET.

In order to gather and consolidate EERA JPs' feedback on their participation in respective IWGs - in particular, and on the SET Plan framework - in general, SUPEERA partners have conducted a set of surveys, which template can be found in this report's ANNEX 1. Among the 18 EERA JPs, 17 have submitted their feedback between April and June 2022, and the results were discussed with Joint Programme Coordinators during the EERA Joint Programme Coordinators meeting (bi-annual event) that took place on the 17-18 May 2022. The results

are correlated by so-called high-level and operational recommendations, discussed and endorsed by the entire community during the EERA Annual Strategy Meeting in Prague (22-23 June 2022), in presence of the EC representatives.

Reaching the EU targets requires balanced participation among all the stakeholders of the transition. In this respect, the European Technology and Innovation Platforms (ETIPs) were also solicited to share their experience and opinion on the SET Plan revamp, via both a request to fill in an adjusted JPs survey and a during hybrid meeting on 23 May 2022 at EERA premises.

Finally, the present report has also taken into account the contributions received from proactive and relevant stakeholders of the SET Plan, but currently not embedded in its structure, namely: SUNERGY and stakeholders from the Hydropower community. In its final version, D1.3 will be disseminated through EERA channels, to the EERA Joint Programs and other relevant stakeholders. If necessary, the report will be complemented with new elements and information from the EERA community and its summarised outcome will be presented at the SET Plan conference in Prague in November 2022.

II CONTRIBUTION OF EERA ON THE REVAMPING PROCESS OF THE SET PLAN

2.1 Background information for the 2nd revision of the SET Plan

Since its inception in 2008, the overall objective of the SET Plan is to provide a common vision, goals and coordination in accelerating the development and deployment of efficient and cost-competitive low-carbon energy technologies, and to enhance the EU's geo-political resilience and security of energy supply.

In 2022, the EC is taking stock of the 14 years of experience of the SET Plan implementation, undertaking a second revision of the Plan to pursue several objectives:

- Adjust to the evolving policy landscape and in particular deliver on the Green Deal by making the SET Plan a more mission-oriented, impactful and politically visible tool;
- Reinvigorate its governance by introducing more simplification and legibility into the existing structure - without the addition of an extra layer or body – to increase its flexibility and tackle cross-thematic areas;
- Support the ERA Policy Agenda and the goals of the Energy Union;
- Make R&I contribution essential in achieving the objectives of the Green Deal;
- Reinforce the synergies between the SET Plan and other financial instruments and supporting schemes (e.g. Next Generation EU, REACT-EU, ESIF, etc.);
- Accelerate innovation and deployment by making the SET Plan consistent with the NECPs and other relevant national policies and measures (and vice versa);
- Address environmental and social aspects (just transition, citizen engagement); Encompass training and education challenges for energy research.

As foreseen by the EC, a proposal for a revision of the SET Plan should be released during the 2022 SET Plan annual conference. This proposal should be based the data collected via a set of surveys and interviews conducted with all the SET Plan stakeholders, between the second and third quarters of 2022.

As EERA gathers more than 250 research actors of the EU and its Associate Countries, and as it bears the role of the research pillar within the SET Plan, its position in the energy research landscape is key within the SET Plan revamping process.

In order to provide the EC with a consolidated feedback and an in-depth analysis of the SET Plan's perspectives and future, reflecting the needs of the energy research community, SUPEERA has therefore been mobilised as the appropriate framework to collect and formalise the EERA community's contribution.

The EERA contribution compliments the official instruments designed by the EC (and its contractors) and as a such represents a further alignment of EERA's action to EC expectations.

2.2 Added value of the SET Plan as perceived by EERA JPs

With intent to formalise EERA JPs' feedback on both their experience of the SET Plan framework since its establishment in 2008 and on its role in the future of the CET, SUPEERA partners have conducted a survey sent to all of EERA JPs' coordinators and members, composed of eleven questions, classified into three categories:

1) Questions related to the SET Plan Implementation Plan(s);
2) Questions related to the SET Plan's general level;
3) A question related to the REPowerEU communication[2].

These questions allowed SUPEERA partners to consolidate EERA members' views within the Joint Programmes regarding the SET Plan's impact and its revised overarching objectives and governance.

The interpretation of the results that follows reflects rather their strategic significance in evaluation of the SET Plan than the order of the questions in the surveys. For example, this section opens with the perceived value that the SET Plan brings to the community (Question 2, Section 2), while single R&I priorities are addressed further on in the analysis (Question1, Section 1).

In that context, the first question reflects JPs perspective on the strategic role of the SET Plan, is EERA JPs' opinion on the SET Plan impact in providing a collaborative mechanism for the execution of the respective Strategic R&I Agendas (SRIAs) and/or Descriptions of Work (DoWs). As shown in **Figure 1,** the level of the perceived impact is quite different between JPs: 6 of the contributing Joint Programmes rate the SET Plan's impact as "High"; 4 of these JPs rate its impact as "Medium"; and 5 other JPs, as "Low" (2 JPs did not provide a response to this question). This result tells us that SET Plan's perceived impact is highly dependent on the scope of each JP.

[2] *Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions. REPowerEU: Joint European Action for more affordable, secure and sustainable energy*, 8th March 2022, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2022%3A108%3AFIN

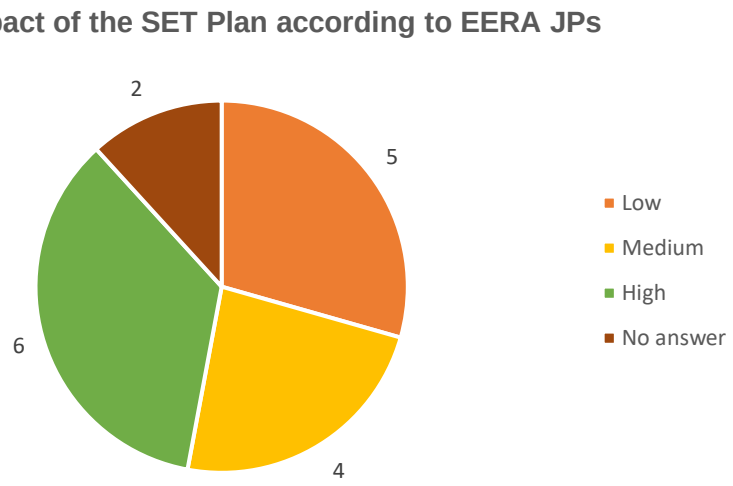


***Figure 1** – EERA JPs' answers to **Question 2, Section 2** of the SUPEERA survey "How would you rate the SET Plan impact in providing a collaborative mechanism (e.g. networking, funding, platforms etc.) for the execution of the SRIAs and DoW of your Joint Programme?"*

In order to have a more detailed understanding what are the most relevant benefits and achievements of the SET Plan in the eyes of EERA's community, JP members were asked to indicate three added values that the SET Plan, both as a normative and collaborative framework, provides to their specific R&I fields, and to support their answers with concrete examples (**Question 5, Section 1** of the SUPEERA survey). Within the next subchapters, the different added values underlined by each EERA JPs were classified and detailed.

2.2.1 A framework for R&I collaboration in low carbon technologies

Firstly, as also identified among IWGs' Supporting Initiatives in the course of this task's second interim report (D1.2.), there is a clear consensus among EERA JPs' members that the SET Plan represents a privileged framework for continuous collaboration, allowing all low carbon energy research stakeholders to gather and discuss policies and actions aiming at achieving the goals of energy transition, including direct interaction with MS/ACs and the EC.

A majority of EERA JPs' members contributing to the present study (AMPEA, Bioenergy, CCS, Ocean Energy, ESI, CSP, DoE, E3S, EEIP, ES, Geothermal, Hydropower, NM, PV Solar Power, SC, SG, Wind Energy) has indeed underlined that the SET Plan provides a structured discussion platform, gathering MS/ACs, European industry, EC and European research community via EERA, enhancing and strengthening their collaboration. In that sense, JP AMPEA identifies that this cross-sectorial collaboration allows for a wider range of research communities being consulted in the policymaking process, while for JP CCS allows for bridging the gap between R&I and policymaking, and furthermore, for their uptake by industry. Following the same observation, the JP ESI underlines that the SET Plan as a collaboration platform provides the operators of all energy networks with guidance regarding the demand for infrastructure in the future. According to the JP ES and shedding light on one of the SET Plan's success stories, this collaboration framework of the SET Plan has provided with assistance in the emergence of a battery industry in Europe, and the consolidation of its aim and structure.

Nevertheless, in the eyes of the JP Ocean Energy, while the SET Plan consists indeed in a privileged forum for an energy dialogue to emerge between the authorities at EU and national levels, it remains unclear at which of these scales the SET Plan should be implemented in practice. Moreover, some of JPs' coordinators (Geothermal, Wind, Ocean, NM, PV) have underlined how involvement of the Member States within IWGs is key for the SET Plan to succeed. To enhance that involvement, some of the JPs (Wind, Ocean) have called for funding support via EU CSA projects, building on the success story of the SETWind project. Nevertheless, EERA JPs' coordinators feel that IWGs should not only be driven by projects, but build their own strategic agendas, endorse these documents with strong political visibility and influence, and aim at aligning their respective priorities.

2.2.2 A tool to better align national R&I agendas

Also identified as an added-value of the SET Plan during SUPEERA's previous study among IWGs' supporting initiatives (JA-a and ETIPs), a high number of JPs' members (AMPEA, Wind Energy, SG, NM, EEIP, Hydropower, ESI) consider that the SET Plan-related activities contribute to a joint planning of energy research agendas and resources. This alignment process of R&I priorities and activities is deemed key to foster complementarities and avoid duplication of efforts at MS, AC and EU levels.

For JP AMPEA, the SET Plan contributes indeed to the alignment of National Energy and Climate Plans (NECPs) across the EU, in the coordination of their implementation progress, and in giving more visibility on their directions and priorities. JP Wind Energy's members see the SET Plan as the only platform where country representatives can actually meet to talk about R&I priorities for energy, to be included in their respective strategies forward. Nevertheless, both JPs calls for a closer connection between this strategy definition process and corresponding research funding opportunities at EU and national levels. While JP NM underlines that including an activity within the SET Plan IPs strengthens the support it receives from MS(s), leading eventually to concrete and consistent actions at national level, the JPs EEIP and ESI associate the SET Plan with an opportunity to provide the EU and MS(s) with policy inputs – generated directly from the expertise and knowledge of researchers – and, therefore, with the guidance on how to improve the smooth, integrated functioning of the energy system across energy vectors and across national borders.

2.2.3 A platform to define common R&I priorities and urgent actions

Moreover, some JPs' members (CSP, PV, EEIP, Geothermal, SG, E3S) have identified the SET Plan as contributing in defining common R&I priorities and urgent actions related to the energy transition and the delivery of the necessary energy technologies. In that perspective, the JP SG feels that the SET Plan's "roadmap" approach allows for the identification of important aspects to be addressed collectively in the energy sector, and produces a concrete overview of the needs and requirements of the energy transition. The JPs PV and E3S also underline that the SET Plan provides with a clear European plan and concrete R&I targets, scope and direction in their fields, while the JP EEIP finds that it even gives the research actors

a direct platform to define common lobbying objectives in the course of the definition of R&D calls. This observation is also shared within JP Geothermal, which, among others, calls for more support to take concrete actions based on this prioritisation process.

2.2.4 An opportunity to include insights from social sciences and humanities perspective

Several EERA members, especially within the JPs AMPEA and E3S, have identified within the SET Plan framework an opportunity to emphasize the role of SSH in the way energy research priorities are defined, and eventually, on how energy research funding programmes are built. For example, Horizon Europe entails within its working programmes several actions related to how experts on materials construct their research methodologies and set targets. For the JP E3S, on another hand, one of the SET Plan's weaknesses is that it lacks societal targets such as diversity, quality of life, or level of happiness.

What is missing though according to EERA JP for ESI, is the inclusion of more R&I actions that address the energy system as a whole. R&I funding should promote such holistic perspective of the energy system and regulations and market designs as well as costs and benefits of individual technologies should be examined under this prism. Nonetheless, JPs' members underline that broader crosscutting issues are still not sufficiently covered by the current SET Plan IPs. The picture is different though at JP's side, where under the request by the research community, EERA JPs proactively created new ones to bridge this gap, namely, JP DoE, JP E3S, JP AMPEA.

2.3 Defining the SET Plan of the future based on the experience of EERA JPs

2.3.1 Structural obstacles and barriers identified as preventing the SET Plan to play its role

Besides the considerations on the political and technological relevance of the SET Plan, EERA JPs were asked several questions related to what were, in their views, the remaining R&I challenges for the energy sector to achieve carbon neutrality and the obstacles and barriers to overcome within the SET Plan framework,

a) Inclusion of R&I actions

In that respect, they were first asked "Which R&I actions pertinent to [*their*] Joint Programme (JP) are not included in the current (or revised) Implementation Plans (IPs), also in relation to the EU strategies on hydrogen, offshore renewable energy, energy system integration and solar energy?" (**Question 1, Section 1** of the SUPEERA survey). As shown in **Figure 2**, the majority (9) of EERA JPs find themselves unsatisfied with the inclusion of the respective R&I priorities within the existing SET Plan IPs, with 4 JPs stating, "Overall unsatisfied" and 5 of

them “Not fully satisfied”. Though, 8 JPs are overall fully satisfied with the inclusion of their R&I actions into the respective IPs.

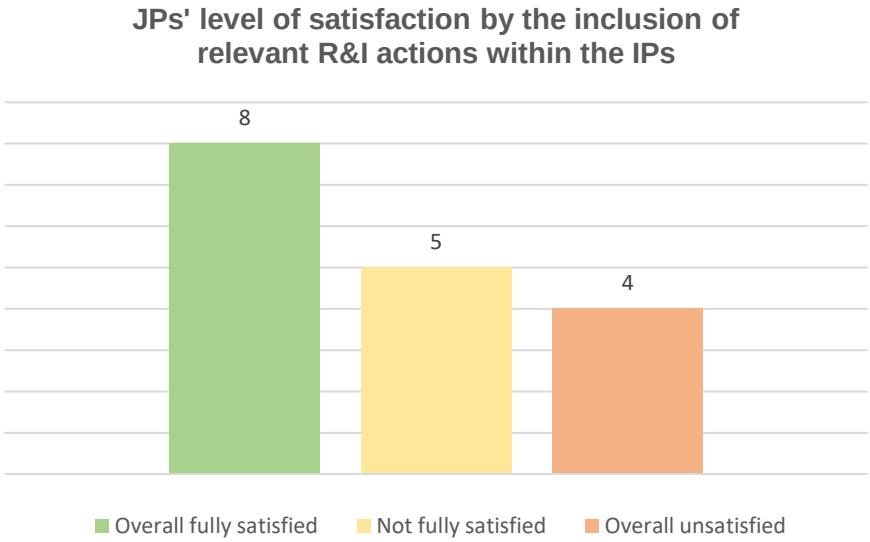


***Figure 2** – EERA JPs’ answers to **Question 1, Section 1** of the SUPEERA survey “Which R&I actions pertinent to your Joint Programme (JP) are not included in the current (or revised) Implementation Plans (IPs), also in relation to the EU strategies on hydrogen, offshore renewable energy, energy system integration and solar energy?”*

Looking more specifically at R&I actions identified as missing in the SET Plan IPs, EERA JPs have provided SUPEERA partners with the following answers, displayed in Table 1.

EERA Joint Programme *& corresponding SET Plan IP*	**R&I actions identified as pertinent to be added to the corresponding SET Plan IP**
Photovoltaics *SET Plan IP: Solar Photovoltaics*	• To add: performance enhancement and cost reduction, sustainability and circularity, socio-economic aspects • To adjust: further focus on the CO2 footprint, and the supply of critical raw materials for the production of PV panels
Concentrated Solar Power *SET Plan IP: CSP/STE*	• IP is well updated • To add: development of high-temperature linear and central receivers • To adjust: over-emphasis on solar PV when talking about solar energy
Wind Energy *SET Plan IP: Offshore Wind*	• IP is well updated
Geothermal *SET Plan IP: Deep Geothermal*	• To add: heat production and storage, and especially seasonal heat storage taking advantage of the surplus of renewable heat available in the summer, production of raw materials for the energy sector • To adjust: further focus on low TRL activities
Ocean Energy	• IP is well updated

SET Plan IP: Ocean Energy	
Smart Cities *SET Plan IP: Positive Energy District*	• To add: social innovation R&I (related to governance structures, behaviours, value modelling, complex decision making processes), spatial and biodiversity impact assessments
Energy System Integration *SET Plan IP: Energy Systems*	• To add: an integral view on the regulation and market design of the energy system as a whole, an analysis on the respective desired roles for electricity and hydrogen as low-carbon energy carriers, the interaction between technologies and the requirements for their optimised operation in an integrated energy system, transition paths towards the development of new energy technologies taking into consideration existing technologies and networks, demand response and end-user flexibility for energy in a resource-efficient integrated energy system, the end-of-life and environmental aspects of existing energy infrastructures and technologies (recycling, resource consumption and use, impact on diversity, etc.) • To adjust: further focus on ESI and on technology sustainability within the EU strategies on solar, offshore energy, hydrogen, and broader scope beyond electricity for the EU strategy for ESI
Smart Grids *SET Plan IP: Energy Systems*	• IP is well updated
Energy Efficiency for Industrial Processes *SET Plan IP: Energy Efficiency in Industry*	• IP is well updated
Energy Storage *SET Plan IP: Batteries*	• IP is well updated • To add: hybridisation
Bioenergy *SET Plan IP: Renewable Fuels and Bioenergy*	• IP is well updated
Carbon Capture and Storage *SET Plan IP: CCS-CCU*	• IP is well updated
Nuclear Materials *SET Plan IP: Nuclear Safety*	• IP is well updated
Advanced Materials and Processes for Energy Applications (AMPEA) *SET Plan IP: NA*	• No IP dedicated to Advanced Materials and Processes for Energy Applications as such – and generalized lack of related R&I actions across the IPs • To add: closed carbon cycles applied to renewable energy supply, new production pathways for key materials with low carbon footprints, high recycling rates and energy from renewable resources, solar energy for renewable fuels and chemicals, cost-efficient, low-carbon and scalable technologies to convert and store solar energy, technologies to produce SFC – either through multi-step or via direct solar

	conversion, conversion of solar energy into solar fuels and chemicals, accelerated development of RTIL
Digitalisation of Energy *SET Plan IP: NA*	• No IP dedicated to the Digitalization of Energy as such • To add: need to make both the EU Action Plan for the DoE and the SET Plan activities converge
Economic, Environmental and Social Impacts of the Energy Transition *SET Plan IP: NA*	• To add: sustainability of each technological innovation, a systemic modelling approach resulting in the development of scenarios, the impact of energy efficiency and demand reduction on energy production and on technologies, the impact of each energy technology on energy poverty, and the technological and societal impacts of EU energy policies
Hydropower *SET Plan IP: NA*	• No IP dedicated to Hydropower as such • To add: assessing factors promoting social acceptance, improved public engagement and increased uptake of hydropower in consumers' energy portfolios, development of new and innovative method for designing, engineering, constructing, installing, and operating flexible hydroelectric units, climate friendly solutions and sustainability, environmental restoration in Hydropower development, impact investigation of climate change on water resources and consequent impacts on power production and freshwater ecosystems, investigating supportive and limiting effects of national and European policies, policy mixes and regulations on the environmental upgrading of existing hydropower infrastructure, new hydropower development and increased operational flexibility, transformation of hydropower asset maintenance from interval-based to prediction- based by use of new sensors and measurements, integration of cross-domain knowledge into new and established business processes in the hydropower sector, resilience of equipment and infrastructure, open-source hydropower data and models for energy system analysis

***Table 1** – EERA JPs' answers to **Question 1, Section 1** of the SUPEERA survey "Which R&I actions pertinent to your Join Programme (JP) are not included in the current (or revised) Implementation Plans (IPs), also in relation to the EU strategies on hydrogen, offshore renewable energy, energy system integration and solar energy?"*

The analysis of the feedback received leads therefore to two important observations:
a) EERA JPs which are fully satisfied with the inclusion of R&I priorities in existing (or those under revision) IPs are those who are generally active in the IWGs work and therefore directly contribute to the definition of the IPs themselves. The clear example of this is JP Wind Energy, that through the SETWind project has provided the IWG with own R&I challenges now included in the revised IP.
b) EERA JPs which are not fully satisfied with the revision of their corresponding SET Plans are not involved in the work of the IWGs as they would like to and therefore advocate for organisational adjustments within the SET Plan framework. In addition, these JPs call for the inclusion of both new technological, but also non-technological R&I actions in the IPs.

b) Non-technological topics

IWGs should address broader and higher level "mission-oriented" cross-cutting transition challenges rather than siloed technology challenges. The SET Plan should be de-siloed and take a holistic, top down, systemic and interdisciplinary approach of the Clean Energy Transition addressing also non-technology-based topics. In that perspective, EERA JPs have selected from a pre-defined list which non-technological topics seem pertinent to be included in the SET Plan IPs. These non-technological topics have been identified in the SUPEERA deliverable D1.2 (in the course of SUPEERA's Work Package 2) after analysing the IPs of the SET Plan IWGs and the NECPs. They include the following: the role of social awareness, acceptance and engagement, policy and regulation, education and training, standardisation, socio-economic policies, international cooperation, and of a closer connection between the SET Plan R&I activities and R&I funding programmes. In **Figure 3**, those non-technological topics are displayed according to their occurrence in EERA JPs' feedback, as well as their prioritisation (**Question 4, Section 1** of the SUPEERA survey: "To the already existing technological and cross-thematic areas, which non-technological topics should be addressed by one or more IPs?"). The resulting matrix shows how the inclusion of R&I actions within the SET Plan related to social awareness, acceptance and engagement, as well as policy and regulation, education and training, international cooperation and the connection of it all with R&I funding programmes, seem to reach the highest consensus within the EERA community.

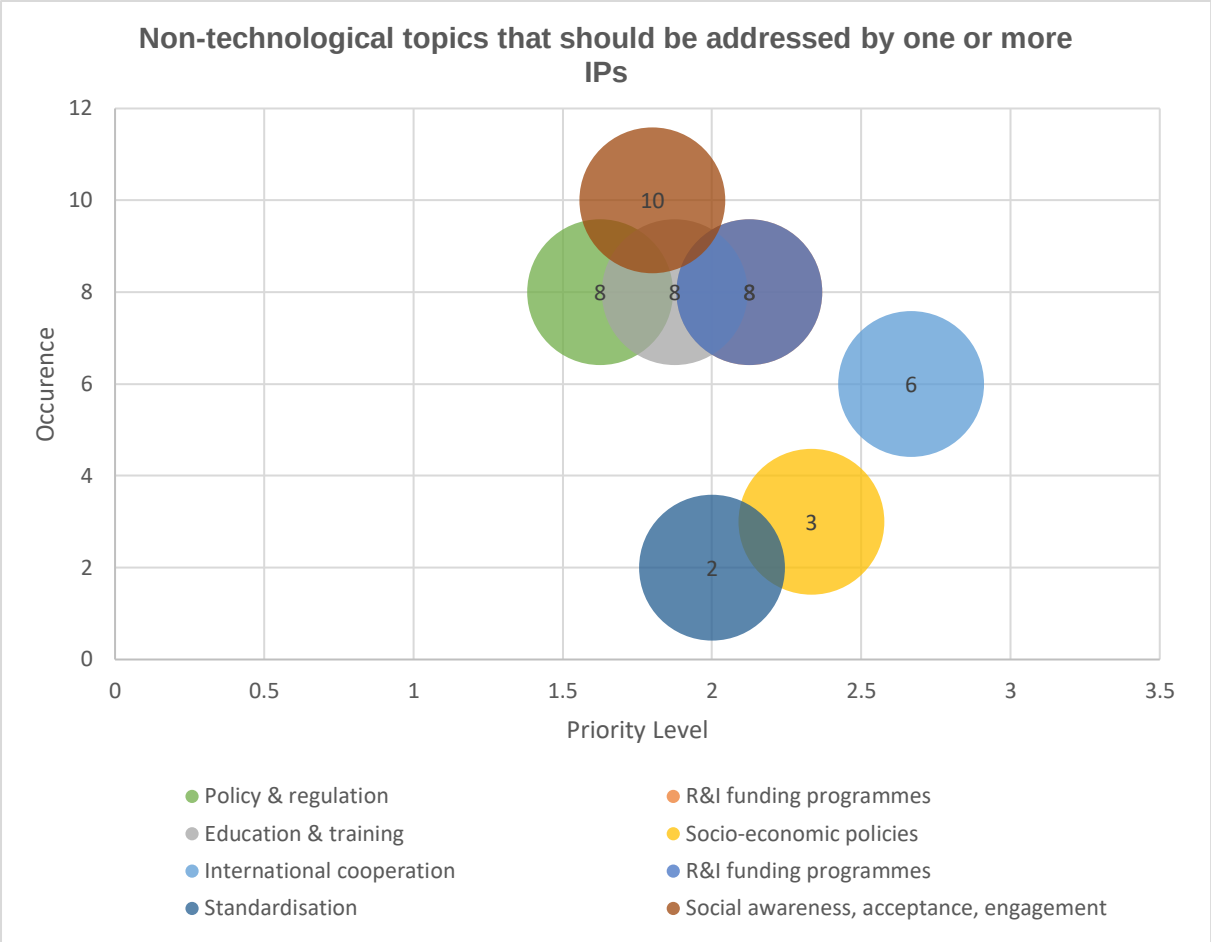


***Figure 3** – EERA JPs' answers to **Question 4, Section 1** of the SUPEERA survey "To the already existing technological and cross-thematic areas (i.e. energy efficiency, digitalisation etc.), which non-technological topics should be addressed by one or more IPs?"*

c) Structural barriers

Apart from specific R&I actions that should be addressed, according to EERA members, within the SET Plan framework, the EERA community was also asked to take a step back, and to provide with its views on the structural barriers preventing the SET Plan as a whole to play its role in the energy transition, and the development of each energy technology field (**Question 2, Section 1** of the SUPEERA survey: "Indicate at least three barriers and obstacles that prevent the smooth execution of the R&I components of JP respective Implementation Plan."). As shown in **Table 2.** these identified barriers refer mainly to: financial barriers, lack of coordination at EU and/or MS levels, regulatory obstacles, and social acceptance and engagement.

Barriers and obstacles to the smooth execution of EU energy R&I objectives identified by EERA JPs

Photovoltaics	Concentrated Solar Power	Wind Energy
• Need for more mobilisation within the SET Plan IWG • Need for alignment between MS on the execution and funding of the SET Plan priorities Need for more public funding for PV R&I	• Need for adequate funding support at MS and EU levels • Need for a dedicated funding call for EERA JP for CSP • Need for a higher number of innovation actions aimed at facilitating market penetration • Need for pilot projects aiming at defining a regulatory framework to ease market penetration • Need for commercial projects within the EU to allow for the implementation of high TRL innovations • Need for higher engagement and collaboration within the PV R&I sector	• Need to reduce cost • Need for energy system integration and sector coupling • Need for market flexibility for green electricity • Need for environmental and social sustainability • Need for adaptation to regional conditions
Geothermal	**Ocean Energy**	**Smart Cities**
• Need for adequate funding • Need for broader scopes and budgets for funding for projects, addressing transversal topics Need to create more opportunities for geothermal heating projects	• Need for more connections between the SET Plan and national strategies and calls	• Need for more consideration dedicated to interdisciplinary research • Need to set up more focus and inclusion of customers/citizens • Need for more connections between research and market within the JP
Energy System Integration	**Smart Grids**	**EE for Industrial Processes**
• Need for an overall perspective on the timing and speed of the development of renewable energy production and its partial conversion to hydrogen • Need for perspectives on the future roles of electricity	• Need for a better alignment between the SET Plan and national objectives • Need for more engagement and involvement from MSs in the SET Plan • Need for more connections between national and EU funding programmes	• Need for more cooperation between EU and MS levels

and hydrogen infrastructures • Need for more consideration for the role of economic incentives in the development of decarbonization options by private actors		
Energy Storage	**Bioenergy**	**Carbon Capture and Storage**
• Need for fundamental research on battery materials, batteries and new chemistries • Need for a common benchmarking, including laboratories for standardisation • Need for more international collaboration via bilateral schemes	• Need for less uncertainty on political support for bioenergy, and easier dialogue MS level • Need for more emphasis on the potential for a "bioeconomy" approach vs. a bioenergy-only approach • Need for a better methodology to quantify GHG emissions	Need for R&I investments in CO2 capture technologies, transport, storage and life cycle analysis
Nuclear Materials	**Adv. Materials & Processes**	**Digitalisation for Energy**
• Need for more political willingness to set up coordinated projects within the SET Plan IWG • Need for dedicated and coordinated funding schemes • Need for an established instrument of cooperation between MS beyond co-funded instruments at EU level	• Need for an overarching IWG on advanced materials • Need to achieve integration / overcome competition between existing technologies • Need for adequate funding for low-TRL R&I	• Need for common efforts on digital developments, profitable for a wider community • Need for effective convergence of funding schemes from different EC DGs Need to adopt digital methodologies
Eco. Env. & Social Impacts	**Hydropower**	
• Need to bridge the gap between technology and social sciences, via a crosscutting, innovative research environment and the development of interdisciplinary skills	• Need to work on both social acceptance and environmental impacts	

***Table 2** – EERA JPs' answers to **Question 2, Section 1** of the SUPEERA survey "Indicate at least three barriers and obstacles that prevent the smooth execution of the R&I components of JP respective Implementation Plan."*

d) Overarching strategic objectives and targets

To complement this mapping of both obstacles and opportunities for the SET Plan to adapt to the current political, technological and societal challenges of the energy sector, EERA

community was eventually consulted on what were, in its views, the overarching strategic objectives and targets laying ahead of the energy sector (**Question 1, Section 2** of the SUPEERA survey: “In addition to specific R&I actions, which in your understanding are the most important overarching strategic objectives and targets per technology that should be covered/included in the SET Plan? Please, list maximum three.”). As shown in **Table 3.**, those challenges mainly relate to: digitalisation, circularity & supply in materials, citizen engagement & acceptance, environmental & social impact of the transition, EU energy sustainability & leadership, and investment & planning for energy infrastructures.

Overarching strategic objectives and targets for the energy sector identified by EERA JPs

Photovoltaics	Concentrated Solar Power	Wind Energy
• Achieving energy self-sustainability at EU-level • Making a success out of the energy transition in Europe • Making PV available and flexible for the wider range of applications • 100% clean energy system with 100% circularity • Rebuilding the strategic value chain of PV in Europe	• Building a clear, consolidated overview of the challenges in the energy sector, and defining corresponding, common roadmaps • Identifying synergies and complementarities between available energy sources • Full understanding of the benefits, contributions, potential of CSP technologies towards carbon neutrality	• Investing in renewable energy technologies • Ensuring EU leadership in renewable energy technologies • Accelerating the EU energy system transformation in a cost-effective way
Geothermal	**Ocean Energy**	**Smart Cities**
• Supporting heating and cooling technologies Reducing EU reliance on critical raw materials	• Developing skills and training • Infrastructure planning Ensuring energy security	-
Energy System Integration	**Smart Grids**	**EE for Industrial Processes**
• Supporting strategic objectives at the system level, instead of considering only each technology’s • Building on system-wide targets and policy measures towards decarbonisation, in order to foster resources optimisation	• Optimising energy resources utilising advanced smart features of the system • Supporting the evolution of energy communities offering advanced flexibility services to the power system • Digitalising the energy grid	• Investing in the development and deployment of industrial heat pumps
Energy Storage	**Bioenergy**	**Carbon Capture and Storage**
• Studying raw materials availability and recycling	• Aligning the SET Plan objectives and EU policies	• Accelerating innovation • Supporting CO2 transport infrastructures

• Developing and improving new battery chemistries • Assessing the manufacturability of new battery chemistries	(Fit for 55, REPowerEU, etc.)	• Deploying a CCUS strategic value chain
Nuclear Materials	**Adv. Materials & Processes**	**Digitalisation for Energy**
-	• Addressing crosscutting challenges of energy R&I • Achieving EU strategic autonomy • Including digital innovations, measurement standardisation, sustainability KPI definition within energy R&I	• Deploying new technologies and services for consumers
Eco. Env. & Social Impacts	**Hydropower**	
• Ensuring the sustainability of RES technologies • Reducing energy demand • Mitigating impacts on energy poverty and quality of life for citizens • Promoting citizen engagement in designing innovation strategies	• Digitalising the energy sector • Adapting hydropower systems to the impacts of climate change • Defining and deploying a market for flexibility services	

***Table 3** – EERA JPs' answers to **Question 1, Section 2** of the SUPEERA survey*
"In addition to specific R&I actions, which in your understanding are the most important overarching strategic objectives and targets per technology that should be covered/included in the SET Plan? Please, list maximum three."

Therefore, for the SET Plan to adjust its political and technological relevance as a tool contributing to achieve EU climate goals, EERA JPs have identified several challenges to overcome, both related to the inclusion of new technological, but also non-technological priorities at EU level, and to the evolution of its framework.

Building on these identified challenges and opportunities for the SET Plan, and taking stock of the feedback also analysed in both previous deliverables of this Task 1.1 of SUPEERA (**D1.1**. and **D1.2**.), a set of recommendations has been drawn up which are incorporated in Chapter V of this report.

2.3.2 SET Plan in the future: feedback and perspectives as identified by EERA JPs

With a scope to properly address above listed obstacles and challenges, EERA JPs' members were asked to make proposals for effective actions to implement in order to improve the SET Plan's impact (**Question 3, Section 2** of the SUPEERA survey: "Which actions would you

consider as more effective to improve the impact of the [*SET Plan*]?"). They were provided with five different multiple-choice options:

1. Enhance collaboration/involvement or on-time mobilization of the relevant stakeholders (industry, member states, research etc.)
2. Increase the accessibility to funding and partnership opportunities to address emerging R&I collaboration needs
3. Ensure more influence for the JPs and relevant platforms (e.g. ETIPs) in the governance of the SET Plan
4. Improve flexibility of both European and national strategies and action plans' revision processes
5. Other

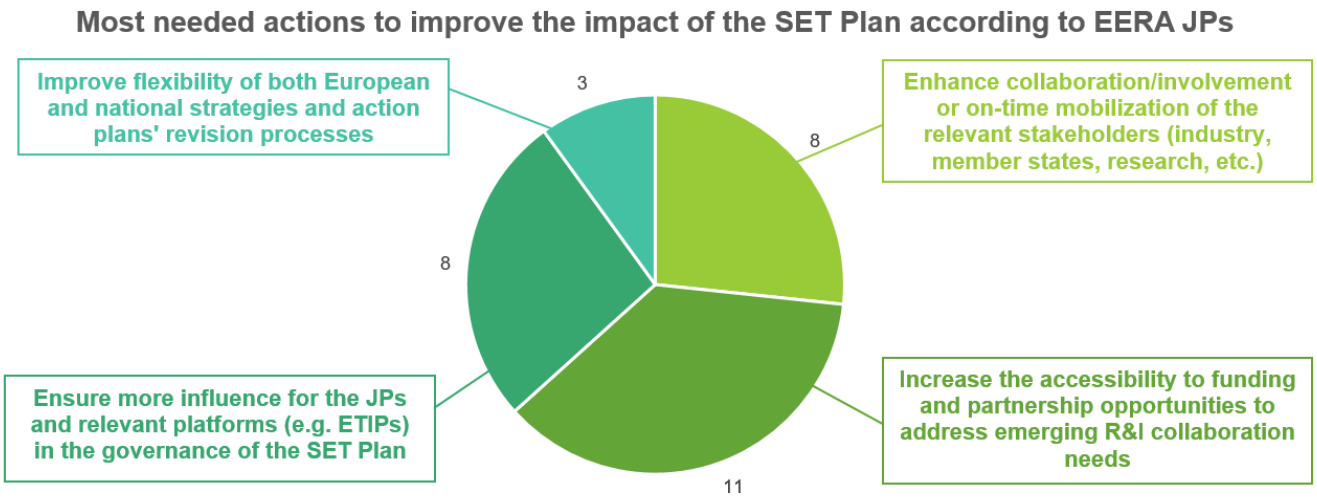


***Figure 4** – EERA JPs' answers to **Question 3, Section 2** of the SUPEERA survey "Which actions would you consider as more effective to improve the impact of the [SET Plan]?"*

As displayed in **Figure 4.**, the most of EERA JPs' members have converged on the need to increase the accessibility to funding and partnership opportunities to address emerging R&I collaboration needs. In that perspective, most of EERA JPs have emphasized that the SET Plan's added value relies on its capacity to mobilise stakeholders to achieve research thinking on strategic issues, which should be driven through consolidated and funded initiatives, and reflected within European and national R&I calls. According to the JP EEIP for example, their success is indeed directly due to its **good overview of the needs of the industry**, which are thereafter included in Horizon Europe calls.

Apart from increasing the link and accessibility to funding and partnership within the SET Plan framework, EERA JPs' members have also expressed the need to **assign more influence to the JPs and relevant platforms** (e.g. ETIPs) within the governance of the SET Plan itself. According to the JP Geothermal for instance, JPs should indeed be assigned with a stronger role and more visibility within the SET Plan framework. This is also mentioned by the JP AMPEA, which calls for the creation of a new IP and corresponding IWG on "Advanced Materials". In that sense, allowing for the EERA JPs to gain influence within the SET Plan

framework could allow for EU energy experts to feed into the SET Plan's general strategy with the concrete needs of the sector.

Furthermore, certain EERA JPs' members feel that the SET Plan would gain impact if the collaboration/involvement or **on-time mobilisation of the relevant stakeholders** within the SET Plan framework (industry, MS(s), research, etc.) were improved. For instance, according to JP CSP, there is a need for **higher involvement and funding efforts from MSs**, as well as **enhanced participation of industry** in the implementation of the developed innovations in commercial CSP plants. This EERA JP also advocates for more involvement in the elaboration of the SET Plan of the EERA JPs' members, with the aim of **aligning the needs of both European and national R&I funding programmes**.

Eventually, EERA JPs' members have expressed their support for the improvement of the **flexibility of both European and national strategies** and action plans' revision processes. To sum it all up, as done by JP PV, **more funding is needed** from EU and MSs' levels for energy research, and **better alignment between MSs and EUs'** and between all EU's funding schemes to achieve the SET Plan targets and the energy transition. Upstream of this alignment process, the JPs feel that technical goals should be defined by the industry and research stakeholders, as assembled within ETIPs and EERA JPs. Moreover, the EERA JP for Ocean Energy has called for a clearer, strategic agreement between the EC and MSs on their respective responsibilities in delivering the SET Plan.

Digging deeper into practical actions that could be implemented to increase the impact of the SET Plan and its contribution to the energy transition, EERA JPs' members were asked to provide with their ideas, which are displayed in **Table 4**. (**Question 4, Section 2** of the SUPEERA survey: "What type of actions should be implemented in order to establish a closer link between the SET Plan and other initiatives and programmes (e.g., European Partnerships, Programmes, National funding etc.)?" and **Question 6, Section 1** of the SUPEERA survey: "How could the broader R&I community better exploit the outcome/benefits of [*the SET Plan's*] added values?").

Quick-win ideas for actions and long-term levers to be implemented to enhance the impact of the SET Plan
Aligning EU and MSs' funding priorities and schemes and the SET Plan
• Aligning national funding programmes and priorities with the EU's, including the SET Plan, in terms of topics, time and rules, e.g. via a strategic agreement • Providing with more incentives for effective cooperation and funding within the SET Plan framework, e.g. via more co-funding of transnational research programmes • Encouraging a more direct dialogue between the R&I community and MSs in the definition-making process of R&I calls • Mobilising the same representatives from MSs in the SET Plan Steering Committee, Horizon Europe framework programme, and the CET Partnership • Appointing representatives for the ETIPs/JPs in the different energy R&I fora (e.g. IWGs) • Increasing the overall funding and investment supporting energy R&I activities

Improving the SET Plan's governance
• Establishing a closer monitoring from the EC on the SET Plan progress, leading to either promoting or fostering additional initiatives or actions when there is low or insufficient progress in achieving the targets • Reinforcing the participation, commitment and communication of the SET Plan contributing countries, and strengthening the involvement of all key stakeholders of the SET Plan • Transferring existing bilateral and multilateral R&I schemes into the SET-plan • Establishing follow-up Coordination and Support Action (CSA) calls to the benefit of the JPs/ETIPs, to support the delivering of the SET Plan IPs and foster the dialogue and cooperation between research and industry • Harmonizing the rules of management, funding, and opportunities allocation between SET Plan contributing countries within partnerships and joint actions • Structuring public consultation processes of the SET Plan stakeholders to allow for timely contributions from the energy R&I sector • Taking stock of EERA JPs' experience and feedback in gathering experts, and building on their structures to channel the SET Plan activities • Creating overarching SET Plan IPs covering multiple IWGs, such as advanced materials and integrated/hybrid energy production/storage technologies to further boost the inter-disciplinary and inter-sectoral collaborations of the SET Plan framework
Increasing energy research collaboration across the EU
• Identifying more practical and effective ways of collaboration between all stakeholders, at EU and national levels, building on the collaboration platform provided by the SET Plan • Defining common energy R&I priorities and roadmaps for 2025, 2030, 2040 and 2050 • Setting European Centres of Excellence where R&I, industry, the public sector and policy makers can define common strategies for further deployment, to be funded by EU, MSs and industry • Taking stock of the success stories of batteries implementation in Europe • Easing and promoting access to data between research and industry • Developing education and training of young people and companies • Including more SSH perspectives within European energy strategies and programmes, in order to contribute in bridging the gap between people and technology, develop knowledge on what it takes to foster the impact of innovation, and to implement technology to the benefit of society
Assigning the SET Plan and its stakeholders with more influence
• Consulting the SET Plan stakeholders and building on the SET Plan targets and priorities to define both European and national energy transition plans and policies • Making EERA JPs part of the SET Plan's strategies and implementation definition-process through the IWGs

***Table 4** – EERA JPs' answers to **Question 4, Section 2** of the SUPEERA survey*
""What type of actions should be implemented in order to establish a closer link between the SET Plan and other initiatives and programmes (e.g., European Partnerships, Programmes, National funding etc.)?"
*& EERA JPs' answers to **Question 6, Section 1** of the SUPEERA survey*
"How could the broader R&I community better exploit the outcome/benefits of [the SET Plan's] added values?"

Overall, the above actions are in line with the objectives set up by the EC in its revamping plan of the SET Plan for 2022, for being more politically visible, mission-oriented, and facilitate more connections between the SET Plan and other existing tools at European, national and local levels. The detailed list of recommendations can be found in Chapter V.

III EERA JOINT PROGRAMMES' CONTRIBUTION TO THE REPOWEREU PLAN

The recent geopolitical developments combined with an enduring energy price crisis have parked the necessity for further urgent and concerted actions in the EU on energy matters. The result is the Communication on "REPowerEU: Joint European Action for more affordable, secure and sustainable energy", aiming both at reducing the price pressure on EU citizens and businesses and minimizing the dependence on Russian gas, oil and coal. In its Communication document, the Commission sets the objective to detach from Russian fossil fuels well before 2030. The strategy to reach this goal is based on a number of actions, which were further detailed in a corresponding REPowerEU Plan.

While the identification of the short and mid-term R&I challenges triggered by the REPowerEU was object of series of targeted actions carried out by the EERA secretariat in April-May 2022, the SUPEERA project challenged EERA JPs' members to underline which are, in their opinion, the long-term (>5 years) R&I challenges that they would like to see integrated into the revised SET Plan IPs, (**Question 1, Section 3** of the SUPEERA survey). Their answers to that question have been coupled with those received in reply to the question: "Name the three main long-term challenges of the energy system that are expected to impact the R&I priorities in your technological field. Do you consider that some priorities that are currently addressed by the IPs are less relevant or soon to become obsolete?" (**Question 3, Section 1** of the SUPEERA survey), and displayed in **Table 5**.

Long-term challenges of the energy system expected to impact energy R&I priorities as identified by EERA JPs

Photovoltaics	Concentrated Solar Power	Wind Energy
• Adapting to the evolution and needs of the smart grid • Adopting a 100% recyclability for PV systems • Lowering the CO2 footprint and reducing the need of critical materials for the production of PV panels	• Reducing the current energy system's dependence on fossil fuels • Reducing CO2 emissions • Ensuring power supply to the grid when most needed	• Building an extensive offshore wind sector in Europe in all different seas • Integrating large amounts of offshore wind power into the energy system • Dedicating R&I efforts to address human capital and infrastructure needs • Support R&I actions for wind energy technologies, wind farms operating as power plants, wind power system integration, assessment of the environmental impacts, optimal use of space, infrastructure and grid development, and

		manufacturing, processing and circularity
Geothermal	**Ocean Energy**	**Smart Cities**
• Electrifying the heating system • Combining energy efficiency, renovation of buildings, smart heating distribution networks, heat storage options within the heating sector • Expanding and refurbishing (smart) district heating systems • Improving access to subsurface data on geothermal energy • Enlarging the scope of technologies under the focus of the REPowerEU strategy, and enhancing the ambitions for the heating sector • Supporting the integration of all renewables, including thermal ones, in the system • Supporting the heating market with adequate policies, as well as geothermal storage, in a circular economy approach	• System balancing with higher penetration of renewables • Addressing the acceleration of demand due to the current EU policies, and the pressure on supply chains and infrastructures • Addressing the competition for raw materials and the related increase of costs • Developing solutions for demand reduction through smart metering • Ensuring European energy integration and balancing Developing strategic skills and supply chain planning	-
Energy System Integration	**Smart Grids**	**EE for Industrial Processes**
• Developing designs for low-carbon energy markets that provide cost-effective security of supply, and integrates efficiently all types of flexibility at all system levels • Studying how should the networks for electricity and gas/hydrogen be developed over the coming decades, given their very long construction times, mutual interactions, the time it takes to develop a fully	• Addressing the issues related to system integration and the inclusion of e-mobility • Using effectively short and long-term ES technologies (e.g. batteries, hydrogen, etc.) and flexibility means to allow for higher penetration rates of renewables • Taking advantage of the digitalisation of the energy grid and “smartness” enabling for more flexible,	• Electrification and renewable electricity deployment • Ensuring resource efficiency and circularity • Ensuring coherence between EU, MS and local policies, market and funding frameworks • Addressing the social acceptance and engagement of the energy transition • Implementing BAT in industry, like e.g. efficient

renewable energy system and the need to maintain gas security of supply in the meantime • Defining the role that CCS and nuclear energy should play during and after the transition	reliable and robust power system operations • Supporting R&I actions for technological advancements in the energy sector in the shortest term possible • Facilitating the integration of other needed systems and technologies (e.g. solar, wind, storage, etc.) in a sector that has more ambitious decarbonisation targets	electrical motors driving pumps and compressors, implementing low temperature heat pumps in industry • Supporting R&D on technologies using electricity iso natural gas
Energy Storage	**Bioenergy**	**Carbon Capture and Storage**
• Ensuring materials availability • Supporting manufacturing of batteries with new chemistries • Supporting fundamental research activities in the energy sector • Developing characterization methodologies, techniques and tools • Supporting the integration of renewables and ES • Addressing the hybridization of ES technologies	• Taking advantage of bioenergy for flexibility and its green base load potential • Studying the potential of bioenergy for the production of hydrogen and synthetic fuels • Increasing significantly biomass gasification to biomethane (and hydrogen), in particular residual forest biomass • Supporting research and implementation of biomass crops in rotation (inter-cropping) and in marginal/abandoned lands • Integrating bioenergy/biofuels in the industrial sector to facilitate closing of productive circles, and enhancing the biorefineries concept • Assessing all biomass uses and roles	• Ensuring energy security • Developing energy system integration and provide with flexibility means • Adopting a circular economy approach
Nuclear Materials	**Adv. Materials & Processes**	**Digitalisation for Energy**
• Deploying small and medium-sized modular reactors • Deploying Gen. IV reactors	• Implementing carbon-neutral routes of materials • Considering the whole production and value chain of products	• Adopting a more human-centric approach • Addressing the digital gap • Deploying a distributed energy source sector

• Supporting nuclear strategies with adequate funding at EU/MS levels	• Addressing intermittency of renewable energy sources • Responding to global energy demand (amount and type) • Handling land-use and water-use • Adopting a circular economy approach with the growing share of RES being integrated to the system	• Taking advantage of digital solutions as key enables to achieve carbon neutrality • Supporting R&I actions in HPC, HTC/IoT, FAIR adoption, data science, AI, cybersecurity, blockchain technologies
Eco. Env. & Social Impacts	**Hydropower**	
• Assessing the sustainability of RES technologies in terms of environmental impact, economic feasibility and dynamics and effects on social equity • Adopting a systemic approach aimed at exploring interactions among the different components of the energy systems (actors, technologies, policies) and their interactions within other social subsystems (e.g. market and the whole economy, welfare, transport, education…) • Studying energy poverty, both for improving its definition and measurements and to mitigate the social effect of the transition • Analysing energy demand, in order to investigate its generative mechanism, to better qualify the demand profile (not only how much but how and why energy is consumed) and to identify dynamics and strategies for its reduction	• Supporting targeted research on new hydropower technology • Supporting R&I actions related to hydropower technologies, power markets and market flexibility • Addressing the impacts and potential of bioenergy for ES, decarbonisation, biodiversity, water availability, and digitalisation • Supporting the role of hydropower in storing water and electricity, enlarging existing storing capacities • Looking more carefully at the role of hydropower in producing hydrogen, and its complementarity with other renewable energy sources	

***Table 5** – EERA JPs' answers to **Question 3, Section 1** of the SUPEERA survey*
"Name the three main long-term challenges of the energy system that are expected to impact the R&I priorities in your technological field. Do you consider that some priorities that are currently addressed by the IPs are less relevant or soon to become obsolete?"
*& EERA JPs' answers to **Question 1, Section 3** of the SUPEERA survey*
"Given the strategic importance of the recent EC communication on the REPowerEU plan, what are in your opinion the long-term (>5 years) R&I challenges that you would like to see integrated into the revised SET Plan IPs?"

In order to free EU from its energy dependency to third countries and to secure its energy autonomy, the EERA community has therefore identified several challenges arising from REPowerEU that should be more emphasized within the SET Plan framework and its IPs. These challenges are very much in line with the long-term challenges related to the SET Plan itself.

IV CONTRIBUTION TO THE REVAMP OF THE SET PLAN FROM THE EUROPEAN TECHNOLOGY AND INNOVATION PLATFORMS (ETIPs) AND OTHER STAKEHOLDERS

4.1 ETIPs contribution to the survey

As one of the main pillars of the SET Plan, the European Technology and Innovation Platforms (ETIPs) play a crucial role at bringing together industry and researchers in key technology areas. Therefore, their perspective on the current effectiveness and the revamping process of the SET Plan is essential. In that regard, SUPEERA partners conducted a second round of surveys with representatives from the ETIPs. The content of the survey's that were sent to the ETIPs were a discounted version of the one that was circulated to the JPs – aiming to collect a harmonised and comparable feedback. The responses of the surveys were collected between 16 May and 26 June, while all inputs were discussed with the ETIP coordinators during the ETIP Forum meeting that took place on 23 May 2022 at EERA premises in Brussels. In total, the survey was filled in by 6 out of the 11 ETIPs, while the ETIP Forum meeting was attended by 10 out of 11 ETIP coordinators. For practical reasons, in the following chapters, the responses from the surveys have been consolidated with the input received during the ETIP forum meeting and categorised in a similar fashion like the ones from the EERA JPs in Chapter II. The detailed responses to the survey from the ETIPs can be found in ANNEX 5.

4.2 Added value of the SET Plan as perceived by ETIPs

The perceived added value of the SET Plan as recognised by the ETIPs was mainly communicated during the ETIP Forum meeting and in a less extent manner then via survey. Overall, ETIPs widely recognise the SET Plan as the only collaboration mechanism between MS/ACs in low carbon technologies. The established communication channels via the IWGs provide unique collaboration opportunities between different stakeholders, despite their high potential for considerable improvements. In fact, according to the ETIPs, these opportunities have not been fully exploited, rating rather low the impact of the SET Plan in providing a collaborative mechanism for the execution of the ETIPs' SRIAs (see **Figure 5** below).

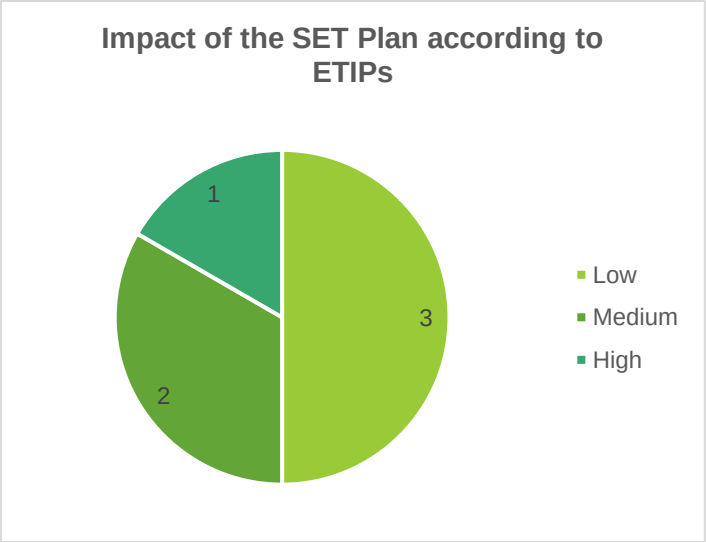


***Figure 5** - ETIP's answers to **Question 2, Section 2** of the SUPEERA survey "How would you rate the SET Plan impact in providing a collaborative mechanism (e.g., networking, funding, platforms et sim.) for the execution of the SRIAs?"*

In comparison with EERA JPs

The majority of both ETIPs and JPs agree that the impact of the SET Plan to provide a collaborative mechanism for the execution of the SRIAs (and DoW) is rather low, while more JPs than ETIPs are perceiving this impact to be high.

4.3 Defining the SET Plan of the future based on the experience of ETIPs and other stakeholders

4.3.1 Structural obstacles and barriers identified as preventing the SET Plan to play its role

Similar to the section 2.3.1 where JPs were asked several questions about the obstacles and barriers that have to be overcome within the SET Plan framework, the first question to ETIPs was about the incorporation of the their SRIA into the existing Implementation Plan of the respective IWG (**Question 1, Section 1** of the SUPEERA survey). As indicated in Figure 6, the majority of the ETIPs are well satisfied with the incorporation of their SRIA into the respective IP.

In comparison with EERA JPs

The majority of ETIPs consider their SRIAs to be well integrated into the IPs of the IWGs, while less than the half of the EERA JPs share the same view. Both ETIPs and JPs agree that there are several R&I topics that are not included in the IPs.

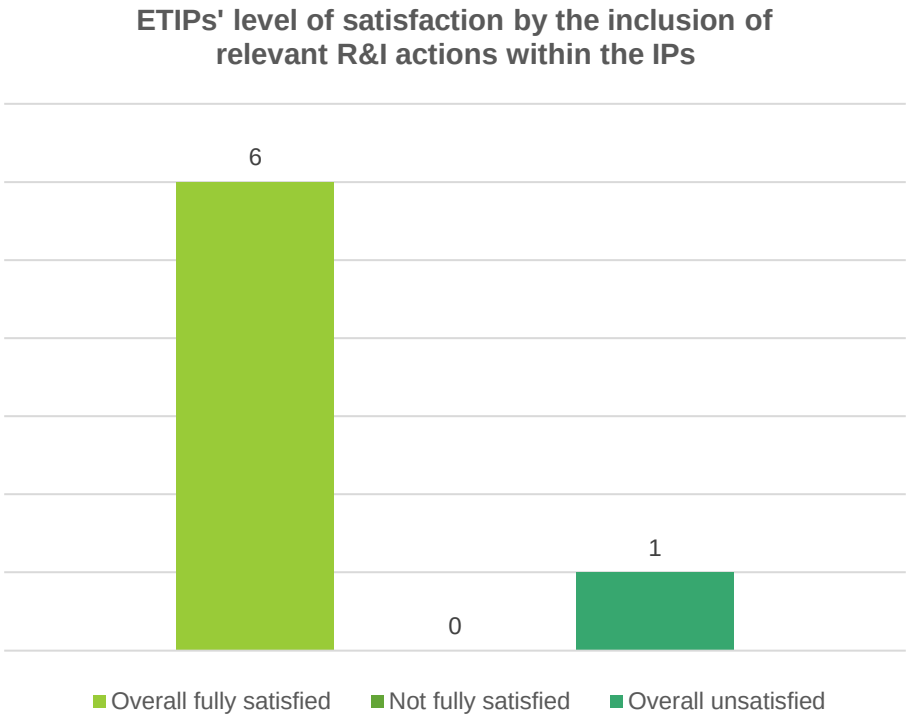


***Figure 6** - ETIP's answers to **Question 1, Section 1** of the SUPEERA survey "To which extent do you consider that your ETIPs' SRIA (or equivalent) is incorporated into the existing Implementation Plans of the respective IWG?"*

Regarding the non-technological and cross-thematic areas (**Question 3, Section 1** of the SUPEERA survey: "To the already existing technological and cross-thematic areas which non-technological topics should be addressed by one or more IPs?") ETIP representatives - similar to the respective question for the JPs - were requested to prioritise three areas among the following: the role of social engagement, policy and regulation, education and training, standardisation, socio-economic policies, international cooperation, and a closer connection between the SET Plan R&I activities and R&I funding programmes. **Figure 7** below, displays the selected non-technological topics according to their occurrence in ETIPs feedback, as well as their prioritisation in their views. ETIPs agree that it is a priority for the IPs to address issues related to policy & regulation and education & training, followed by social awareness, acceptance and engagement. Though, the areas of R&I funding programmes, standardisation and socio-economic policies should not be overlooked.

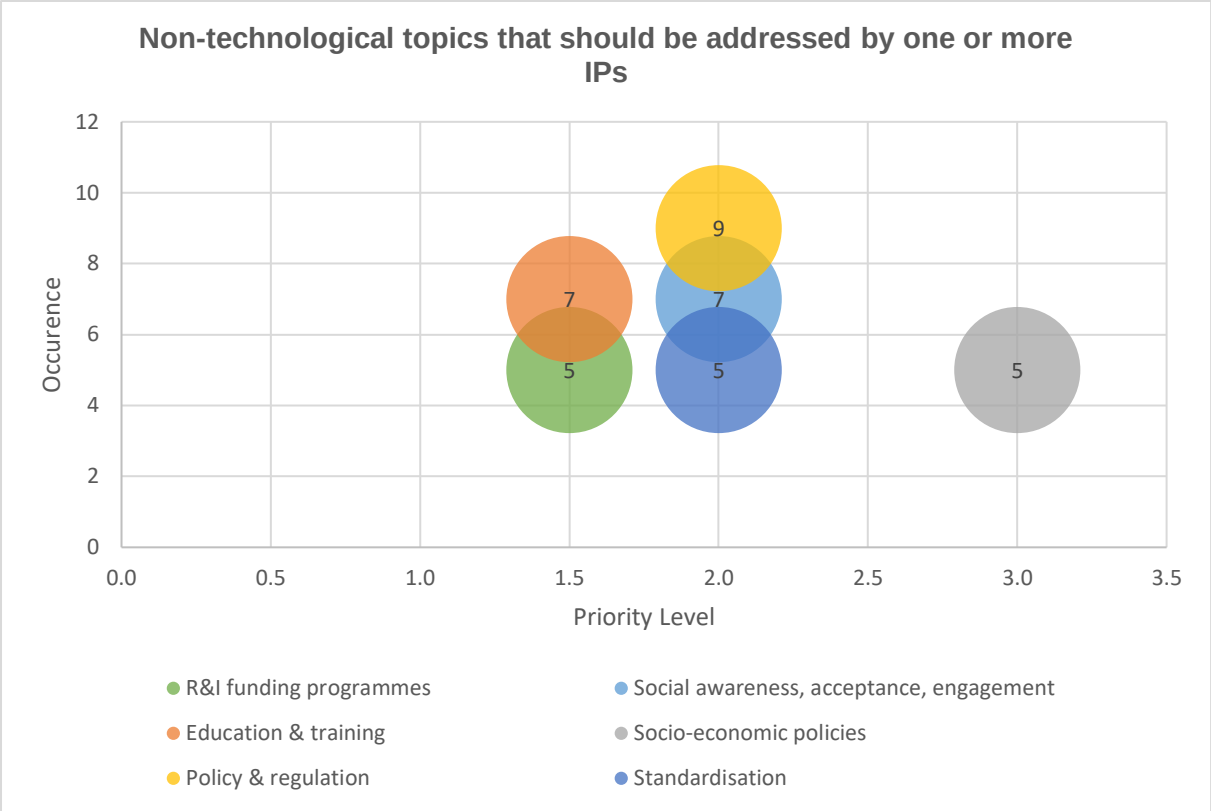


***Figure 7** - ETIPs' answers to **Question 4, Section 1** of the SUPEERA survey*
"To the already existing technological and cross-thematic areas (i.e. energy efficiency, digitalisation etc.), which non-technological topics should be addressed by one or more IPs?"

In comparison with EERA JPs
There is a consensus between JPs and ETIPs that the non-technological and cross-thematic areas that should be addressed by the IPs are the following:

- *Policy & regulation*
- *Social awareness, acceptance and engagement*
- *Education & training*

As far as the perceived structural barriers preventing the SET Plan as a whole to play its role in the energy transition and the development of each technology field, ETIPs' representatives provided answers both via the questionnaire (**Question 2, Section 1** of the SUPEERA survey: "Please, indicate at least three barriers and obstacles that prevent the smooth integration of ETIP's priorities into respective Implementation Plan") and during the ETIP Forum meeting. Their answers are shown on

Barriers and obstacles to the smooth execution of EU energy R&I objectives identified by ETIPs

ETIP Photovoltaic	ETIP Wind	ETIP Deep Geothermal

• Need for a higher level of engagement by MS representatives. • Need for direct communication between ETIPs and Steering Group members. • Need for better communication between ETIPs and the EC (e.g. in the form of a side event during the SET Plan conference).	• Need for a better alignment of IPs with the European policy ambitions and the NECPs.	• Need for a better definition of roles between the different agencies: Too many agencies are dealing with the same themes and often there is an overlapping of competencies.
ETIP Ocean Energy	**ETIP Smart Networks for Energy Transition (SNET)**	**ETIP Renewable Heating and Cooling**
• Need of better integration of the SET Plan to national and EU policies & priorities.	• Need for better coordination between SET Plan stakeholders, efficient and continuous information exchange, and direct communication links among all SET Plan stakeholders (ETIPs, MS/ACs, JPs etc.). • Need of technical expertise within the SET Plan Action 4 to translate technology-specific challenges to concrete R&I actions.	• Need for a dedicated IWG, as at the moment is linked to IWG5 under action 5.2 on Cross cutting heating and cooling technologies for buildings. However, the scope of renewable heating and cooling technologies go beyond the scope of buildings. This results to underrepresented technologies and the partial exclusion of ETIP SRIA priorities to the IWG5 IP.
ETIP Batteries	**ETIP Bioenergy**	**ETIP CCS – zero emission platform**
• Need for better collaboration between ETIPs (e.g. sharing activities, timelines etc.)	• Need for closer collaboration with the national funding agencies.	

ETIP Sustainable Nuclear Energy (SNETP)	**ETIP Hydropower**
• Need for better collaboration with the other ETIPs is needed, especially on cross-cutting activities. • Need for more resources and long-term vision both at the MS and EC levels. • Need for not siloed approach of EU energy strategy and utilisation of all available tools to reach the net-zero goals.	• Need for more clarity on the SET Plan structure and the roles of the different actors.

• Need for better coordination between the decision makers within the EC.	

Table 66. The perceived obstacles are mainly related to the need for better collaboration between the different SET Plan entities, and better coordination between stakeholders at national and EU level.

Barriers and obstacles to the smooth execution of EU energy R&I objectives identified by ETIPs

ETIP Photovoltaic	ETIP Wind	ETIP Deep Geothermal
• Need for a higher level of engagement by MS representatives. • Need for direct communication between ETIPs and Steering Group members. • Need for better communication between ETIPs and the EC (e.g. in the form of a side event during the SET Plan conference).	• Need for a better alignment of IPs with the European policy ambitions and the NECPs.	• Need for a better definition of roles between the different agencies: Too many agencies are dealing with the same themes and often there is an overlapping of competencies.
ETIP Ocean Energy	**ETIP Smart Networks for Energy Transition (SNET)**	**ETIP Renewable Heating and Cooling**
• Need of better integration of the SET Plan to national and EU policies & priorities.	• Need for better coordination between SET Plan stakeholders, efficient and continuous information exchange, and direct communication links among all SET Plan stakeholders (ETIPs, MS/ACs, JPs etc.). • Need of technical expertise within the SET Plan Action 4 to translate technology-specific challenges to concrete R&I actions.	• Need for a dedicated IWG, as at the moment is linked to IWG5 under action 5.2 on Cross cutting heating and cooling technologies for buildings. However, the scope of renewable heating and cooling technologies go beyond the scope of buildings. This results to underrepresented technologies and the partial exclusion of ETIP SRIA priorities to the IWG5 IP.
ETIP Batteries	**ETIP Bioenergy**	**ETIP CCS – zero emission platform**

• Need for better collaboration between ETIPs (e.g. sharing activities, timelines etc.)	• Need for closer collaboration with the national funding agencies.	
ETIP Sustainable Nuclear Energy (SNETP)	**ETIP Hydropower**	
• Need for better collaboration with the other ETIPs is needed, especially on cross-cutting activities. • Need for more resources and long-term vision both at the MS and EC levels. • Need for not siloed approach of EU energy strategy and utilisation of all available tools to reach the net-zero goals. • Need for better coordination between the decision makers within the EC.	• Need for more clarity on the SET Plan structure and the roles of the different actors.	

***Table 6** – ETIPs' answers to **Question 2, Section 1** of the SUPEERA survey "Indicate at least three barriers and obstacles that prevent the smooth integration of ETIP's priorities into respective Implementation Plan"*

In the following question, they were asked to list three of the most important overarching strategic objectives that should be covered by the SET Plan. The received responses are categorised in **Table 7**7.

Overarching strategic objectives and targets for the energy sector identified by ETIPs

ETIP Photovoltaic	ETIP Wind	ETIP Deep Geothermal
		• Electrification of domestic and industrial users through the implementation of heat pumps (geothermal). • Installing new renewable energy capacity.
ETIP Ocean Energy	**ETIP Smart Networks for Energy Transition (SNET)**	**ETIP Renewable Heating and Cooling**
	• Chemical storage technologies and P2X (e.g. H2): Improve efficiency and costs. • Thermal storage technologies: improve energy density, cost and lifetime at different working temperature. • Pump hydropower: Development of small-	• 2030 RED target of 40% RES share for heating must be a priority. H&C accounts for half of all energy consumption and continues to be neglected. This target (and sub-targets) covers a wide range of technologies. • Highly energy-efficient and climate neutral EU building stock":

	scale solutions and marine solutions, reduction of time for deployments.	a) “Accelerated fuel switch fuel from gas to RHC in buildings” b) “Accelerated fuel switch fuel in District heating and cooling systems”“ 3) “Switch fuel in industry: H&C supply for low- and medium-temperature processes”
ETIP Batteries	**ETIP Bioenergy**	**ETIP CCS – zero emission platform**
• Skills and education: Attract the most prominent experts from all value chain with a focus on domains recently emerging, notably recycling and manufacturing. • New thematic areas: Bring new thematic areas, facilitated by the creation of new Task Forces (such as Social Science & Humanities, Standardization and Hybridization), as well as strengthening the effort on current critical domains: Digitalization among all. • International cooperation: Facilitate the establishment of a dialogue at a global level around selected topics to influence the international battery agenda with EU priorities and values. Citizens’ Engagement: citizens and stakeholders and promote STEM disciplines to push societal transformation towards a climate neutral economy.		
ETIP Sustainable Nuclear Energy (SNETP)		**ETIP Hydropower**

• Nuclear R&D&I develops cutting-edge knowledge that may be beneficial to several other sectors, such as health, aerospace, digital etc. • Other cutting-edge technologies such as artificial intelligence for example could be used in nuclear technology (e.g. for design and maintenance of nuclear facilities). • SNETP intends to promote those cross-sectorial benefits in its R&D&I programme. • Cross-sectorial industrial cooperation between electricity, heat, hydrogen generation and energy intensive sectors will be a key element to drive success.	

***Table 7** – ETIPs' answers to **Question 1, Section 2** of the SUPEERA survey "In addition to specific ETIP's priorities, which in your understanding are the most important overarching strategic objectives and targets per technology that should be covered/included in the SET Plan?*

4.3.2 SET Plan in the future: feedback and perspectives as identified by EERA JPs

Complementing the opinion of JPs on what effective actions could be taken to improve the impact of the SET Plan, (see paragraph 2.3.2), ETIP representatives were requested to provide their view on this topic. Their feedback was based on the relevant question of the SUPEERA survey (**Question 3, Section 2** of the SUPEERA survey: "Which actions would you consider as more effective to improve the impact of the [SET Plan]?") and inputs received during the ETIP Forum meeting.

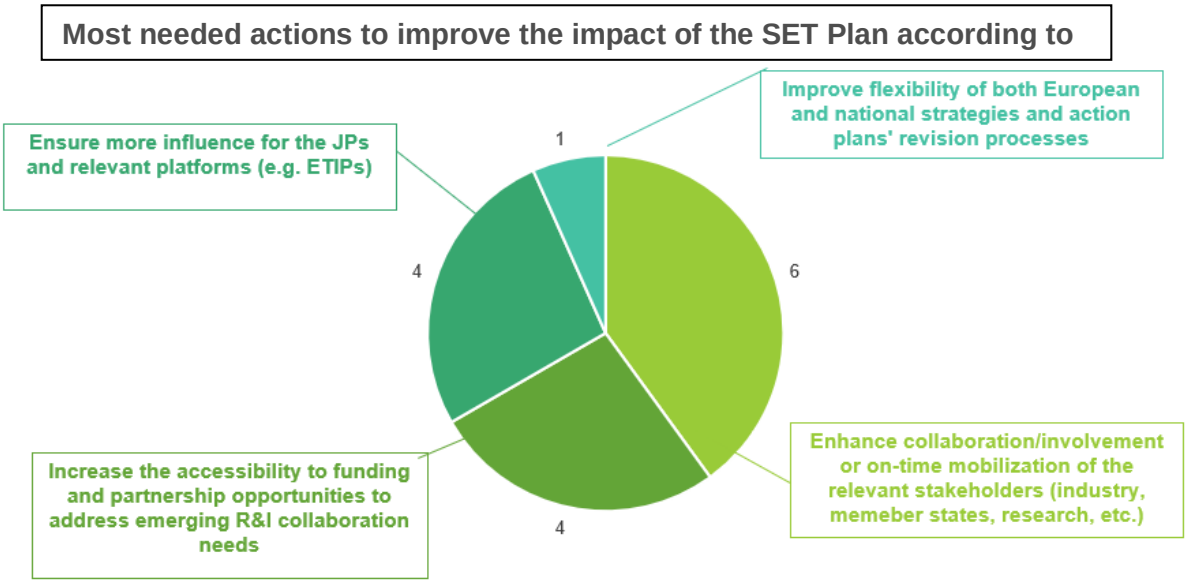


***Figure 8** - ETIPs' answers to **Question 3, Section 2** of the SUPEERA survey "Which actions would you consider as more effective to improve the impact of the [SET Plan]?"*

As shown in **Figure 8**, the enhancement of collaboration or on-time mobilization of the relevant stakeholders (industry, MS, research etc.) was noted as the needed action to improve the impact of the SET Plan. This opinion was widely voiced from several ETIP representatives during the ETIP Forum meeting. ETIP Bioenergy underlined the importance of **collaboration between ETIPs and national funding agencies**, especially since the current collaboration scheme does not allow for an efficient **acknowledgment of ETIP's SRIA by policy makers**. In the same note, ETIP PV mentioned that **higher engagement from MS/ACs representatives** would enable a more efficient workstream, recommending that a new SET Plan structure should foresee a **better communication channel between ETIPs and the Steering Group members** (this was also remarked in the *D1.2. – Second interim report on the state of play of the SET Plan IPs and mapping of R&I activities)*. This view was also expressed by ETIP SNET, asking for more engagement from the MS/ACs side. Moreover, they highlighted the need for **closer collaboration between the ETIPs and the EC** – proposing that this collaboration could possibly materialise through a side event during the SET Plan conference with the participation of all ETIPs representatives. Lastly, there was a consensus among ETIPs that **closer and more frequent collaboration between ETIPs** is needed, with ETIP SNETP mentioning the need to **address collectively cross-cutting challenges** and ETIP Batteries expressing the need for a forum to share experience, best practices and receive feedback from each other.

According to ETIPs, one of the second most effective actions to improve the SET Plan impact is the increased **accessibility to funding and partnership opportunities** to address emerging R&I collaboration needs. As noted by the ETIP RCH, renewable heating and cooling technologies must significantly increase the next years (also in face of current energy crisis) and the allocated funding should allow for the development of several actions to switch fuels and at different TRLs.

Increasing the influence of relevant platforms (e.g. JPs, ETIPs, NRCGs) was also seen as a solution to improve the impact of the SET Plan (voted as second most effective action), mentioning that increased influence in the governance of the SET Plan would improve coordination and alignment between different entities, while it was suggested that the strategy adopted for the ETIP Batteries should be replicated to other across SET Plan. Additionally, ETIP Batteries suggested to **assign the role of observer to the ETIPs and JPs** to ensure a continued dialogue with the SET Plan's main stakeholders.

Other important suggestions that were mainly expressed during the ETIP Forum meeting suggested that **the IPs should be in alignment with the NECPs**, and the SET Plan should be the instrument to support delivering the European policy ambitions and climate objectives of 2030 and 2050. In that extent, the **SET Plan should be more politically visible** and be seen as such by the national governments.

In comparison with EERA JPs

- *Increasing accessibility to funding and partnership opportunities to address emerging R&I needs is considered as the most needed action for the JPs, while for ETIPs the second most important one.*
- *Ensuring more influence for the relevant platforms (JPs, ETIPs, NRCG) is the second most important action for JPs, while it comes on the second place on ETIPs' priorities.*
- *Enhancing collaboration or on-time mobilization of relevant stakeholders is deemed as the most important action for ETIPs, while it comes third on the JPs priorities.*

4.4. ETIPs' contribution to the REPowerEU Plan

Following the response of the JPs (see Chapter III) regarding the long-term R&I challenges that should be included into the revised SET Plan IPs in the light of the REPowerEU communication, ETIPs also provided their view to this topic. Their answers can be seen in the **Table 8** below.

Long-term challenges (>5 years) of the energy system expected to impact energy R&I priorities (in relation to the EC communication on the REPowerEU plan) as identified by ETIPs

IP Photovoltaic	ETIP Wind	ETIP Deep Geothermal
		• Building infrastructures for electric mobility and renewable energy utilisation (including geothermal energy).
ETIP Ocean Energy	**ETIP Smart Networks for Energy Transition (SNET)**	**ETIP Renewable Heating and Cooling**
• Reaching 1 GW of installed ocean energy capacity by 2030	• Doubling EU's photovoltaic and wind capacities. • Accelerating the rollout of rooftop PV systems.	• Meeting winter heating demands in the absence of Russian gas together with the development and scale up of alternative, low-carbon heating solutions. • Boosting resilient and renewable technologies and sector coupling to

	Overcoming the barriers that energy storage and conversion technologies are facing and enable a rapid and effective penetration of renewable energy and the decarbonisation of energy-intensive industries.	reduce dependence from fossil fuels across several heating and cooling intensive sectors, ensuring that: - 100% of new and refurbished H&C installations in buildings are with RHC technologies. - 100% of new low to medium temperature industrial processes are with RHC. • - 100% of new H&C systems in the agri-food industry are with RHC.
ETIP Batteries	**ETIP Bioenergy**	**ETIP CCS – zero emission platform**
The long term challenges on electrochemical storage as key enabler of RES efficient use. In the long term, R&I community has to provide new concept of batteries, more cost effective or more integrated into the use (i.e. in the "zero emission houses"). Important keywords will be flexibility, interoperability, hybridization (on energy storage (ES) technologies) and sustainability. Another important aspect will be digitalization at all level: from research data management to digital tools enabling the efficient integration of RES and ES in the grid.		
ETIP Sustainable Nuclear Energy (SNETP)		**ETIP Hydropower**
Striking the right balance between nuclear energy and renewables to ensure security of supply, energy autonomy and high production of low-carbon hydrogen.		

***Table 8** - ETIPs' answers to **Question 1, Section 3** of the SUPEERA survey "Given the strategic importance of the recent EC communication on the REPowerEU plan, what are in your opinion the long-term (>5 years) R&I challenges that you would like to see integrated into the revised SET Plan IPs?"*

4.5. ETIPs' preliminary recommendations for the revamp of the SET Plan

The views expressed by ETIPs' coordinators based both on the SUPEERA survey (see ANNEX 5) and the outcome of the ETIP Forum meeting, are reflected in the following 9 preliminary recommendations. These recommendations will be subject to discussions and approval by all ETIPs and will be communicated with the relevant EC officials in the near future.

1. Implementation Plans and SRIA's should be more impactful documents and be taken into account by all involved actors.
2. Closer collaboration and alignment of priorities between national funding agencies (IWGs) and industry (ETIPs) is needed.
3. The revamped SET Plan should be in alignment with the recent policy developments, and it should be uniformly integrated into the NECPs (The IP of the IWGs should be in line with the priorities set out at the NECPs).
4. The revamped structure of the SET Plan should foresee the collaboration between ETIPs and the Steering Group members (something that is currently missing in the present structure of the SET Plan).
5. The revamped structure of the SET Plan should be simpler and clearer with clear roles and responsibilities of all involved actors.
6. A closer communication between ETIPs and EC is needed. It could materialise in the form of a side event during the SET Plan conference where all ETIPs can discuss with the EC.
7. The ETIP Forum could be a platform for collaboration between the different ETIPs and a tool for sharing experiences and best practices (sharing information on the activities and the timeline of each ETIP would enable more effective interactions between ETIPs).
8. More collaboration on cross-cutting activities is needed between different IWGs.
9. Lack of expertise in the IWGs to translate technology specific challenges into specific innovation and R&I objectives (ETIP SNET specific).

4.6 Added value of the SET Plan as perceived by other stakeholders

As seen in the previous chapters, the ETIPs and EERA's JPs are essential parts of the SET Plan structure, representing the most important low-carbon technologies and bringing together a wide range of stakeholders. While there is a consensus among stakeholders that the current technology-based structure of the SET Plan should be revised to adopt a more holistic approach towards the energy transition, at the same time, some emerging and potentially crucial technologies are currently underrepresented in the SET Plan. For this reason, the current report has included the views of two of these stakeholders, in the domain of solar fuels and chemicals, and hydropower.

4.6.1 Inputs from SUNERGY/SUNER-C EU funded project

SUNERGY is an initiative building upon the ENERGY-X & SUNRISE EU funded projects, while it will be supported by the recently funded SUNER-C project. It aims at becoming a large European R&I initiative working towards the conversion and storage of renewable energy into fossil-free fuels and chemicals. The SUNER-C supporting action will enable SUNERGY to create an innovation ecosystem for solar fuels and chemicals, develop a roadmap and prepare for a large-scale R&I initiative on solar fuels and chemicals. The most important key messages that SUNERGY aims to convey to policy makers in respect to the revamp of the SET Plan are summarised below, while the full report can be found in ANNEX 6.

Currently a dedicated area for Solar Fuels and Chemicals is absent in the SET Plan. Some priorities of this domain are addressed by some relevant IWGs (e.g. CCU, Renewable fuels and bioenergy etc.), but they exclude important topics. For instance, “Renewable fuels and bioenergy”, are focused solely on biofuels and bioenergy, excluding synthetic, solar and electrofuels. Also, the technological scalability, readiness level, and dependence on infrastructures are different for biofuels and solar fuels, which creates a gap in the energy and policy landscape which is important to bridge. To this end, the SET Plan strategy and priorities on solar energy should embrace a portfolio of technology solutions, besides the more established ones which are already included in the IPs of existing IWGs (e.g. PV, CSP).

There is an insufficient recognition of Solar Fuels and Chemicals and their potential in the short/medium and longer-term alike. Therefore, R&I actions on Solar Fuels and Chemicals should be included in the revised SET Plan as an important asset to unlock and maximise the potential of solar energy.

Conversion and storage of solar energy into Solar Fuels and Chemicals should be considered as complementary - and not in competition - to more established solar technologies (e.g. solar PV, CSP, biofuels). This is in line with supporting technology integration within the energy system to achieving the Green Deal objectives, including Europe’s energy security and independence. Converting solar energy into fuels and chemicals is imperative to minimize dependence on natural gas.

4.6.2 Inputs from Hydropower community

Several stakeholders across Europe, active in the domain of hydropower highlight its important role as a catalyst and facilitator for the clean, safe and independent energy transition in Europe. Their argumentation is presented in a position paper that has been duly communicated with the relevant policy makers and SET Plan officials. The position paper is drafted and signed by Hydropower Europe, International Hydropower Association (IHA), IEA Hydropower TCP and EERA Joint Programme Hydropower, while it is expected to be endorsed by other industry stakeholders in the near future. The most important key messages of the position paper are summarised below, while the full document can be found in ANNEX 7.

- Given Europe's ambition to raise the 45% hydropower is critical to ensure Europe's energy system has the necessary renewable electricity and flexibility to protect grid stability from intermittent renewable energy, to sustain the green transition.
- To ensure there is enough hydropower to meet Europe's decarbonization goals and maintain energy security, hydropower must have a prominent role within the Strategic Energy Technology (SET) Plan.
- More funding is needed in R&I to deploy solutions at the scale required in support of sustainable solutions that offer win-win situations for the environment and from an operational perspective.
- The newly established ETIP will serve as the basis for collaboration between stakeholders on hydropower and increase their visibility within the SET Plan.

V HIGH LEVEL AND OPERATIONAL RECOMMENDATIONS ON THE FUTURE OF THE SET PLAN

Following the information presented in the previous chapters, reflecting *inter alia* on EERA's consolidated expertise accumulated through the direct execution of the SET Plan, the aim of this chapter is to provide recommendations for the revamping process of the SET Plan at the disposal of the EC officials and relevant policy makers involved in it. The recommendations consist of two parts: the first part includes **high level recommendations** which are aligned with EERA's strategic role in the SET Plan and in the CET and aim to suggest improvements both on its content and governance structure at high level. The second part of the recommendations is based on the aggregated knowledge of the EERA Joint Programmes from their actual, practical, involvement in the execution of the SET Plan, which was collected via the SUPEERA survey and the JP Coordinators' meeting (17-18 May 2022). It aims to provide a set of **operational recommendations** categorised by overarching objectives. Both set of recommendations are summarised in **Table 9** on page 51.

5.1 EERA - High Level recommendations

EERA is committed to address the revamp of the EC SET Plan in a way that will allow for a fast-track implementation of the CET in the new political context, with particular reference to the priorities highlighted in the EC relevant strategies and policies (EGD, Fit-4-55, the recently published REPowerEU action plan, et sim). Against this backdrop and building also on the several actions already undertaken in this context both at internal and vis-à-vis the EC and other external stakeholders' level, EERA wishes to put forward the following high-level recommendations to further inform this most topical exercise.

5.1.1 Revamp of the SET Plan – Content-related recommendations

1. **A new mission-focused approach centred on cross-cutting collaboration**

EERA believes that the revamped SET Plan should be reshaped along the lines of a mission-focused approach based on cross-cutting collaboration to deliver effectively on the short-, medium- and long-term energy priorities. Missions should be organised along the lines of "Energy Transition Pathways" detailing concrete short-term objectives (e.g., connected to the REPowerEU Action Plan) as well as medium- to long-term ones (e.g., linked to the EU climate-neutrality goals 2030-2050). In addition, they should include systemic considerations, for example, those stemming from SSH and those understanding the energy system as a whole across sectors and energy vectors. This approach would enable a closer and much-needed collaboration across Industry (ETIPs), MS/ACs (IWG) and research (EERA JP) and allow to break away from the initial silos-based structure of the SET Plan to ensure increased speed of performance and enhanced impact.

2. **NECPs as a concrete tool for better communication between EU and MS**

National Energy and Climate Plans (NECPs) constitute an essential link between EU goals and the combined efforts of the MS/ACs, and their next revision is currently scheduled for spring 2023. It is crucial that revised Plans are coherent with the redefined high-level SET Plan objectives of climate-neutrality and that support the deployment of the low carbon technologies across Europe. To this end, each NECP should be more prescriptive in describing the foreseen energy–climate measures and policies to be implemented over this period to reach the proposed national targets.
In addition, states traditionally more focused on the high TRL scale would greatly benefit from increased integration and focus on the R&I and the policies linked to low TRLs. If expanded along these lines, the SET Plan community and management could be better positioned to push for an even closer cooperation between MS/ACs active in their respective sectors.

3. **Increased effectiveness in the on-boarding of EU13 countries**

Despite a series of ad hoc measures, the overall participation of EU13 countries in the SET Plan and framework programmes is highly contrasting compared to the EU14 and, in some cases, very low. This situation thereby creates substantial imbalances in the deployment of new low carbon technologies, leading to different levels of societal acceptance and preventing a harmonised achievement of 2030 and 2050 climate-neutrality goals across Europe. The revamped SET Plan needs to address these shortcomings by foreseeing both long-term structural approach and tailor-made mechanisms to foster dialogue among the different research institutions in the EU. All while making the mutual benefits connected to increased participation of EU13 countries in the SET Plan and EC framework programmes more explicit.

5.1.2 Revamp of the SET Plan – Governance-related considerations

4. **EERA as a strategic pillar of the revamped SET Plan**

The SET Plan constitutes a unique and strategic platform for increased EU joint programming, which is of utmost importance for the EU to deliver on the Green Deal by consolidating its leadership in key industries of the future, and successfully driving its transition towards climate neutrality. To deliver on these objectives and considering the urgency brought forward by the very recent geopolitical developments, it will be crucial not only to maintain EERA as the formal research pillar of the revamped SET Plan, but also to place it in a strategic position to facilitate continued dialogue with the SET Plan's main stakeholders. This can be achieved by envisaging for EERA, for example, an observer role to the Steering Committee in the revamped governance structure. This assignment would first and foremost constitute a natural acknowledgement of the work carried out by EERA throughout these years as a key actor in the translation of the CET imperatives into the EU R&I agenda. It will also allow for MS/AC's energy research priorities to be taken into account in a more timely and effective manner.

In addition to this formal recognition, we would welcome the opening of dialogue to agree on a set of expectations linked to this role (even if not detailed, at a functional level). This would

help focus on what the EU and MS/ACs alike envisage to harness from EERA's potential and constitute a reference for SET Plan stakeholders. Such acknowledgement will provide the EERA community with tangible support and the required legitimacy for taking initiatives.

5. **Use instruments both for the execution of the SET Plan and the support to the IWGs and ETIPs**

The revamped SET Plan should allow for more and better designed public support for energy technology R&I that facilitates the execution of the IPs. This would permit a more efficient alignment of available European, national, trans-national and regional funding instruments and would support the coordination of the industrial stakeholders in the SET Plan, in particular from the ETIPs.
On one side, the funding schemes for the execution of the SET Plan (preferably structured upon best practices of ECRIA, IRP, or ERANET co-funds) should be structured as "mission type" projects with a clear goal aiming for a quantified impact and flexible concerning the type of co-funding.
On the other side, IWGs and ETIPs should continue to be supported by CSAs (or similar instruments), which have demonstrated to be crucial in the coordination between research community, industry and MS/ACs. Actively initiating arenas for close dialogue between stakeholders is part of the new EERA strategy to increase the impact of its JPs. Therefore, CSAs requiring these actions will provide the EERA JPs with the resources needed as they will draw on available in-kind contributions in terms of committed resources and membership fee funding.

5.2 SUPEERA - Operational recommendations

Capitalising on the EERA members' experience as well as the broader SET Plan community's which have voluntarily contributed to this report, SUPEERA partners have produced the following set of concrete operational recommendations – clustered along four objectives- aiming at defining a more efficient, politically visible, mission-oriented SET Plan framework:

- **Objective 1**: Aligning EU and MS/ACs' funding priorities and schemes and the SET Plan
    - **Recommendation 1**: Mobilising the same representatives from MS/ACs in the SET Plan Steering Committee, the Horizon Europe framework programme, and the CET Partnership governance
    - **Recommendation 2**: Harmonizing the rules of management, funding, and opportunities allocation between SET Plan contributing countries within partnerships and other joint actions
    - **Recommendation 3**: Including new technological and non-technological R&I actions into the SET Plan: social awareness, acceptance and engagement, education and training, R&I funding programmes, policy regulations and international collaboration. This inclusion should be also reflected in the structuring of the future IWGs way of work .

- **Objective 2**: Improving the SET Plan's governance
    - **Recommendation 4**: The future SET Plan should be endorsed with more political strength in order to facilitate the translation of EC actions into nationals R&I agendas. Towards this objective, the key players should assume more accountability in the entire process (for instance, detailed roles and responsibilities might be defined by ToRs).
    - **Recommendation 5**: Assure follow-up CSA calls to support the delivering of the SET Plan IPs and foster the dialogue between research and industry

- **Objective 3**: Increasing energy research collaboration across the EU
    - **Recommendation 6**: Easing and promoting access to data between research and industry
    - **Recommendation 7**: Setting European Centres of Excellence or other joint energy R&I framework where R&I, industry, the public sector and policy makers can define common strategies for further development, to be funded by EU, MS/ACs and industry
    - **Recommendation 8**: Following "Batteries Europe" successful example of collaboration between ETIPs, JPs, CSAs, partnerships, etc.

- **Objective 4**: Assigning the SET Plan and its stakeholders with more influence
    - **Recommendation 9**: Building on EERA's JPs to collect the needed scientific input for energy policymaking and R&I funding frameworks definition (for example, by assessing the execution of the revised SET Plan or CET-P SRIA)
    - **Recommendation 10**: Appointing smaller and more efficient representations for the JPs in the different energy R&I fora (e.g. IWGs, partnerships, etc.)

EERA - High Level recommendations
A new mission-focused approach centred on cross-cutting collaboration
NECPs as a concrete tool for better communication between EU and MS
Increased effectiveness in the on-boarding of EU13 countries
EERA as a strategic pillar of the revamped SET Plan
Use instruments both for the execution of the SET Plan and the support to the IWGs and ETIPs

SUPEERA - Operational recommendations
Objective 1: Aligning EU and MSs' funding priorities and schemes and the SET Plan
Mobilising the same representatives from MSs in the SET Plan Steering Committee, the Horizon Europe framework programme, and the CET Partnership governance
Harmonizing the rules of management, funding, and opportunities allocation between SET Plan contributing countries within partnerships and other joint actions
Including new technological and non-technological R&I actions into the SET Plan to adjust to the energy sector's needs: social awareness, acceptance and engagement, education and training, R&I funding programmes, policy regulations and international collaboration. This inclusion should be also reflected in the structuring of the future IWGs way of work.
Objective 2: Improving the SET Plan's governance
The future SET Plan should be endorsed with more political strength in order to facilitate the translation of EC actions into nationals R&I agendas. Towards this objective, the key players should assume more accountability in the entire process (for instance, detailed roles and responsibilities might be defined by ToRs).
Assure follow-up CSA calls to support the delivering of the SET Plan IPs and foster the dialogue between research and industry
Objective 3: Increasing energy research collaboration across the EU
Easing and promoting access to data between research and industry
Setting European Centres of Excellence or other joint energy R&I framework where R&I, industry, the public sector and policy makers can define common strategies for further development, to be funded by EU, MSs and industry
Following "Batteries Europe" successful example of collaboration between ETIPs, JPs, CSAs, partnerships, etc.
Objective 4: Assigning the SET Plan and its stakeholders with more influence
Building on EERA's JPs to collect the needed scientific input for energy policymaking and R&I funding frameworks definition (for example, by assessing the execution of the revised SET Plan or CET-P SRIA)
Appointing smaller and more efficient representations for the JPs in the different energy R&I fora (e.g. IWGs, partnerships, etc.)

***Table 9** – High level and operational recommendations*

VI CONCLUSION

In the context of the revision of the SET Plan in 2022, this third and last deliverable of SUPEERA's task 1.1. aims at providing with consolidated feedback from the EERA community on the SET Plan's achievements, added value for energy research in the EU, and its perspective for the future. It builds on both the data provided by the SETIS in its SET Plan progress report for 2021, as well as on a set of surveys conducted with EERA JPs' members and some other proactive stakeholders, namely the SET Plan's ETIPs, and other stakeholders currently non structured in the SET Plan (e.g. SUNERGY and Hydropower community).

Firstly, based on the feedback received from the 17 out of the 18 EERA JPs, this report details what is the SET Plan's added value according to the EERA community, and as such, which are the benefits related to the SET Plan framework that should be further supported in years to come. As such, EERA JPs identify the SET Plan as a tool to better align national R&I agendas, a platform to define common R&I priorities and urgent actions, and opportunities to include insights from a SSH angle into R&I actions.

Furthermore, this report displays the key challenges and remaining barriers related to both the energy-related technological and political landscape and the SET Plan framework itself, that should be addressed as to fully implement the SET Plan and to achieve our climate goals. Mainly, those challenges cover financial barriers, a lack of coordination at different levels, a lack of a holistic perspective, a need to include EU citizens in the SET Plan's processes, and regulatory obstacles. Put in perspective with the recent REPowerEU communication and action plan, EERA's JPs were also asked to provide their opinion on which challenges should be emphasized even more within the SET Plan's framework and IPs, in order to fulfil the energy research community's part.

In addition to the above, the report analyses the feedback from the SET Plan's ETIPs and other stakeholders, comparing it to the one received from the EERA JPs in respect to the SET Plan's added value and the current challenges to overcome. The outcome of the collected information resulted to two sets of recommendations: high level (focused on SET Plan content and governance structure at higher level) and operational (relevant to the execution of the Plan at the IWG level) to be used as a guide for the future design of the SET Plan.

ANNEX 1 – Template of the survey: "EERA's JP position on the revamp of the SET Plan"

I. On the SET Plan Implementation Plan(s):

1. Which R&I actions pertinent to your Join Programme (JP) are not included in the current (or revised) Implementation Plans (IPs), also in relation to the EU strategies on hydrogen, offshore renewable energy, energy system integration and solar energy?

[enter your text here]

2. Please, indicate at least three barriers and obstacles that prevent the smooth execution of the R&I components of JP respective Implementation Plan.

[enter your text here]

3. Please, name the three main long-term challenges of the energy system that are expected to impact the R&I priorities in your technological field. Do you consider that some priorities that are currently addressed by the IPs are less relevant or soon to become obsolete?

[enter your text here]

4. To the already existing technological and cross-thematic areas (i.e. energy efficiency, digitalisation etc.), which non-technological topics should be addressed by one or more IPs? Please, prioritise at least three from the drop-down lists below.

Priority 1: Choose an item: Education & Training / Policy & Regulation / R&I programmes & measures / Social awareness, acceptance, engagement / Standardisation / Socio-economic policies & measures / International cooperation

Please, elaborate on your choice above:

[enter your text here]

Priority 2: Choose an item: Education & Training / Policy & Regulation / R&I programmes & measures / Social awareness, acceptance, engagement / Standardisation / Socio-economic policies & measures / International cooperation

Please, elaborate on your choice above:

[enter your text here]

Priority 3: Choose an item: Education & Training / Policy & Regulation / R&I programmes & measures / Social awareness, acceptance, engagement / Standardisation / Socio-economic policies & measures / International cooperation

Please, elaborate on your choice above:

[enter your text here]

5. **Please, indicate three added values that the SET Plan provide to your specific R&I field both as a normative and collaborative framework. Please, provide any examples if possible.**

[enter your text here]

6. **How could the broader R&I community better exploit the outcome/benefits of these added values? (Optionally, you can mention the main leverage means available).**

[enter your text here]

II. On the SET Plan general level:

1. **In addition to specific R&I actions, which in your understanding are the most important overarching strategic objectives and targets per technology that should be covered/included in the SET Plan? Please, list maximum three.**

[enter your text here]

2. **How would you rate the SET Plan impact in providing a collaborative mechanism (e.g., networking, funding, platforms et sim.) for the execution of the SRIAs and DoW of your Joint Programme?**

☐ Low impact

☐ Medium impact

☐ High impact

3. **Which of the following actions would you consider as more effective to improve the impact of the above-mentioned mechanism?**

☐ Enhance collaboration/involvement or on-time mobilization of the relevant stakeholders (industry, member states, research etc.)

☐ Improve flexibility of both European and national strategies and action plans' revision processes

☐ Increase the accessibility to funding and partnership opportunities to address emerging R&I collaboration needs

☐ Ensure more influence for the JPs and relevant platforms (e.g. ETIPs) in the governance of the SET Plan

☐ Other action

Please, elaborate on your choice(s) above:

[enter your text here]

4. **What type of actions should be implemented in order to establish a closer link between the SET Plan and other initiatives and programmes (e.g., European Partnerships, Programmes, National funding etc.)? Please, list maximum three.**

[enter your text here]

III. EC communication of the REPowerEU plan

1. **Given the strategic importance of the recent EC communication on the *REPowerEU* plan, what are in your opinion the long-term (>5 years) R&I challenges that you would like to see integrated into the revised SET Plan IPs?**

[enter your text here]

ANNEX 2 – Template of the survey: "ETIPs' position on the revamp of the SET Plan"

I. On the SET Plan Implementation Plan(s):

1. To which extent do you consider that your ETIPs' SRIA (or equivalent) is incorporated into the existing Implementation Plans of the respective IWG?

[enter your text here]

2. Please, indicate at least three barriers and obstacles that prevent the smooth integration of ETIP's priorities into respective Implementation Plan.

[enter your text here]

3. To the already existing technological and cross-thematic areas (i.e. energy efficiency, digitalisation etc.), which non-technological topics should be addressed by one or more IPs? Please, prioritise at least three from the drop-down lists below.

Priority 1: Choose an item: Education & Training / Policy & Regulation / R&I programmes & measures / Social awareness, acceptance, engagement / Standardisation / Socio-economic policies & measures / International cooperation

Please, elaborate on your choice above:

[enter your text here]

Priority 2: Choose an item: Education & Training / Policy & Regulation / R&I programmes & measures / Social awareness, acceptance, engagement / Standardisation / Socio-economic policies & measures / International cooperation

Please, elaborate on your choice above:

[enter your text here]

Priority 3: Choose an item: Education & Training / Policy & Regulation / R&I programmes & measures / Social awareness, acceptance, engagement / Standardisation / Socio-economic policies & measures / International cooperation

Please, elaborate on your choice above:

[enter your text here]

II. On the SET Plan general level:

1. **In addition to specific ETIP's priorities, which in your understanding are the most important overarching strategic objectives and targets per technology that should be covered/included in the SET Plan? Please, list maximum three.**

[enter your text here]

2. **How would you rate the SET Plan impact in providing a collaborative mechanism (e.g., networking, funding, platforms et sim.) for the execution of the SRIAs?**

☐ Low impact

☐ Medium impact

☐ High impact

3. **Which of the following actions would you consider as more effective to improve the impact of the above-mentioned mechanism?**

☐ Enhance collaboration/involvement or on-time mobilization of the relevant stakeholders (industry, member states, research etc.)

☐ Improve flexibility of both European and national strategies and action plans' revision processes

☐ Increase the accessibility to funding and partnership opportunities to address emerging R&I collaboration needs

☐ Ensure more influence of relevant platforms (e.g. ETIPs, EERA Joint Programmes, NRCGs) in the governance of the SET Plan

☐ Other action

Please, elaborate on your choice(s) above:

[enter your text here]

4. **What type of actions should be implemented in order to establish a closer link between the SET Plan and other initiatives and programmes (e.g., European Partnerships, Programmes, National funding etc.)? Please, list maximum three.**

[enter your text here]

III. EC communication of the REPowerEU plan

1. **Given the strategic importance of the recent EC communication on the *REPowerEU* plan, what are in your opinion the long-term (>5 years) R&I challenges that you would like to see integrated into the revised SET Plan IPs?**

[enter your text here]

ANNEX 3 – List of the surveys' recipients

IP	EERA JPs	Other SET Plan Stakeholders
Solar Photovoltaics	• EERA JPC/JP Members for Photovoltaic Solar Energy	• ETIP Members for Solar Photovoltaics • SUNERGY Members
CSP/STE	• EERA JPC/JP Members for Concentrated Solar Power	
Offshore Wind	• EERA JPC/JP Members for Wind Energy	• ETIP Members for Wind
Deep Geothermal	• EERA JPC/JP Members for Geothermal	• ETIP Members for Deep Geothermal
Ocean Energy	• EERA JPC/JP Members for Ocean Energy • EERA JPC/JP Members for Hydropower	• ETIP Members for Ocean Energy • Hydropower community
Positive Energy District	• EERA JPC/JP Members for Smart Cities	• ETIP ECTP Members • ETIP Euroheat Members
Energy Systems	• EERA JPC/JP Members for Energy Systems Integration • EERA JPC/JP Members for Smart Grids	• ETIP SNET Members
Energy Efficiency in Buildings		• ETIP RHC Members
Energy Efficiency in Industry	• EERA JPC/JP Members for Energy Efficiency in Industrial Processes	
Batteries	• EERA JPC/JP Members for Energy Storage	• ETIP Members for Batteries
Renewable Fuels and Bioenergy	• EERA JPC/JP Members for Bioenergy • EERA JPC/JP Members for Fuel Cells and Hydrogen	• ETIP Members for Bioenergy
CCS-CCU	• EERA JPC/JP Members for Carbon Capture and Storage	• ETIP Zero Emissions Platform Members
Nuclear Safety	• EERA JPC/JP Members for Nuclear Materials	• ETIP SNETP Members
Out of the SET Plan IPs' scope	• EERA JPC/JP Members for Advanced Materials and Processes for Energy Applications (AMPEA) • EERA JPC/JP Members for Digitalisation for Energy • EERA JPC/JP Members for Economic, Environmental and	

	Social Impacts of the Energy Transition (E3S)	

ANNEX 4 – Consolidated results from the gathered answered surveys on the revamp of the SET Plan by JPs

Surveys' responses from the Joint Programmes

I. On the SET Plan Implementation Plan(s):

1. Which R&I actions pertinent to your Joint Programme (JP) are not included in the current (or revised) Implementation Plans (IPs), also in relation to the EU strategies on hydrogen, offshore renewable energy, energy system integration and solar energy?

AMPEA	Generalized lack of R&I actions in advanced energy materials development: Advanced energy materials research (characterization, design, etc.) are explicitly addressed only in few IPs (energy efficient buildings, batteries). There is a plethora of multi-functional materials and meta-material examples with high application potential in several energy applications; e.g., biopolymers, ionic liquids, MOFs, etc. On specific areas of research: It is essential to work on closed carbon cycles applying renewable energy supply. Such cycles need to be applied in in increasing field of applications in order to save resources and to avoid emissions. So R&D on new production pathways to produce key materials with low carbon footprint, high recycling rates and energy from renewable resources are needed. Related to this aspect, solar energy for renewable fuels and chemicals (thereafter "solar fuels and chemicals - SFC"), will play an important role in the future (in the short as well as medium and longer-term) to unlock solar energy potential for decarbonisation. The challenge is to develop cost-efficient, low-carbon and scalable technologies to *convert and store solar energy*, using resources that are abundant in Europe (CO_2, N_2, H_2O), into fossil-free fuels and base chemicals. Technologies to produce SFC - either through *multi-step* (*e-fuels/chemicals*) or via *direct solar conversion (artificial photosynthesis)* – will be essential for defossilizing the energy, transport and chemical sectors besides the use of renewable power. Conversion of solar energy into solar fuels and chemicals is thus complementary to more established solar technologies (e.g. solar PV, CSP), and support technology integration within the energy system. We believe that solar fuels and chemicals should be included and gain recognition in the revised version of the SET-Plan, in particular related to the topics "*Renewable fuels and bioenergy*" and "*CCS – CCU*". Indeed SFC can be considered as one form of renewable fuels, also as a CCU, when it relates to CO_2 conversion. SFCs are addressed in JP AMPEA, with a strong focus on the related materials, but it is also a topic of interest for other EERA JPs, in particular ES, CSP, CCS/CCU and Bioenergy.

	The use of room temperature ionic liquids (RTIL) in energy applications has seen a marked increase in the last 20 years (biofuel production, batteries, nuclear waste recovery) and is likely to continue due to their tunable electrochemical and thermophysical nature. Number of theoretically possible (synthesizable) ionic liquids far outnumbers that of actually synthesized ones. Accelerated development of RTIL will contribute to several technologies overseen by SET-Plan, thus cannot be entrusted to a single IWG (see below).
Bioenergy	IWG 8 is dedicated to biomass and biofuels, EERA Bioenergy is participating on SET-Plan IWG8 activities.
Carbon Capture and Storage	EERA JP CCUS R&I actions are completely aligned with the ones addressed on the corresponding SET Plan Implementation Plan.
Concentrated Solar Power	As the IP has been revised in the last months, almost all pertinent actions are well included. Perhaps it could have been missed to have included the development of high-temperature linear and central receivers (with working temperatures above 600ºC) and except very low TRL actions that should perhaps be considered. As for the EU strategy, since we are concerned with the JP CSP, there is the perennial issue of the over-emphasis on solar PV when talking about solar energy. CSP has an important role to play in the EU solar energy strategy, given its maturity, LCOE, and dispatchability advantage using thermal energy storage (TES). CSP also has a role to play in green hydrogen production – providing the energy for water splitting technologies, and in solar fuels production in general.
Digitalisation for Energy	According to https://setis.ec.europa.eu/implementing-actions/set-plan-documents_en, there isn't any Implementation Plan fully devoted to the digitalization of the energy sector. On the other hand, there is an Action Plan launched by the EC on this topic (https://ec.europa.eu/info/news/action-plan-digitalisation-energy-sector-roadmap-launched-2021-jul-27_en). Both efforts should converge.
Economic, Environ. and Social Impacts of the Energy Transition	A) Addressing the **whole sustainability** of the technological innovation, i.e its environmental impact, the economic and financial sustainability (business models included)and the potential effect on social dimensions (such as energy affordability, security of supply to marginal and vulnerable groups, jobs loss…) B) A **systemic modelling approach** able to produce development scenarios. The modelling exercise should take into account the many diverse actors of the system (households, enterprises, public administrations, energy companies, public and private stakeholders), the different levels of the system (micro, meso and macro, from the individual citizens to the EU and the market). Attention to interaction among the different SET plan technological domains should also be considered

<table>
<tr><td></td><td>C) Investigating the generative processes of energy demand and measuring the impact of its reduction on the energy production and how the different tech domains might be affected
D) Investigating how the development of the different technologies might positively and negatively affect energy poverty, intended as the opportunity all to be able to satisfy their own diverse energy needs (electricity, heating and cooling and transport)
E) E3S can provide analyzing of the policy components of the EC with respect to impact, efficiency of the policy and provide research based recommendation on policy development and assessment.
F) E3s can investigate and discuss narratives supporting the CET and support/dismiss the narrative with research based knowledge</td></tr>
<tr><td>Energy Efficiency in Industrial Processes</td><td>We are heavily involved in IWG 6 on Energy Efficiency in Industry of the Set-plan. In 2021 a Revised SET Plan Action 6 Implementation was made, which includes many/all R&I actions of our JP. The R&I actions are given in the Table below*.
Table 5-1 Thematic Groups and prioritised R&I activities
<table><tr><th>TG</th><th>No.</th><th>Title</th></tr><tr><td rowspan="4">Heat & Cold</td><td>1.1</td><td>Heat upgrade from low to high grade</td></tr><tr><td>1.2</td><td>Waste heat to power (low and high temperature)</td></tr><tr><td>1.3</td><td>Waste heat to cold generation</td></tr><tr><td>1.4</td><td>Polygeneration (heat, cold, electrical power and hybrid plants integrating renewable heat</td></tr><tr><td rowspan="4">Systems</td><td>2.1</td><td>Industrial symbiosis</td></tr><tr><td>2.2</td><td>Non-conventional energy sources in process industry including carbon capture and use</td></tr><tr><td>2.3</td><td>Digitalisation</td></tr><tr><td>2.4</td><td>Knowledge exchange, training and capacity-building</td></tr><tr><td rowspan="4">Cement</td><td>3.1</td><td>Resource efficiency*</td></tr><tr><td>3.2</td><td>Energy efficiency*</td></tr><tr><td>3.3</td><td>Carbon Capture Storage and Usage (CCS/U)*</td></tr><tr><td>3.4</td><td>Recarbonation and mineralisation*</td></tr><tr><td rowspan="6">Chemicals</td><td>4.1</td><td>Electrification</td></tr><tr><td>4.2</td><td>Integrated production of Hydrogen with low carbon footprint*</td></tr><tr><td>4.3</td><td>Plastic waste as an alternative feedstock*</td></tr><tr><td>4.4</td><td>CO_2 / CO as an alternative feedstock*</td></tr><tr><td>4.5</td><td>Biomass as an alternative feedstock*</td></tr><tr><td>4.6</td><td>Process efficiency</td></tr><tr><td rowspan="6">Iron & Steel</td><td>5.1</td><td>CO_2 emissions avoidance through direct reduction of iron using Hydrogen</td></tr><tr><td>5.2</td><td>CO_2 emissions avoidance through direct reduction iron using electricity*</td></tr><tr><td>5.3</td><td>Process integration: Hlsarna smelting reduction process for lowering energy consumption and CO_2 emissions of steel production</td></tr><tr><td>5.4</td><td>Process integration: Top Gas Recycling – Blast Furnace (TGR-BF) using plasma torch</td></tr><tr><td>5.5</td><td>Carbon Capture and Usage (CCU)*</td></tr><tr><td>5.6</td><td>Circular economy*</td></tr><tr><td></td><td>6.1</td><td>Integral drying and heat recovery processes*</td></tr></table></td></tr>
<tr><td>Energy Storage</td><td>IP on batteries is well updated. Hybridization is not taken care, because is a cross cutting topic so no IPs is dedicated to it
SET plan has been updated through ETIP.</td></tr>
</table>

Energy System Integration	Not or only weakly included are: i. An integral view on the regulation and market design of the energy system as a whole, i.e. as a system of multiple energy carriers. ii. An analysis on the desired roles of electricity and hydrogen, as future low-carbon energy carriers that are partly complementary and partly competing solutions. iii. The interaction of technologies in an energy system and the requirements for optimized operation in an integrated energy system. iv. The transition path towards the new technologies (which should include the consideration of existing technologies and energy networks). v. Demand response and end-user flexibility for energy and a resource-efficient integrated energy system. vi. The end-of-life aspect of existing infrastructure & technology (e.g. including recycling) is rarely covered as well as the interdisciplinary aspects of environmental impact (resource consumption and use, impact on diversity etc.). **EU-Strategies**: Solar: focusses on how to sell & install more solar power. Any integration issues are pointing towards other areas (digitalization, grid infrastructure, storage) with limited focus on what could or should be done to integrate solar better. The end-of-life issue is not covered at al and the interaction with the environment only touched. The document seems to have a narrow focus mainly driven by the manufacturers point of view (increase installations and sales). Offshore energy: mentioning integration into the grid, storage etc. as well as interdisciplinary aspects. However, the main focus in on offshore, for which specific actions are defined, but less on its interaction with the rest of the energy system(s). Hydrogen: mentions also other sectors/areas than only hydrogen but only touches them. Limited consideration of integration topics especially not what needs to be done/fulfilled
Geothermal	The path towards energy system integration involves heat production and storage that are not very supported by the actual IPs. Especially seasonal heat storage, taking advantage of the enormous surplus of renewable heat available in the summer, is not included anywhere. This is where geothermal systems can play a major role. Also, the production of raw materials for the energy sector is only partially included.
Hydropower	Hydropower has all the criteria to serve as the catalyst in achieving the energy transition. However, the European Strategic Energy technology plan does not include hydropower as part of the 14 IWGs. Hydropower should be a pivotal actor in seizing the current geopolitical momentum. Hydropower is a fundamental key enabling technology and the largest renewable energy sources in Europe. In 2019, the electricity production from HP in Europe was 653 TWh/year (334 TWh/year within the EU). This

	means that hydropower generates about 36% of the electricity coming from renewable energy sources in the EU and 10% of the entire generation, contributing significantly to achieving EU targets for energy and climate. It provides sustainable, reliable, and secure energy supply at affordable prices. Through its flexible production (quick response to demand fluctuations and up to seasonal storage) hydropower is a key enabler for Europe's energy transition. This because it can balance the energy production with the energy consumption. Moreover, Hydropower already supports both the integration of energy grid through flexibility and the storage capacity. The fact that hydropower is dispatchable, flexible and stores large amounts of renewable energy makes it an important part of any future energy scenario. As a robust enabler and a balancer for other renewable source, hydropower must have a prominent role in the SET Plan. As it will be explained later in the following sections, together with targeted R&I actions, communication is a fundamental key to disseminate information on hydropower's current and potential capabilities to policy makers and governments. The R&I areas requiring focus and targeted research efforts can be categorized into: vii. Assessing factors promoting social acceptance, improved public engagement and increased uptake of hydropower in consumers` energy portfolios viii. Development of new and innovative method for designing, engineering, constructing, installing, and operating flexible hydroelectric units. ix. Climate friendly solutions and sustainability x. Environmental Restoration in Hydropower Development xi. Impact investigation of climate change on water resources and consequent impacts on power production and freshwater ecosystems xii. Investigating supportive and limiting effects of national and European policies, policy mixes and regulations on the environmental upgrading of existing hydropower infrastructure, new hydropower development and increased operational flexibility xiii. Transformation of hydropower asset maintenance from interval-based to prediction- based by use of new sensors and measurements xiv. Integration of cross-domain knowledge into new and established business processes in the hydropower sector xv. Resilience of equipment and infrastructure xvi. Open-source hydropower data and models for energy system analysis

Nuclear Materials	None
Ocean Energy	EERA Ocean JP has been fully involved in the production of SRIA for ocean energy (leading its preparation in the framework of ETIP Ocean) and has been adopted by the IP on ocean energy – so there is a full alignment with EERA Ocean JP and the IP
Photovoltaic Solar Energy	There is not enough focus on the big challenge of lowering the CO2 footprint and reducing the need of critical raw materials for the production of PV panels. This will become crucial in the further upscaling of PV production by a factor of 10 in the coming decade. **Cost reduction and performance enhancement** of solar PV has been extremely successful in past decades, but very large-scale deployment of PV with integration into the energy system and our living environment requires even further cost reduction. Performance enhancement is a lever for cost reduction and an enabler for efficient use of available areas. **Sustainability and circularity**: lifetime and reliability need to be guaranteed **Socio-economic aspects** to be valued and fully considered
Smart Cities	Social innovation R&I is neither mentioned separately (at least at the energy system integration EU Strategies) nor integrated in the more technology-oriented paragraphs. The spatial consequences and biodiversity consequences are not part or at least it is not emphasized
Smart Grids	There is a very good coordination between the IWG, JP and ETIP even though there are different IPs from each stakeholder group. There are two partnerships from which ETIP SNET is receiving frequent updates and information. Also, ETIP SNET is part of the governance of these partnerships. The IWG is independently acting but closely collaborating striving to follow a common approach (related to R&I) with ETIP SNET without duplicating efforts.
Wind Energy	IWG of offshore wind recently published an update of the IP. In this update of the IP, all actions that are urgent and required for the energy transition have been included. Link to the publication: https://setis.ec.europa.eu/system/files/2022-04/2nd%20SET-Plan%20Implementation%20Plan%20for%20Offshore%20Wind_2022.pdf

2. **Please, indicate at least three barriers and obstacles that prevent the smooth execution of the R&I components of JP respective Implementation Plan**

AMPEA	There is a lack of **overarching IWG on advanced materials** (with IPs on key material development and implementation methodologies such as AI, high-throughput characterization, digital-twin, etc.) synergizing the actions of technology-specific IWGs.

	Integration/competition with existing technologies: Most developments try to start with established technologies and plants and try to modify them towards low-carbon technologies which often leads to non-optimal solutions on the long-run. Early implementations of disruptive technology changes and very innovative routes are needed. In sufficient funding/investments and/or fragmented R&I efforts: From AMPEA's low-TRL R&I perspective, there is too little funding available for too many researchers/activities. At the core of every disruptive technology, there exists a novel material with its breakthrough functionality & properties, discovered through basic research. Large and uncomplicated funding scheme to support **non-technology specific, low-TRL materials research activities** is necessary for incubating next generation disruptive technologies. The approach will also avoid fragmentation and overlapping of materials development in various energy technology sectors (not applicable for established materials)
Bioenergy	1. Ongoing debate on biomass for bioenergy/biofuels. Uncertainty on policy scenario regarding support on bioenergy. Difficulties with relation with decision makers at Member State level. 2. Consideration just of the energy 'side' of biomass, instead of considering all the potential uses in a circular bioeconomy approach. 1. 3. The way GHG emissions are quantified in mobility (tail pipe emissions). Methodology of carbon sinks.
Carbon Capture and Storage	The CCUS technology ready for deployment and industrial engagement is now in place as in the past few years the drive for such technology has been changed, from being mainly politically supported to be driven by industry. Nevertheless, there are still challenges that require R&I investment such as the ones listed below: • CO2 capture technology – need to further develop/optimize existing technologies (membrane technology, Chemical Looping Combustion, liquefaction…) to reduce technological costs. • CO2 transport – corrosion (due to contamination issues) and need to improve transport security • CO2 storage – (monitoring, large capacities needs to be ready for use/deployment) • CCU – Life Cycle Analysis, connection with Circular Economy
Concentrated Solar Power	1) Lack of proper/adequate financial support from Member States and the Commission. R&I activities are not fully covered within Horizon Europe framework programme (very limited number of specific calls for CSP technology), and for those that are covered, the budget is very low. In addition, calls for proposals specific for the JP are needed. 2) Due to high level of maturity of some technological solutions, a higher number of innovation actions aimed to facilitate the market penetration should be advisable. 3) Pilot projects aiming to define a regulatory framework to ease the market penetration are needed. 4) There is also a lack of commercial projects in the EU that could lead to the implementation of high TRL innovations resulting from previous research initiatives.

	5) Lack of interest of collaboration from the PV R&I sector
Digitalisation for Energy	- Common effort on digital developments, creating synergies and making solutions and outcomes profitable for a wider community. - Effective convergence of funding schema coming from different EC DGs. - Adopt digital methodologies as key enablers.
Economic, Environ. and Social Impacts of the Energy Transition	While it is takes a short time to bridge the gap between technology research it takes longer time to bridge technology and social science. Therefore persistent work across science fields are needed to create the innovative environment that push forwards the e3s research and implements it solutions. Cross cutting competence development over time is therefore particular important to e3s.
Energy Efficiency in Industrial Processes	An important barrier is the translation/cooperation between the EU SET-plan and the individual countries. There is a good line to transfer R&I actions to Horizon Europe calls especially for heating & cooling. The JP has a close cooperation with IWG6. The JP is invited at the meetings and workshops for input and receives all documentation and are asked to input to them. We also invited in Eric Lecomte at our half year meeting to present the high lights of the revised action 6 SET plan. In March 2022 the JP was participating in the Annual Event of the SET Plan Action on Energy Efficiency in Industry focusing on cross-cooperation between the SET Plan Implementation Working Groups (IWGs). More info see https://setis.ec.europa.eu/implementing-actions/energy-efficiency-industry_en
Energy Storage	1. Fundamental research on battery materials, batteries and new chemistries should be improved 2. Absence of common benchmarking, including laboratories for standardization 3. International collaboration should be improved through bi-lateral schemes
Energy System Integration	1. A lack of an overall perspective on the timing and speed of the development of renewable energy production and its partial conversion to hydrogen. 2. A lack of perspective on the future roles of electricity and hydrogen infrastructures. 3. A lack of consideration of the role of economic incentives in the development of decarbonization options by private actors.
Geothermal	1) The ratio of available R&I funds to the number of submitted proposals for the geothermal sector is ridiculously low, geothermal R&I has been systematically underfunded, clearly visible in all EU framework programmes in the last 20 years; 2) the funded projects mostly have a small size and often refer to very specific topics, such that many relevant (transversal) topics are not covered. 3) the focus on electricity reduces opportunities for geothermal heating projects.

Hydropower	Some of the barriers that require strategic actions are: ➢ **Social acceptance** • Many HPP were built in a time when there was limited knowledge and environmental and social impact were not a priority. To ensure that HP is a renewable energy source on the long term, i. e. sustainable, it is important to increase the knowledge about the impacts on the affected ecosystems and how to mitigate these. Sustainable solutions may offer win-win situations for both the environment and from an operational perspective, e.g. regarding reservoir desilting techniques. And it is important to stress that nowadays the technology has been updated and it should be treated accordingly. • Hence, it is important to address the social acceptance in new or modified hydropower schemes to give guidelines for future and flexible hydropower production: • Assess factors promoting social acceptance and improved public engagement • Investigate the uptake of hydropower in consumers' energy portfolios (e.g. Role of eco-labels) • Investigate public knowledge, attitudes, perceptions, and responses to hydropower • Develop strategies to reduce negative and promote positive socio-economic impacts of hydropower • Investigate strategies to reduce negative socio-economic impacts of hydropower and for effective public and stakeholder participation • Investigate policymaking practices ➢ **Environmental impacts** • Increased flexibility from hydropower can have an environment impact on the river downstream the hydropower plants. Increased research on the impact of HP on the environment will mitigate its effects on climate and organisms populating water streams and bodies, increasing biodiversity, and reducing the impact on local hydrology. Research on the role environmental mitigation measures play in improving the perception of existing and new hydropower can facilitate social acceptance on all societal levels and hence strengthen the role of hydropower in the energy system. ➢ **Regulatory frameworks** • Frequent changes in regulations negatively impact the innovation as it increases the uncertainty.
Nuclear Materials	- Lack of actual political willingness to set up coordinate projects within the relevant SET-plan IWG - Lack of intention of devoting bespoke funds in a coordinated way - Lack of an established instrument of cooperation between MS beyond co-fund instruments essentially backed by the EC
Ocean Energy	Although we believe, the Commission uses the SRIA for planning their work programmes – the Ocean Energy sector has not seen evidence of the SRIA or IP being used by the member states to plan their national calls – I would say this is by far the most important overarching barrier

Photovoltaic Solar Energy	SET-plan implementation group of PV is not active enough. Most likely because membership to this group is on a voluntary basis. There is no alignment between the member states on the execution and financing of the SET-plan. There is not enough public financing of PV R&I to execute the SET-plan.
Smart Cities	Not focussed on interdisciplinarity research but much more focused on technology development. Citizens could be part of research as well. JP are too much research organization oriented and last year focused on positioning itself, it should be externally focused on competition between other networks
Smart Grids	1. Better alignment with the national objectives is needed 2. Not the same engagement of different countries. Some regions are underrepresented 3. Need for more collaboration between national and EU programmes
Wind Energy	1. **Cost**: R&I can contribute significantly to cost reduction; 2. **Value**: Energy system integration and sector coupling is key to this, as it enables greater scale and flexibility in the market for green electricity; 3. **Sustainability**: The offshore wind energy sector needs to fully integrate sustainability considerations both environmentally and socially. With the massive build-out of offshore wind underway, the impact on the marine environment and the multiple users of the sea needs to be addressed. Onshore, active engagement with communities that are affected positively and negatively by the installation of offshore wind farms, power lines, production, and logistic facilities but also the jobs created must be addressed. At the technology level, circularity by design is a key topic to address. 4. **Regional Conditions**: Offshore wind energy is currently dominated by the development in the North Sea, but other regions are now following suit with ambitious plans for offshore wind power.

3. **Please, name the three main long-term challenges of the energy system that are expected to impact the R&I priorities in your technological field. Do you consider that some priorities that are currently addressed by the IPs are less relevant or soon to become obsolete?**

AMPEA	- Implementation of carbon-neutral production routes of materials (thermal reduction of ores, reduction with green hydrogen, recycling or spent products with renewable energy supply) - Consideration for whole production and value chain (e.g. in the case of hydrocarbons and plastics from atmospheric CO2 to final product) - Intermittency of renewable energy source - Global energy demand (amount and type), especially from large countries with steep growth in the standard of living. - Land-use/Water-use (availability)

	- Circular economy approaches related to the growing share of renewables in the energy system
Bioenergy	1. Role of bioenergy for flexibility and green base load. 2. Hydrogen and synthetic fuels. In general, we consider the direction set out in the IP is still valid for bioenergy/biofuels.
Carbon Capture and Storage	- Energy security (REPowerEU) – CCUS shall play an even more important role in the future European energy system since The European Commission presented the REPower Communication - Energy system integration – CCUS can provide flexibility to the energy system - The need for a circular economy – CCU can contribute significantly to an European circular economy
Concentrated Solar Power	1) Reducing the current energy system's dependence on fossil fuels could lead to the improvement or development of new materials, including those for higher working temperatures as suitable and cost-efficient Heat transfer fluids (HTF) for higher operating temperature for parabolic troughs systems, and of new components for CSP plants. It could also lead to reduce the capital costs (mainly of the solar field); reduce the cost production of the electricity, e.g. through lower-cost Thermal Energy Storage (TES) systems; and increase the reliability of CSP plants. 2) Reducing CO2 emissions can help to increase thermochemical production of solar fuels and hydrogen, leading to the development of higher efficiency processes, to the reduction of the cost of production, e.g. through cost-effective production of liquid synthetic fuels from solar redox cycles; to the development of new generation of CSP-driven solar fuels production technologies; and to the development of an industrial-scale demonstration plant targeting future market penetration. 3) The need to supply power to the grid when it is most needed could lead to develop innovative technological solutions allowing an effective integration of thermal storage systems with power distribution network, thus providing ancillary services to the grid, and entering in the electricity spot market. It could also lead to develop cost-effective technological solutions to implement seasonal thermal storage, and to develop technological solution to increase energy yield and reduce land occupation. These challenges are not expected to become obsolete in the short term
Digitalisation for Energy	- Human-centric approach - Digital gap for many prosumers for effectively adopting and exploiting the previous item. - Real distributed energy source sector (to become true if digital capabilities are integrated).

Economic, Environ. and Social Impacts of the Energy Transition	Energy poverty increasing the differences in society Technology analphabeths that is in danger of being left behind in the transition REPowerEU requieres faster approval rates of both projects and socital change, understanding the needed dialog to reach acceptable solutions will be increasingly
Energy Efficiency in Industrial Processes	- Electrification and renewable electricity: The nature of the Action 6 sectors and other energy intensive industries means that there are inherent challenges that need to be overcome in order to achieve the electrification targets set out in the 2050 Climate Strategy. Of critical importance will be designing an electricity market that has the capacity to accommodate the required electricity as well as the building, operation and regulation of grid infrastructure. - Resource efficiency & circularity: Increased circularity can drive resource efficiency through increased recycling, re-use or outright reduction. Waste collection, treatment and recovery are areas that can drive circularity. New practices for end-of-life phase of products are another. Finally, customer information can lead to reorientations of demand. For the Action 6 sectors, specifically Pulp & Paper and the bioeconomy, the availability of high-quality fibres from recycling is important to increase circularity. - Non-technical barriers: ○ Policy barriers: Trade-offs between incremental efficiency improvements and radical transformation, Carbon leakage risk, leading to under-investment, Lack of pro-active (and uniform) European, national, regional, and local framework conditions, ○ Market barriers: Product differentiation, Lack of collaboration across sectors (ecosystems) ○ Financial barriers: High capex / opex, Access to risk financing, financial and administrative barriers ○ Social barriers: the need for a just transition, information and skills barriers, lack of access to new workforce skills, lack of co-creation processes to improve implementation of new (technological) solutions All challenges are relevant now and in the future.
Energy Storage	1. Materials availability (partially taken care of by SET plan) and recycling 2. Willingness for manufacturing of batteries with new chemistries (not addressed) 3. Lack of fundamental research activities (many activities are driven by industry) 4. Lack of development of characterization methodologies, techniques and tools
Energy System Integration	• Long-term adjustment of existing rules and regulations which might hinder or on the other hand, stimulate, the transition towards and integrated energy system. • The need for stakeholders to change habits and behavior with respect to energy use, and generation might hinder the implementation of integrated energy system.

	• Optimization of individual business & technologies in contrast to the need of cooperation to be benefit of the big picture; the need to coordinate between network operators and energy producers/conversion/storage/consumers.
Geothermal	Electrifying the heating system is a major challenge and probably not a very sustainable approach. For the heating sector, a combination of energy efficiency, renovation of buildings, smart heat distribution networks and heat storage options (in combination with cooling) seems to be a more promising approach, at least for densely populated areas. Electricity will have its (albeit much smaller than anticipated in most scenarios) role in such a system via the heat pumps coupled to low temperature grids. Expanding and refurbishing (smart) district heating systems is a major challenge The enormous use of CRM for some renewables sources (and batteries) forces us to look for alternatives for heating&cooling (such as geothermal district heating and storage options) Lack of (access to) subsurface data is a major bottleneck that needs to be addressed for geothermal energy to reach its full potential (i.e., 25% of all residential heating demand)
Hydropower	Hydropower faces different challenges: environmental, societal, and technological. Lack of targeted research on new hydropower technology has become a barrier for new opportunities. Hydropower it is often considered a mature technology, however, research is fundamental in boosting its potential. Besides communications, the European research for the hydropower sector will also have to focus on technology, power markets and market flexibility. Some long-term priorities that are expected to impact the R&I priorities in the technological field: - Energy storage - Decarbonisation - Biodiversity - Water availability - Digitalisation
Nuclear Materials	- Deployment of small and medium-sized modular reactors - Deployment of Generation IV reactors - Any specific decision made at European, rather than national, level on these systems (so far each MS has its own programme, if any, generally with insufficient dedicated budget to actually produce a break-through in terms of licensing and construction)
Ocean Energy	- System balancing with higher penetrations of renewables - RepowerEU and Net Zero will accelerate demand and put pressure on supply chain and infrastructure - Competition for raw material will also drive-up cost Main IP priorities are still valid for ocean energy but new priorities might need to be considered due to the current energy scenario in Europe.

Photovoltaic Solar Energy	The evolution and needs of the smart grid will impact how we must configure and design PV installations. The energy system of the future must be fully circular, so our PV systems need to be designed for 100% recyclability.
Smart Cities	I am not involved in any technological field (this is one very big challenge!)
Smart Grids	Issues related to system integration and especially the inclusion of e-mobility as it is a technology that connects many different aspects (e.g. infrastructure needs, smartness, flexibility, reliability etc.) Effective use of short and long-term energy storage technologies (e.g. batteries, hydrogen etc.) to allow higher penetration rates of RES. Effective use of flexibility in the system (e.g. the efficient use of load aggregation, DSM, electromobility etc.). An important transversal topic is the digitisation of the energy grid and "smartness" that will enable more flexible, reliable, and robust power system operation.
Wind Energy	1. Europe needs to build an extensive offshore wind sector in Europe in all different seas. That means that floating wind power needs to be developed with all its R&I requirements as well as the2. integration of large amount of offshore wind power into the energy system. 3. Human capital and infrastructure needs to go hand in hand with the implementation which requires dedicated R&I efforts.

4. **To the already existing technological and cross-thematic areas (i.e. energy efficiency, digitalisation etc.), which non-technological topics should be addressed by one or more IPs? Please, prioritise at least three from the drop-down lists below. Please, elaborate on your choice(s) above:**

	Priority 1	**Priority 2**	**Priority 3**
AMPEA	Policy & regulation	R&I funding programmes and measures	International cooperation
	While bottom-up approach is essential for ensuring the continued progress of all technologies, the urgency to become a climate-neutral society/economy by 2050 requires multi-national policies and regulations to steer how we produce, distribute and use energy. For example, from the production side it is essential to bring technologies to the market which ensure the efficient conversion of CO2	EU-aligned energy policies must also be reflected in the prioritized R&I activity funding scheme. This is already the case; however, more emphasis should be given on overarching actions such as advanced & multi-functional materials and integrated and/or hybrid energy production strategies; i.e., connecting different products such as fuels and commodities to make the optimal use of different types and qualities of	DNHS principle should be applied beyon the EU perimeter. Accelerated RE implementation in EU should not be done achieved to the detriment of harmful and excessive mining (critical elements, metal ores, sand, etc.) and land-exploitation (deforestation, riverbeds, habitat loss). Also as witnessed by the COP21 last year, disparity in energy demands and RE readiness level

	and water into carbon neutral fuels. Adequate policies & regulations are needed for accelerated integration of renewable energy solution in chemical and base material producing industry in a disruptive manner. From the distribution/usage side, lack of regulative frameworks allowing the deployment of particular RE (e.g., financial infrastructure) results in current disparities in the deployment of RE cooperative projects across EU, and also hampers the progress of the technology itself.	energy available (e.g. high and low temperature heat, electricity…) are needed.	(infrastructure, societal & industrial acceptance, tech know-how, etc.) among nations is clear. While the latter (systemic and individual social factors) may be beyond the scope of technology-specific IWGs, the former can be addressed from the starting materials development level in their R&I activities.
Bioenergy	Policy & regulation	Social awareness, acceptance, engagement	International cooperation
			Biomass is everywhere
Carbon Capture and Storage	*Deeply integrated energy systems*	*Circularity and raw materials dependance*	/
	CCUS technology can play an important role in the deployment of several energy vectors (e.g. BioCCS, H2-CCUS) as well as in the decarbonisation of hard-to-abate sectors	CCU can contribute to recycling of CO2 into valuable products (organic compounds, chemical building blocks, synthetic fuels, building materials)	
Concentrated Solar Power	R&I funding programmes and measures	Policy & regulation	Social awareness, acceptance, engagement
	Funding for CSP R&I projects needs to be expanded at both European and national level, with both funding programmes fully aligned to cover the broad spectrum of R&D activities included in the Implementation Plan. In addition, there should be special funding programmes for the designing, building, and operating of larger CSP plants (up to several hundred MW), where the latest innovations can be implemented. Clearly digitalization and renewable energies and technologies integration to the achievement of 100% decarbonisation of power	There is a lack of regulation in the electricity market in Europe. The adoption of a common policy focused on the development of renewables together with the regulation of the electricity market would benefit the development of European CSP industry and increase the investment in the development of this CSP technology and its market deployment, with the consequent benefit to society. In other ways, it would help to increase power interconnection capabilities and, at the same time, promoting and facilitating the electricity exchange among countries; to facilitate and	Raising awareness among officials in relevant ministries and national policy makers of the benefits and challenges of CSP technology.

	systems also guaranteeing the full availability and stability of the electricity	harmonize the procedures to the access and connection to the grid the future renewable projects, at EU level (currently, very different rules and procedures suppose a significant difficulty the promotion, as example, of CSP projects); and to differentiate and independently promote the development and deployment of dispatchable renewable technologies to properly accompanying and support the non-dispatchable ones (mainly PV and Wind).	
Digitalisation for Energy	R&I funding programmes and measures	Standardisation	Social awareness, acceptance, engagement
	Europe's investment is highly appreciated and paramount. Nevertheless, it is not fully aligned with others similar ones such as the American. That is why we must optimize our funding schema and efforts in order to obtain the highest possible "revenue".	The digital advances and solutions achieved should be based on standards that will make them interoperable and replicable. Otherwise, they won't be adopted by a large community.	This priority is selected ex aequo with Education and training. The idea is to avoid a digital gap between the prosumers that will make undoable a human-centric approach of the digitalization of the energy sector
Economic, Environ. and Social Impacts of the Energy Transition	Social awareness, acceptance, engagement	Socio-economic policies & measures	Education & training
	In order for RES technologies to be properly adopted by individual and collective public and private actors (e.g. households, SME, public administration) it is crucial to spread the right narrative of the energy transition in order to raise the knowledge and awareness of the general public, with specific attention paid to energy demand reduction. Citizens in particular need to be properly engaged in the design and development of RES projects at any level in order to increase the adoption of innovative technologies and the moderate the opposition to the needed infrastructures development Local social innovation is requiring a community	It is crucial to assess the positive and negative synergies among energy transition strategies and, on the economic development processes that need to be fostered to react and recovery from the long-lasting economic crisis made worse by the pandemic and the Ukraine war. On the other hand, the impact in terms of equity and justice in order to avoid that the transition to renewables will reproduce/enlarge pre-existing social differences or create new ones It is critical to address and strengthen the research on how the energy transition affects different people regarding their quality of life. Hopes and fear are related to conservative and liberal perspectives on energy transition, and may provoke	Beyond the technical skills it is important to systematize the knowledge to be transferred on the topics of the sustainability of energy transition, that is on its economic, environmental and social factors and potential impacts. In order for the transition strategies to be developed, we need experts able to assess the complex many faceted impact of the new technologies, ability to design proper business models and market strategies to foster the diffusion of the tech innovation and able to make these innovations fair and available for all. In the context of Local Social Innovation attention should be given to educate and train people in understanding the social dynamics in transitional

	approach. Agent Based Simulations are now in a stage (EU SMARTEES project) to be used in co-creative ways in supporting local communities to explore their own role in the energy transition Contributing to fairness is important for the CET regarding both burden sharing and benefit sharing pointing to and investigating how these characteristics can be obtained.	counterproductive polarisations. Challenge false news with research based reliable knowledge will be increasingly important as well as understanding the social mechanisms that allows false news to become the trusted news.	times. We have to, and should go beyond an individualistic perspective for solving a global challenge.as global warming.
Energy Efficiency in Industrial Processes	International cooperation	Education and training	R&I funding programmes and measures
	Every EU country has a different plan and focus for Energy efficiency in Industry. More alignment between governments is needed. International cooperation between research institutes and a mobilization scheme will increase the knowledge and developments on R&I topics.	Education & training: of young people (universities, applied universities but also medium and lower education for installation of the new technologies) and people in companies to become more familiar with the new technologies and increase the implementation	Needed to demonstrate e.g. industrial heat pumps, R&D on new stable materials for heat storage, pilot demonstration of efficient separation, R&D on new process intensification technologies, technologies for drying and dewatering and efficient electrification technologies.
Energy Storage	Education & training	Standardisation	International cooperation
	The lack of a skilled work force and also well-dedicated academic careers will become the bottleneck for the objectives of EBA250. Overcoming this issue will also pave the way of a better social acceptance.	Batteries will be a keystone to enable a new “all-electric” world, there is still a strong need for standardization, also regarding the so many different applications	
Energy System Integration	Socio-economic policies and measures	R&I funding programmes and measures	/
	Economic regulation of the energy sector as a whole: how to set the incentives to achieve the desired mix of renewable electricity, hydrogen, geothermal energy and CCS.	How to model large, integrated (multi-vector) energy systems?	
Geothermal	Social awareness, acceptance, engagement	Policy & regulation	International cooperation
	Too often, the IPs mention this topic for too specific or too broad goals. It is hard to find the right dimension for a proper integration among different energy sector. It might be a good idea to develop a	These topics are strategic for a complete and proper sustainable development of energy technologies. They include environmental and social aspects, and other crucial terms. E.G., for the geothermal	Materials, resources, energy systems are very variable in the EU countries, and flexible solutions are required. Strategic cooperation may speed up the development and the application. The establishment

	scenario with ALL possible solutions with such that the public can see and discuss the pro&cons of all of them including the alternatives. This is the only way to overcome the NIMBY effect.	sector the liberalization of underground data is a key aspect	and use of large-scale research infrastructures works well with international collaboration, such that complementary infrastructures may be used could strengthen the overall the research areas. In geothermal energy, real scale field laboratories, like the FORGE in the USA, would be such an example, also to cooperate with US research partners.
Hydropower	Social awareness, acceptance, engagement	Socio-economic policies and measures	R&I funding programmes and measures
	To achieve acceptance of HP infrastructure, more efforts to bring forward the positive aspects. Environmental, economic, and social concerns on different societal scales must be considered and addressed through a proper communications strategy. It is important to address the social acceptance in new or modified hydropower schemes to give guidelines for future and flexible hydropower production.	The methods for assessing the environmental impacts should be improved and adapted to the new regime of future hydropower operation and climate to optimise production and minimise environmental impact. The framework should be based on updated research. Priorities: preserving biodiversity, improving river ecosystems, increasing the knowledge on environmental impact	Hydropower seems to be rather neglected; one of the reasons may consist in a lack of unity and common voice. The JP Hydropower is working toward the construction on an ETIP to facilitate its access to funding programmes
Nuclear Materials	Education and training	Policy & regulation	R&I funding programmes and measures
	It is crucial in the nuclear field to maintain competence and knowledge	Harmonised licensing policies and regulations within the EU are essential for the deployment of SMRs	See barriers to execution of the implementation plan
Ocean Energy	Education & training	Policy & regulation	International cooperation
	To ensure a skilled future energy sector workforce	To ensure a strategic EU wide planning process	To ensure knowledge and tech transfer to accelerate innovation
Photovoltaic Solar Energy	Education and training	Social awareness, acceptance, engagement	R&I funding programmes and measures
	We will need a massive amount of engineers and installers trained for the renewable energy system of the near future.	This will be crucial to be able to have a timely and successful energy transition	It makes no sense to have ambitious plans (e.g. be number 1 in renewables) and not to have the right amount of money and funding programs in place. We need especially better alignment between the member states and Europe.
Smart Cities	Social awareness, acceptance, engagement	Policy & regulation	Socio-economic policies and measures

Smart Grids	Policy & regulation	Social awareness, acceptance, engagement:	Education & skills
	Technology evolution is moving faster than policy and regulation improvements. Slower paced regulation processes might slow down the technological evolution of the system. Regulators should provide incentives to the operators. Incentivized regulation and sandbox approach should be used by regulators to enhance the process and facilitate the adaption of emerging technologies.	Energy communities and through that the citizen participation to the energy market is important to get the end-users on board.	Education and skills should catch up with the rapid transformation of the sector and there is a need of reskilling and upskilling to keep up with the new technological needs and enable involved professions to be active in the transition.
Wind Energy	R&I funding programmes and measures	Social awareness, acceptance, engagement	Education and training
	Scaling up the offshore wind sector with a factor of 10 requires technology development in order to make further steps in efficiency and costs reduction. For this purpose, R&I funding programmes are required across all TRL levels.	The energy system does not only consist of technologies and services; it also consists of the people employed to develop and manage the system, the people using its output, and the people who are affected by its presence both positively and negatively. While it is understandable that we tend to think of the already hugely complex energy system primarily as the system of technology and services, we must think of energy system integration as a system including people and society. Only in this way can we ensure that we achieve a comprehensive and fully sustainable transformation of our energy system.	Realising the energy transition requires a lot of investments and activities, the peopled required to do the work still need to be trained and made available.

5. **Please, indicate three added values that the SET Plan provide to your specific R&I field both as a normative and collaborative framework. Please, provide any examples if possible**

AMPEA	- Alignment of NECP across EU (or the progress toward this goal) ➔ leads to clear visibility in the future (or new) direction of priority R&I activities and targets, e.g., the recent addition of HDVC into SET-Plan IWG creates new opportunities in the related field of research (although not much for AMPEA)

	- Cross-sectoral collaboration and broader partnership ➔ Wider range of research communities are consulted for building SET-Plan, leading to a faster response revising the IPs. - Citizens engagement and emphasis on SSH research activities ➔ This has led to increased weight of SSH (economy, environment, social, regulations, etc.) in the Horizon EU working programmes, affecting how materials scientists construct their research methodology and set targets.
Bioenergy	Through the Implementation Working Groups → Enhance collaboration.
Carbon Capture and Storage	The main added value provided by the SET Plan has been cross-sectorial collaboration between the R&I community, industry and authorities (Member States/EU), allowing to bridge the gap between R&I and policy making. This is nicely reflected, for instance, by the ERANET project ACT (Accelerating CCS Technologies)
Concentrated Solar Power	1) Prioritisation of common objectives aimed at the most urgent R&I for the advancement of CSP technology 2) Enhancing collaboration among participants
Digitalisation for Energy	As aforementioned, there isn't any IP devoted to digitalisation.
Economic, Environ. and Social Impacts of the Energy Transition	- Limits and define the scope of relevant e3s research - Stating targets that define the direction of the e3s research - A weakness is not setting targets on qualities such as importance of diversity, quality of life and happiness.
Energy Efficiency in Industrial Processes	- Discussion platform/contact with the industry - Input/lobby for R&D EU calls - Input/lobby for policy both EU as individual countries
Energy Storage	1. SET plan was the starting point to initiate the growth of battery industry in Europe 2. Assisted with strategic development at the early stages 3. Initial collaborative framework was set in Europe (EERA, ETIP, etc..)
Energy System Integration	1. Guidance to the operators of all energy networks regarding the future demand for infrastructure. 2. Guidance to governments how to improve the smooth, integrated functioning of the energy system across energy vectors and across national borders. 3. Insight in the costs and benefits of individual technologies to the energy system as a whole.
Geothermal	The SET plan provides clear targets. In geothermal energy these are primarily cost reduction goals for exploration and drilling, and the efficiency increase of power generation. These goals are helpful as guidance for R&I

	efforts and for communication purposes. What is lacking is the support to take action.
Hydropower	The SET Plan would contribute to establish a consistent approach among industry, experts, academia in preserving and developing the know-how, take actions and decisions on the hydropower deployment.
Nuclear Materials	Only one: MS often ask for consistency with the SET-plan IP, so if an activity is mentioned there it does not need a lot of justification
Ocean Energy	I would say that the main value the SETPLAN brings is that it is providing a energy dialogue between the MS and commission – however there seems to be a lack of clarity between the MS and EC who responsibility it is to deliver the SETPLAN.
Photovoltaic Solar Energy	A clear European plan with concrete R&I goals
Smart Cities	-
Smart Grids	The most important aspect of the SET Plan is the continuous attempts to align national with EU objectives. This is beneficial for all actors involved. It is of high importance also the fact that it facilitates the contribution from industry, academia and MS. Another significant added value is that the SET Plan prioritises the needs and requirements of the energy transition and bringing all stakeholders on board to form a common strategy forward. The initiation of strategic thinking (eg the roadmap) as an approach identifies the important aspects to be addressed in the energy sector.
Wind Energy	1. The IWG is the only place where country representatives can meet to talk about R&I priorities for offshore wind energy; 2. The priorities set by IWG are transferred to the national strategies; 3. It would be good if the IWG would lead to funding opportunities for offshore wind energy research.

6. **How could the broader R&I community better exploit the outcome/benefits of these added values? (Optionally, you can mention the main leverage means available).**

AMPEA	Creating overarching IPs covering multiple IWGs, such as advanced materials and integrated/hybrid energy production/storage technologies would further boost the inter-disciplinary and inter-sectoral collaborations. ➔ more funding and investments to support such R&I activities.
Bioenergy	Using JP Bioenergy to channel the SET Plan activities related to bioenergy/biofuels.
Carbon Capture and Storage	The R&I community could better exploit the benefits by setting these outcomes into implementation through, for instance, European Centres of Excellece where R&I, industry, the public sector and policy makers would define a common strategy for further deployment. Such strategy would

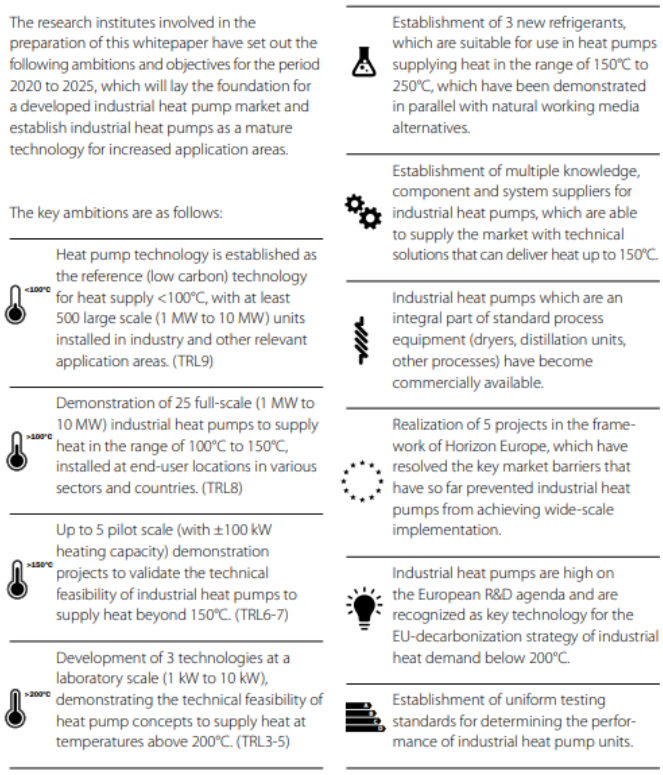
	build on trust and common understanding developed during the SET Plan (specially remarkable since the IWG on CCUS was established).
Concentrated Solar Power	Lobbying the EC and Member States to seek additional and to call for the acceleration of the achievement of defined targets and goals defined in the current CSP Implementation Plan.
Digitalisation for Energy	Even when there is no IP, the main way for a better exploitation of the digital solutions is the 4 points mentioned in the previous question 4
Economic, Environ. and Social Impacts of the Energy Transition	- E3S must work bridging the gap between people and technology. - E3S must provide better information about what it takes to bring innovation to high impact - E3S can provide a framework for the technology research adding the humanities aspect on impact and implementation of technology in society
Energy Efficiency in Industrial Processes	- Input for their R&D programs - Knowledge on goals of industry & governments - Give input on new developments to industry and policy makers - Education & training of young people and companies
Energy Storage	1. R&I community has already started to exploit the SET plan 2. Other R&I communities can learn from the experience in batteries implementation 3. SET plan could be a common ground to improve scientific collaboration between different actors across battery value chain
Energy System Integration	The values mentioned above are to the benefit of society. R&I should support these values.
Geothermal	Easier and better access to existing data (from the mining and the oil&gas industry) would be a first step to reduce uncertainty in geothermal energy developments. An important means to help with the exploitation of SET Plan targets would be a more explicit focus on heatin&cooling (not just energy).
Hydropower	-
Nuclear Materials	No idea
Ocean Energy	By the R and I community having directly dialogue with the MS funders
Photovoltaic Solar Energy	More collaboration between R&I actors with common roadmaps between institutes and common programs to achieve the R&I goals of Europe.
Smart Cities	-
Smart Grids	The R&I community plays an important role in contributing to the maturity of thinking on building R&I agendas. Being part of the process on implementing these strategic objectives through the IWGs. The objectives set out at EU level can be followed and reached by R&I community at national level.

Wind Energy	The R&I community could better exploit the outcomes the IP would lead to funding opportunities both in the European as well as national context. Currently, there is no leverage available.

II. On the SET Plan general level:

1. **In addition to specific R&I actions, which in your understanding are the most important overarching strategic objectives and targets per technology that should be covered/included in the SET Plan? Please, list maximum three.**

AMPEA	AMPEA does not address any specific technology per se. However, creating overarching IPs covering multiple IWGs is desirable; e.g., advanced materials development, integrated/hybrid energy production/storage technologies, addressing not only the legitimacy of the RE/LC technologies but also the sustainability (including EU strategic autonomy) dimensions. Inclusion of digital innovations, measurement standardization, sustainability KPI definition are some of the key supporting R&I actions for these IPs.
Bioenergy	SET Plan objectives should be aligned with all the new policies (Fit to 55, RePowerEU, etc.).
Carbon Capture and Storage	1) Accelerate innovation through Innovation Funds projects to include R&I components 2) Support CO2 transport infrastructure, through a Connecting Europe Facility – (European infrastructure) 3) Deployment of the CCUS strategic value chain through IPCEI – Important Project of Common European Interest
Concentrated Solar Power	• Clear visualization and development of corresponding roadmap about how the full decarbonization of power sector is going to be achieved in the EU • Proper identification of synergies and complementarities of different renewable sources at EU level also identifying the barriers and difficulties to the optimum use of such complementarity • Full understanding of benefits, contributions, and possibilities of CSP technology to the achievement of full decarbonization at EU level
Digitalisation for Energy	From the 10 actions for research and innovation already identified in the integrated SET Plan, “New technologies and services for consumers” is the most important as it will make possible the human-centric approach for the coming energy sector
Economic, Environ. and Social Impacts of the Energy Transition	- Sustainability of the RES technologies - Reduction of energy demand - Mitigation of impacts on energy poverty and quality of life for the citizens. - Citizens engagement in designing innovation strategies

Energy Efficiency in Industrial Processes	There are many energy efficient technologies developed see revised SET plan. An important technology for different industrial sectors is industrial heat pumps for which the JP has made a white paper in 2020. The objectives and targets for industrial heat pumps indicated for the period 2020-2025 are*: 
Energy Storage	1. Raw materials availability and recycling 2. Development and improvement of new battery chemistries 3. Assessment of manufacturability for new battery chemistries
Energy System Integration	There should not only be strategic objectives per technology, but also at the system level. For instance, decarbonization efforts should be directed towards the most cost-efficient solutions and not, for instance, at high cost in one sector while ignoring low-cost decarbonization options elsewhere. It is dangerous to set lower level targets such as a percentage of green hydrogen, as this might redirect valuable resources from areas where they would have a bigger decarbonization impact. Therefore, the energy system should be guided as much as possible by system-wide targets and policy measures, and individual technology policy should be limited to getting promising policies ready for the market.
Geothermal	A much more explicit focus on heating&cooling (including heat/cold storage) is needed. In addition, the reduction on the reliance of critical raw materials such as Lithium, Cobalt, Nickel … is a major aspect to be addressed. Geothermal energy is a renewable energy that does rely on CRM as much, but can actually provide some of them (Lithium from geothermal brines)
Hydropower	1. Digitalization

	2. Digitalization will create new economic opportunities for hydropower operators, by reducing the costs and increase the income for the entire lifespan of hydropower assets. Innovative digital technologies will also improve turbine yields and productivity while driving down costs in design, operations and maintenance, thereby reducing the cost of energy. 3. Climate effect on the HP system 4. Market for flexibility
Nuclear Materials	-
Ocean Energy	- Skill and training - Infrastructure planning - Energy security
Photovoltaic Solar Energy	The two main overarching strategical challenges are: 1. Making the energy transition a European success: To become self-sustainable at EU-level, meaning producing our own technology and needing as few resources and raw materials from outside EU as possible. In this way, PV would be competitive in all parts of Europe while allowing for (the additional cost of) energy system integration and integration in the living environment 2. It is important to make PV available for a wider range of application, with emphasis on flexible integration (buildings, infra, etc.) and dual functionality (agri-PV/ agrivoltaics, etc.), as well as floating system. 3. Obtaining a 100% clean energy system with 100% circularity is crucial. 4. Rebuilding the strategical value chain for PV, by exploiting Europe's technological leadership
Smart Cities	-
Smart Grids	The optimisation of the energy resources utilising **advanced smart features** of the system (e.g. batteries, storage, hydrogen, DSM etc.). The evolution of **energy communities** can offer advanced **flexibility benefits** to the operation of the power system. **Digitalisation** of the energy grid would have a central role on the evolution of the energy system.
Wind Energy	1. To place renewable energy technologies at the heart of the energy transition; 2. Europe should become No1 in renewables; 3. Accelerate the EU energy system transformation in a cost-effective way.

2. **How would you rate the SET Plan impact in providing a collaborative mechanism (e.g., networking, funding, platforms et sim.) for the execution of the SRIAs and DoW of your Joint Programme?**

AMPEA	High impact
Bioenergy	Low impact
Carbon Capture and Storage	High impact
Concentrated Solar Power	Medium impact
Digitalisation for Energy	Low impact

Economic, Environ. and Social Impacts of the Energy Transition	High impact
Energy Efficiency in Industrial Processes	High impact
Energy Storage	Medium impact
Energy System Integration	-
Geothermal	Medium impact
Hydropower	High impact
Nuclear Materials	Low impact
Ocean Energy	Low impact
Photovoltaic Solar Energy	Medium impact
Smart Cities	-
Smart Grids	High impact
Wind Energy	Low impact

3. **Which of the following actions would you consider as more effective to improve the impact of the above-mentioned mechanism? Please, elaborate on your choice(s) above:**

	Enhance collaboration/involvement or on-time mobilization of the relevant stakeholders (industry, member states, research etc.)	**Improve flexibility of both European and national strategies and action plans' revision processes**	**Increase the accessibility to funding and partnership opportunities to address emerging R&I collaboration needs**	**Ensure more influence for the JPs and relevant platforms (e.g. ETIPs) in the governance of the SET Plan**
AMPEA			X	X
	As a transversal joint programme, creation of an IWG on 'Advanced Materials' covering several Key Actions (at the moment, there is KA5: New materials & technologies is limited to buildings) would increase the influence of materials scientists of EERA (AMPEA) to the SET-Plan mechanisms.			
Bioenergy			X	X
Carbon Capture and Storage	X	X	X	
	Other: Establishment of an European Centre of Excellence (see question 6).			
Concentrated Solar Power	X		X	X
	For the implementation of the DoW, there is a need for greater involvement of Member States to fund the R&D activities, as well as greater participation of industry in the implementation of the developed innovations in commercial CSP plants, with the aim of demonstrating the reliability of the technology. Currently, the framework programme budget for CSP is less than 5%, compared to other technologies such as wind or photovoltaics, which exceed 20%. Therefore, increased			

	funding opportunities are needed if real deployment of CSP technology is to take place. Finally, it is necessary that the JP members, who are the most active in the development of CSP technology, are more involved in the elaboration of the SET Plan with the aim of aligning the needs of both European and national R&D funding programmes			
Digitalisation for Energy			X	
	Because most of the JPs developments should be driven through consolidated and funded initiatives.			
Economic, Environ. and Social Impacts of the Energy Transition	X		X	
Energy Efficiency in Industrial Processes	X		X	
	The impact for the JP EEIP is high since the JP gets a good overview of the needs of the sectors and the relevant topics e.g. on heating & cooling are included in the Horizon Europe RIA and IA calls.			
Energy Storage	X		X	X
Energy System Integration				
Geothermal			X	X
	The specific needs of the different JPs and the technologies they work on vary a lot. Therefore, the best way forward is to give the JPS and etips a stronger role and more responsibility			
Hydropower	X	X	X	X
Nuclear Materials			X	
Ocean Energy	X	X		
	The main impact improvement would be strategic agreement between the EC and MS on the responsibilities for delivering the SETplan			
Photovoltaic Solar Energy			X	X
	More money from EU and member states is needed and better alignment between all EU funding schemes to realize the goals of the SET-plan. Technical goals should be defined by the industry and research stakeholders as assembled by ETIP and EERA.			
Smart Cities				
Smart Grids	X			X
	The SET Plan success lies on the fact that it mobilises stakeholders to achieve research thinking on strategic issues. This is an added value that should be maintained and reinforced.			
Wind Energy			X	
	Other: The IWG should have intense strategic discussions with ETIP Wind and EERA JP Wind on research priorities with the intention to have this reflected in European and national calls.			

4. **What type of actions should be implemented in order to establish a closer link between the SET Plan and other initiatives and programmes (e.g., European Partnerships, Programmes, National funding etc.)? Please, list maximum three.**

AMPEA	-
Bioenergy	a. To improve the coordination and synergies. b. To make sure the key agents are involved in SET Pan initiatives and programmes.
Carbon Capture and Storage	Establishment of a follow-up CSA (JA-2 IMPACTS9) in line with the CSA project from ETIP ZEP to continue delivering on the SET Plan IP in close dialog and strong cooperation with industry
Concentrated Solar Power	1. Having the same representatives from Member States in SET Plan Steering Committee, Horizon Europe Framework Programme, and Clean Energy Transition Partnership. 2. National funding programmes should be aligned to Horizon Europe Framework Programme, in terms of topics, time, and rules. 3. Closer monitoring from EC and the SET-PLAN of CSP-IP evolution, promoting or fostering additional initiatives or actions when low or insufficient progress (to the targets achievement) would be identified.
Digitalisation for Energy	Most of the countries are already customising their own R&D funding calls with the European identified priorities. Not so familiar with the SET Plan. As far as I know, the governing bodies pursues the alignment with EC's funding programmes, so just a strong effort in coordinating calls and joining funding should be achieved.
Economic, Environ. and Social Impacts of the Energy Transition	SSH should be stronger positioned in the conference scene in Europe and especially in the conferences driven by the JRC and the EC.
Energy Efficiency in Industrial Processes	Better contact/link with the ministries of the participating countries Indicate priorities and roadmap for 2025, 2030, 2040 and 2050 Translation of the SETplan to national Energy transition plans Input to EU policy, faster and joined input, outreach and action to the EU
Energy Storage	Development of understanding of the R&I needs by National programs (better communication of SET plan targets to the national programs)
Energy System Integration	-
Geothermal	Partnerships and actions such as ERA-Net Calls suffer from the different management of national fundings, and the opportunities are very unbalanced. A support for harmonizing the rules is recommended. The EU can provide more (financial) incentives for the cooperation, essentially more co-funding of transnational research programmes.
Hydropower	-

Nuclear Materials	Difficult to know which actions. There should be willingness to identify mechanisms for effective and funded cooperation between the MS within the SET-plan. Bilateral schemes (multilateral in the case of, e.g., Northern Europe countries) do exist, but they are not generalized to the SET-plan.
Ocean Energy	An agreement on joining up NECPs, national funding, EC work programme funding and the IPs
Photovoltaic Solar Energy	-
Smart Cities	-
Smart Grids	There should be more effort to identify **practical and more effective ways of collaboration** with the respective stakeholders. This also applies for collaboration at national level. Additionally, a stro**nger representation of countries** is needed as the level of participation and commitment among them varies. There should be a more robust process to allow **timely contributions in specific topics**. In this end, it would be beneficial to establish more **thematic areas of common interest**. The established **working groups** (in parallel to the IWGs) that bring together experts, have been proved very successful. This is a good example and similar mechanisms should be identified. **A "workable" representation of 3-4** people should be established to represent ETIP/JP in the different fora and the meetings with other stakeholders (e.g. IWG, partnerships etc.). It is expected that a smaller and more efficient representation consisted of committed people would be welcomed by the EC instead of direct collaboration with all separate entities that is considered an impossibility.
Wind Energy	The offshore wind sector should create a ECoE with the input of both ETIP Wind, IWG and research community to define the strategic goals and commit significant funding to programmatic approach. The impact would be significantly increased. The ECoE should then be funded from EU, national governments, and industry.

III. EC communication of the REPowerEU plan

1. **Given the strategic importance of the recent EC communication on the REPowerEU plan, what are in your opinion the long-term (>5 years) R&I challenges that you would like to see integrated into the revised SET Plan IPs?**

AMPEA	-
Bioenergy	- To significantly increase biomass gasification to biomethane (and hydrogen), in particular residual forest biomass. - Research and implementation on biomass crops in rotation (inter-cropping) and in marginal/abandon lands.

	- Integration of bioenergy/biofuels in the industrial sector to facilitate closing of productive circles. Enhancing the biorefineries concept. - Integral assessment of all the biomass uses. Different roles of biomass should be integrated.
Carbon Capture and Storage	-
Concentrated Solar Power	The IP has recently been revised and all short- and long-term R&D challenges have been included. The IP is just pending approval by the SET-PLAN Steering Committee.
Digitalisation for Energy	REPowerEU mainly focuses on increasing the production of energy from different sources different than the fossil Russian ones we are now consuming. In this sense, it is a logical approach for the short- and medium-term. Might we want to succeed with this plan, digital solutions are the actual key enablers for achieving the 2050 objective in due time. In a world in which the digital transformation is empowering every daily process, the energy sector must be a prominent example of the adoption of digital solutions. Beyond current developments in HPC, HTC/IoT, FAIR adoption, data science, or artificial intelligence, cybersecurity and blockchain will be important actors as well.
Economic, Environ. and Social Impacts of the Energy Transition	Sustainability assessment of RES technologies in terms of environmental impact, economic feasibility and dynamics and effects on social equity Systemic approach aimed at exploring interactions among the different components of the energy systems (actors, technologies, policies) and interactions within other social subsystems (e.g. market and the whole economy, welfare, transport, education…) Specific focus on energy poverty, both for improving their definition and measurements and to mitigate the social effect of the transition Specific focus on energy demand, in order to investigate its generative mechanism, to better qualify the demand profile (not only how much but how and why energy is consumed) and to identify dynamics and strategies for its reduction
Energy Efficiency in Industrial Processes	- short term actions: implement BAT in industry like e.g efficient electrical motors driving pumps and compressors, implement low temperature heat pumps in industry - actions >5year: most are already included in the SETplan Action 6, more attention to R&D on technologies using electricity iso natural gas is needed.
Energy Storage	On the path set by the REPowerEU plan it would be beneficial to stress the integration of RES and energy storage. Hybridization of energy storage (ES) technologies is a main challenge for the medium-long term horizon.
Energy System Integration	- How to design low-carbon energy markets that: ○ Provide security of supply at the an economically efficient cost level; ○ Integrate all types of flexibility at all system levels efficiently.

	- How should the networks for electricity and gas/hydrogen be developed over the coming decades, given: o Their very long construction times; o Their mutual interactions; o The time it takes to develop a fully renewable energy system and the need to maintain gas security of supply in the mean time? - What role should CCS and nuclear energy play during and after the transition?
Geothermal	RePowerEU is too focused on a few technologies. It should be more ambitious for the heating sector, not only electrifying it but integrating all RES, including thermal ones, in the system. Policies for the heat market should be also considered. Storage, including geothermal storage for the heating sector, should be included, circular economy referenced.
Hydropower	The role of HP in storing water (and thus electricity) will require more effort to enlarge existing storing capacities The role of HP in producing hydrogen will have to be looked carefully at. The role of HP in relationship with other renewable energy sources
Nuclear Materials	Nuclear is not considered by REPoweEU, whichever the reason, thus in our case it is very difficult to tell.
Ocean Energy	- Solutions for demand reduction through smart metering - European energy integration and balancing - Strategic skills and supply chain planning
Photovoltaic Solar Energy	The REPowerEU plan focuses among others on getting much more PV installed in Europe in the coming years. To realize this, we need to bring back the whole value chain of PV to Europe and ensure that R&I goals are tuned to providing this EU PV value chain with the right R&I advancements that will be needed for a sustainable and clean massive PV production in Europe. Hence, lowering the CO2 footprint and reducing the need of critical raw materials for the production of PV panels are critical long-term goals that need to be added into the revised SET-plan for PV
Smart Cities	-
Smart Grids	In a fast-evolving technological field as the smart grids, the R&I topics that need to be addressed are already well-defined within the current strategy leading to Fit for 55 and repeated in the REPowerEU communication. REPowerEU poses an urgency to accelerate technological advancements in shorter term and facilitate the integration of other needed systems and technologies (e.g. solar, wind, storage etc.) in a sector that has more ambitious decarbonisation targets in comparison to other sectors.
Wind Energy	With implementation of offshore wind, the EU energy sector can have low cost, bulk energy on relatively short timescales. The R&I challenges that should be integrated are: - Wind energy technology - Wind farms operating as power plants - Wind power system integration

	- Environmental impact - Optimal use of space - Infrastructure and grid development - Manufacturing, processing and circularity

ANNEX 5 – Consolidated results from the gathered answered surveys on the revamp of the SET Plan by ETIPs

Surveys' responses from the ETIPS

IV. On the SET Plan Implementation Plan(s):

7. To which extent do you consider that your ETIPs' SRIA (or equivalent) is incorporated into the existing Implementation Plans of the respective IWG?

ETIP DG European Technology & Innovation Platform on Deep Geothermal	It is well incorporated
ETIP OCEAN Ocean Energy	Very well after their recent revision
ETIP RHC Renewable Heating & Cooling	Limited extent (only electrical and absorption heat pumps, renewable district heating and cooling, renewable process heat and cold, thermal energy storage, Micro CHP/CCHP covered in the IP)
ETIP SNET Smart Networks for Energy Transition	To a large extent, but can be improved The published ETIP SNET IP 2022-2025 is covering quite well the main objective of SET Plan Action 4
SNETP - Sustainable Nuclear Energy Technology Platform	The SNETP is being involved and coordinate the actions and dialogue with the Member states representatives and the European commission officers, especially those of DG-RTD/JRC-Euratom
ETIP Batteries	In 2020, Batteries Europe revised the batteries implementation plan, its targets and R&I activities, as reflected in the updated Strategic Research Agenda (SRA) for batteries and as supplemented with roadmaps for various segments of the value chain. Therefore, the Batteries Europe SRA is identical to the IP of the IWG.

8. Please, indicate at least three barriers and obstacles that prevent the smooth integration of ETIP's priorities into respective Implementation Plan.

ETIP DG European Technology & Innovation Platform on Deep Geothermal	Authorisation problems; Too many agencies dealing with the same themes and overlapping of competencies
ETIP OCEAN Ocean Energy	The issue is not the integration from ETIP to SET Plan, but from SET Plan to national and EU policies & priorities.
ETIP RHC Renewable Heating & Cooling	Renewable heating and cooling lacks a dedicated Implementation Working Group. RHC comprises several individual technologies as well as several end-uses. Since the creation of SET Plan, RHC has been linked to IWG5 - Energy efficiency in buildings through action 5.2 on Cross cutting heating and cooling technologies for buildings. However, through different technologies/end-uses, it is relevant to several other IWGs, beyond the level of buildings. In case of IWG5, this linkage applies only to a selection of technologies that RHC covers, which leads to underrepresentation of others as well as barriers to incorporation of RHC-ETIP´s SRIA priorities to the IWG5 IP.
ETIP SNET Smart Networks for Energy Transition	Insufficient coordination Insufficient exchange of information No direct discussions Especially with regard to energy storage, the SET Plan Action 4 lacks a state-of-the-art specific analysis of different energy storage and conversion technologies that would help translate the challenges that these technologies are facing into specific innovation and R&I objectives at EU level. This will help to define the scope and objectives of the EU R&I strategy and to appropriately manage and monitor the results.
SNETP - Sustainable Nuclear Energy Technology Platform	Many obstacles, among others: 1) lack of resources and long-term vision both at the MS and EC levels 2) The energy strategy of the EU is divided in silos rather than using all available tools to reach the net Zero 3) lack of dialogue between the decision makers within the EC
ETIP Batteries	No barriers or obstacles are observed in the integration of ETIP Batteries priorities to the IP. Similarly to the previous answer, the SRA of Batteries Europe is completely embedded in the IP of the IWG.

9. **To the already existing technological and cross-thematic areas (i.e. energy efficiency, digitalisation etc.), which non-technological topics should be addressed by one or more IPs? Please, prioritise at least three from the drop-down lists below. Please, elaborate on your choice(s) above:**

	Priority 1	Priority 2	Priority 3
ETIP DG European Technology & Innovation Platform on Deep Geothermal	Policy & Regulation	Social awareness, acceptance, engagement	Socio-economic policies and measures
ETIP OCEAN Ocean Energy	Policy & Regulation	R&I funding programmes and measures;	
	Permitting is a common challenge and a hot topic now with the Commission's guidelines	Clean energy transition requires more push for R&I to bring technologies to market.	
ETIP RHC Renewable Heating & Cooling	Policy & Regulation	Education & Training	Social awareness, acceptance engagement
	Policy and regulatory support is needed to streamline administrative processes including permitting of technology deployment;	Rapid training all along the value chain of professionals is needed for deployment of existing technologies;	Understanding of user behaviour is required to implement smart solutions and enable demand side management. IPs should address the challenge of holistic societal acceptance and use of renewable energy sources across all end-use sectors; Social acceptance needs to be boosted through awareness campaigns. People still think for example solar thermal or PV are harmful to the environment and that they take away land, which can be used for agricultural purposes or as playground for families;
ETIP SNET Smart Networks for Energy Transition	**ETIP SNET 1**		
	Education & Training	Social awareness, acceptance, engagement	Policy & Regulation
	Education is of primary importance for future citizens and has not been given adequate attention so far. School and university curricula need to be enriched with new knowledge and provide better technical and social skills;	The central role of the citizen in energy transition is of primary importance, this involves all citizens beyond school education. Engagement as prosumers, energy communities and active citizens is extremely important.	Policies and regulation have been sometimes barriers to the energy transition, these need to be constantly evaluated and adapted, also in view of technological and social developments
	ETIP SNET 2		

	Social awareness, acceptance engagement	Standardisation	Policy & Regulation
	Citizen participation is a priority in any strategy and avoid unnecessary and inefficient delays and social tensions	Especially for new technologies, if carefully considered, standardisation helps to stimulate market growth and support innovation.	Policy and regulation can be of great help, but they must be properly tailored to the interests of EU citizens
SNETP - Sustainable Nuclear Energy Technology Platform	R&I funding programmes and measures	Education & Training	Socio-economic policies and measures
	Nuclear R&D&I develops cutting-edge knowledge that may be beneficial to several other sectors, such as health, aerospace, digital, …	In 2019, the nuclear industry sustains more than 1.1 million jobs throughout the European Union, out of which more than half a million are staffed with highly skilled professionals, among them 15000 researchers. Without continuous support the EU cannot compete at the international level	The EU has the most advanced legally binding and enforceable regional framework for nuclear safety in the world and, despite diverging views among Member States on nuclear generated electricity, there is a shared recognition of the need to ensure the highest possible standards for the safe and responsible use of nuclear power and to protect citizens and environment from radiation. Thus, nuclear, together with renewables, can play an important role in reducing the dependence on fossil fuel energy imports in Europe and produce industrially a large quantity of decarbonised electricity at affordable and stable price.
ETIP Batteries			
	Education & Training	Standardisation	Policy & Regulation
	R&I is needed to provide the European industry with the required technological advances along the value chain. One of these advances is to create a workforce with the necessary skills along the full battery value chain as well as excellent scientists. The development and expansion of different educational segments must be rapidly invested in and implemented, including Academic, Professional, Vocational and Public/User segments along with measures that stimulate gender balance in all areas. This transversal approach should focus to provide a workforce with the necessary span of competencies and depth of	Most research efforts focus on improving battery performance and durability; however, battery safety is paramount to ensure confidence and widespread adoption of e-mobility and electrical energy storage in our society. Battery research outcomes are increasing, and further usage-state development are quickly reached. All these advances need to be foreseen and aligned with safety protocols or processes in order to provide safe and quick solutions to the battery market. Accordingly, standardization bodies like, ISO, IEC, SAE, CEN-CENELEC, etc. provide the needed standards to proceed safely with battery solutions.	Sustainability will be a major differentiation factor of EU battery technologies within the international competitive landscape. To this end, a close cooperation with policy makers is necessary to establish the adequate regulation framework to ensure competitiveness. Important issues should be addressed across the three main sustainability pillars (i.e. economic, social, environmental).

	knowledge required to elevate the European Battery Industry.		

V. On the SET Plan general level:

5. In addition to specific ETIP's priorities, which in your understanding are the most important overarching strategic objectives and targets per technology that should be covered/included in the SET Plan? Please, list maximum three.

ETIP DG European Technology & Innovation Platform on Deep Geothermal	Electrification of domestic and industrial users through the implementation of heat pumps (geothermal) installing new renewable energy capacity
ETIP OCEAN Ocean Energy	/
ETIP RHC Renewable Heating & Cooling	2030 RED target of 40% RES share for heating must be a priority. H&C accounts for half of all energy consumption and continues to be neglected. This target (and sub-targets) covers a wide range of technologies. a) "Highly energy-efficient and climate neutral EU building stock": b) "Accelerated fuel switch fuel from gas to RHC in buildings" c) "Accelerated fuel switch fuel in District heating and cooling systems"" d) "Switch fuel in industry: H&C supply for low- and medium-temperature processes"
ETIP SNET Smart Networks for Energy Transition	Chemical storage technologies and P2X (e.g. H2): Improve efficiency and costs Thermal storage technologies: improve energy density, cost and lifetime at different working temperature Pump hydropower: Development of small-scale solutions and marine solutions, reduction of time for deployments
SNETP - Sustainable Nuclear Energy Technology Platform	• Nuclear R&D&I develops cutting-edge knowledge that may be beneficial to several other sectors, such as health, aerospace, digital, … • Vice-versa other cutting-edge technologies such as artificial intelligence for example could be used in nuclear technology, for example for design and maintenance of nuclear facilities.

	• SNETP intends to promote those cross-sectorial benefits in its R&D&I programme. • Cross-sectorial industrial cooperation between electricity, heat, hydrogen generation and energy intensive sectors will be a key element to drive success
ETIP Batteries	Skills and education: Attract the most prominent experts from all value chain with a focus on domains recently emerging , notably recycling and manufacturing. New thematic areas: Bring new thematic areas, facilitated by the creation of new Task Forces (such as Social Science & Humanities, Standardization and Hybridization), as well as strengthening the effort on current critical domains: Digitalization among all. International cooperation: Facilitate the establishment of a dialogue at a global level around selected topics to influence the international battery agenda with EU priorities and values. Citizens' Engagement: citizens and stakeholders and promote STEM disciplines to push societal transformation towards a climate neutral economy.

6. **How would you rate the SET Plan impact in providing a collaborative mechanism (e.g., networking, funding, platforms et sim.) for the execution of the SRIAs?**

ETIP DG **European Technology & Innovation Platform on Deep Geothermal**	Medium Impact
ETIP OCEAN **Ocean Energy**	Low Impact
ETIP RHC **Renewable Heating & Cooling**	Low impact
ETIP SNET **Smart Networks for Energy Transition**	Medium/low Impact
SNETP - Sustainable Nuclear Energy Technology Platform	Low impact
ETIP Batteries	High impact

7. **Which of the following actions would you consider as more effective to improve the impact of the above-mentioned mechanism? Please, elaborate on your choice(s) above:**

	Enhance collaboration/involvement or on-	**Improve flexibility of both European and**	**Increase the accessibility to funding and**	**Ensure more influence of relevant platforms (e.g.**

	time mobilization of the relevant stakeholders (industry, member states, research etc.)	**national strategies and action plans' revision processes**	**partnership opportunities to address emerging R&I collaboration needs**	**ETIPs, EERA Joint Programmes, NRCGs) in the governance of the SET Plan**
ETIP DG European Technology & Innovation Platform on Deep Geothermal				
ETIP OCEAN Ocean Energy				
ETIP RHC Renewable Heating & Cooling				
	The budget allocated to RHC technologies for the next years (i.e. HE WP 2023-2024), must increase significantly to face the gas crisis and the high heating prices caused by the increased prices for electricity, gas and oil. It is crucial to tackle the issues in the heating sector for a smart sector integration. The amount allocated for RHC technologies must allow for development of several types of actions to switch fuels and at different TRLs for the destination "Global leadership in renewable energy			
ETIP SNET Smart Networks for Energy Transition	**ETIP SNET 1**			
	Enhancing the collaboration/involvement of relevant stakeholders is of major importance. At ETIP SNET the participation of the energy industry (including operators) is at good level, but not of member states. Influence of the ETIP platforms in the governance of SET Plan would certainly help coordination and alignment			
	ETIP SNET 2			
	Replicate the strategy adopted for batteries also for other energy storage and conversion technologies.			
SNETP - Sustainable Nuclear Energy Technology Platform				
	Several recent studies from the European Commission, the IPCC and various stakeholders have explored the potential for increased ambition for the decarbonisation of the power sector: These studies suggest a growing role of electricity, from circa 20% of the European final energy consumption in 2015 to more than 40% to 50% by 2050 through electrification of transport, heating and cooling and industrial processes. Nuclear energy also contributes to improving the dimension of energy security (i.e., to ensure that energy, including electricity, is available to all when needed) since: • fuel and operating costs are relatively low and stable: about 15% of the kwh produced by a nuclear power plan (other 85% are related to the construction and dismantling);			

	• it can generate electricity continuously for extended periods; and • it can make a positive contribution to the stable functioning of electricity systems Thus, nuclear, together with renewables, can play an important role in reducing the dependence on fossil fuel energy imports in Europe and produce industrially a large quantity of decarbonised electricity at affordable and stable price.
ETIP Batteries	Assigning the role of observer to ETIPs and EERA Joint Programmes in the revamped governance structure of the SET Plan to ensure a continued dialogue with the SET Plan's main stakeholders.

8. **What type of actions should be implemented in order to establish a closer link between the SET Plan and other initiatives and programmes (e.g., European Partnerships, Programmes, National funding etc.)? Please, list maximum three.**

ETIP DG European Technology & Innovation Platform on Deep Geothermal	/
ETIP OCEAN Ocean Energy	SET Plan should have a stronger role so that national governments would take it seriously
ETIP RHC Renewable Heating & Cooling	It is crucial that the SET Plan considers the entire energy system, power, heating and cooling, fuels and the match between supply and demand through storage. It should also consider all energy users: built environment, industry, agriculture and transport. 'Energy' should not be used as a synonym for 'electricity' for enhanced clarity. Technological progress is a quick win for international collaboration. While consumer needs in various countries differ, better technologies serve all. The SET Plan must play at its strengths. It must support the implementation of the Fit-for-55 package and the climate objectives 2030 and 2050.
ETIP SNET Smart Networks for Energy Transition	**ETIP SNET 1**
	All the available
	ETIP SNET 2
	Actions to enhance influence in the SET Plan Governance Actions for information exchange - consultations
SNETP - Sustainable Nuclear Energy	SMR-partnership" launched in June 2021 under the auspice of the European commission is an opportunity to develop cross-sectorial

Technology Platform	synergies and to deploy modern and innovative technologies in the nuclear sector. It is also an opportunity to strengthen EU research and industrial nuclear capabilities on SMR which may lag behind a number of other countries.
ETIP Batteries	1. Align the schedule of the publications of key deliverables, such as SRIA, with the rest of the ecosystem and in particular with BEPA 2. Identification of the challenges and opportunities of the collaboration and consolidate the synergies with all players of the EU Batteries Ecosystem but also exploring interactions with other ETIPs, via the recently established ETIPs Forum, and to raise the debate on selected topics at an international level. 3. Create guidelines based on which the synergies will be developed

VI. EC communication of the REPowerEU plan

2. Given the strategic importance of the recent EC communication on the REPowerEU plan, what are in your opinion the long-term (>5 years) R&I challenges that you would like to see integrated into the revised SET Plan IPs?

ETIP DG European Technology & Innovation Platform on Deep Geothermal	Infrastructures for electric mobility; renewable energy utilisation including geothermal
ETIP OCEAN Ocean Energy	1 GW of ocean energy by 2030, as stated in the EU Offshore Renewables Strategy.
ETIP RHC Renewable Heating & Cooling	Meeting winter heating demands in the absence of Russian gas is the largest challenge in the context of the REPowerEU plan. From a R&I perspective, the challenge lies in the development and scale up of alternative, low-carbon heating solutions - Boost of resilient/renewable technologies and sector coupling to reduce dependence from das and oil - 100% of new and refurbished H&C installations in buildings are with RHC technologies - 100% of new low to medium temperature industrial processes are with RHC - 100% of new H&C systems in the agri-food industry are with RHC
ETIP SNET Smart Networks for	**ETIP SNET 1**
	Doubling EU's photovoltaic and wind capacities Accelerating the rollout of rooftop PV systems

Energy Transition	**ETIP SNET 2** It should examine the challenges that energy storage and conversion technologies are facing and enable a rapid and effective penetration of renewable energy and the decarbonisation of energy-intensive industries.
SNETP - Sustainable Nuclear Energy Technology Platform	According to the European Commission's REPowerEU Plan, nuclear will have a role to play in ensuring security of EU energy supplies. Furthermore, the Commission recognises that hydrogen produced from nuclear will act as a substitute for natural gas. As rightly pointed out in the plan, stopping the phase out of nuclear power plants can help to reduce the EU's dependence on Russian gas. "Furthermore, the Commission makes clear that this will also bring economic benefits, as it will lead to lower investment costs. Given this, we firmly believe that one of the best ways of ensuring security of supply and lower investment costs today is to keep as many nuclear power plants running for as long as possible." However, this only provides a solution in the relatively short term. If the EU really is committed to a longterm, stable and affordable supply of low-carbon energy, more needs to be done to support the development of new nuclear projects, including small modular reactors. The shift towards increased electrification and greater use of low-carbon hydrogen will require vast amounts of low carbon energy. And this energy needs to be produced in Europe. Relying on massive imports of renewable hydrogen from outside of Europe to meet our demands will not solve our import dependency issues. We need to focus on increasing production of low-carbon hydrogen in Europe. The best way of achieving this is through an electricity mix made up of nuclear and renewables.
ETIP Batteries	The long term challenges on electrochemical storage as key enabler of RES efficient use. In the long term, R&I community has to provide new concept of batteries, more cost effective or more integrated into the use (i.e. in the "zero emission houses"). Important keywords will be flexibility, interoperability, hybridization (on energy storage (ES) technologies) and sustainability. Another important aspect will be digitalization at all level: from research data management to digital tools enabling the efficient integration of RES and ES in the grid.

ANNEX 6 – Position of SUNERGY on the revamp of the SET Plan

The current energy crisis and geopolitical situation have made even more evident that diversification and integration of complementary technology solutions to replace fossil-based energy sources and raw materials are essential to support Europe's energy independence, secure energy supply and support sustainability and EU competitiveness and innovation.

SET-Plan strategy and priorities on solar energy should embrace a portfolio of technology solutions, besides the more established ones which are already included (e.g. PV, CSP). **Conversion of solar energy into renewable fuels and chemicals (thereafter "solar fuels and chemicals" - SFC)** is complementary to these solar technologies and support technology integration within the energy system. In this respect, **R&I actions on SFC should be included in the revised SET-Plan**, as an important asset to unlock and maximise the potential of solar energy, **in the short/medium and longer-term alike**. In the current structure of the SET-Plan, SFC are particularly relevant to the **key actions** on **"Renewable fuels and bioenergy"** and **"Carbon capture and storage/use"** (SFC, when involving CO_2 as a feedstock, is a form of CCU) and the related IPs, and could be addressed there. While in principle "Renewable fuels and bioenergy", according to its name, should encompass also synthetic fuels, i.e. solar fuels and electrofuels ("e-fuels"), in reality the IP, the IWG, and related initiatives, are focused solely on biofuels and bioenergy. However, technological scalability, readiness level, and dependence on infrastructures are different for biofuels and solar fuels – therefore, there's currently a gap in the energy and policy landscape which is important to bridge. SFC are also related to the IP on CSP and solar thermal electricity, but actions in these areas currently address few fuel-producing technologies.

The technological portfolio related to synthesis of SFC is based on two main approaches with different timelines for development and deployment:

- *Indirect* routes, where solar energy is converted into fuels and chemicals via multiple steps. This includes, on one hand, the synthesis of renewable e-fuels from solar photovoltaic power via electrochemical processes and, on the other hand, the direct use of solar concentrated energy to carry out thermochemical processes. In terms of time frame, such indirect routes could turn into reality by 2025 with technologies adapted to existing infrastructures;

The second, more disruptive route is the *direct conversion of solar to chemical energy* (usually referred to as "*artificial photosynthesis*") enabling a decentralized manufacturing of SFC. There are several approaches at different levels of technological maturity for direct conversion of solar energy: photo-catalytical and photoelectro- catalytical systems, biological and biohybrid systems. By 2030, direct conversion routes will allow the transition to a partially decentralised

production. Beyond 2030/by 2050, efficient solar energy conversion of CO_2 into long- lasting materials, as an approach to Carbon Capture and Use (CCU), will contribute to a CO_2-neutral circular economy, net-climate neutral mobility, and to cost-effective and negative emission technologies deployed on a large scale.

In both indirect and direct routes, high production yields are key to limit the footprint of those technologies in terms of surface area, thus implying the optimization of production processes and related materials.

Barriers and obstacles that prevent the smooth execution of the R&I components of SUNERGY

- **Absence of SFCs as a dedicated area** in the current version of the SET-Plan to unlock solar energy potential for decarbonization and long-term energy storage;
- **Insufficient recognition of SFC and their potential in the short/medium and longer-term alike, considering different development timeframes:** e-fuels/chemicals from renewable and low-carbon power can turn into reality by 2025, linking surplus of green electricity and electrochemical processes to develop technologies adapted to existing infrastructures; by 2030, direct conversion processes of solar to chemical energy as SFCs will allow the transition to a partially decentralised production; beyond 2030/by 2050, efficient solar energy conversion of CO_2 into long- lasting materials, as an approach to CCU technologies, will contribute to sustainable energy development based on a CO_2-neutral circular economy, net-climate neutral mobility, and to cost-effective and negative emission technologies deployed on a large scale;
- **Competition vs integration with other technology solutions:** conversion and storage of solar energy into solar fuels and chemicals should be considered as complementary – and not in competition - to more established solar technologies (e.g. solar PV, CSP, biofuels). This is in line with supporting technology integration within the energy system to achieving the Green Deal objectives, including Europe's energy security and independence. Converting solar energy into fuels and chemicals is imperative to minimize dependence on natural gas.

Main long-term challenges of the energy system that are expected to impact the R&I priorities in SUNERGY technological field

- **Seasonal energy storage**. The EU share of solar energy technologies has been growing in the past decades; however, renewable power from PV/other renewable sources needs to be supplemented by energy carrier molecules to cope with their intermittency, allow seasonal energy storage and supply energy to sectors difficult to electrify (e.g. energy-intensive industries, heavy-duty transportation). SFC address the challenges to *convert and store solar energy* into fossil-free fuels and base chemicals, by developing cost-efficient, low-carbon and scalable technologies that are essential for defossilizing the energy, transport and chemical sectors. Technologies to produce SFC use abundant resources (CO_2, N_2, H_2O) to develop solutions either through *multi-step* (*e-fuels/chemicals*) or via *direct solar conversion (artificial photosynthesis)*;

- **Ensuring Europe's security of energy supply and industry's increased autonomy**. This aspect is essential, as shown by the current crisis related to the war in Ukraine. Local production of SFC contribute to facing this challenge through solutions replacing fossil resources - as an energy source or as a feedstock of commodity chemicals for the chemical & fertilizers industries - and technologies without/with a minimum of critical raw materials; supporting circular economy by helping to close the C- and N-cycles (esp. in energy-intensive and chemical industries); developing new routes for producing sustainable fuels/chemicals while building on infrastructures already available in Europe, with enormous investment savings, and developing new industrial value chains based on sustainable feedstocks. In this respect, SFC can contribute to *ensure supply for the whole energy system to the scale of its needs*: in fact, while biofuels are a mature technology that can supply renewable fuels and chemical products, its *scale* cannot be increased to the magnitude required for replacing fossil fuels completely. Technologies taking advantage of industrial solutions as well as distributed modular production are needed to complement and expand the renewable fuel market;

- **Replacing the centralised, fossil-powered energy system by a decentralised system** – e.g. through artificial photosynthesis, where large-scale centralized energy supply is not required. This would also help enhancing the *active role of communities and citizens as prosumers* through e.g. distributed energy solutions

SUNERGY's view on the long long-term (>5 years) R&I challenges in light of the REPowerEU Plan

The Commission Communication on the "EU Solar Energy Strategy" (COM(2022)221 final), recently released as part of the REPowerEU plan, doesn't explicitly include SFC as a form of solar energy besides solar PV (which is the main focus of the communication) and CSP/solar thermal. Being complementary to established solar technologies for a future decentralized energy system based on renewables, **conversion of solar energy into solar fuels and chemicals (SFC)** – and related R&I challenges and priorities (*summarised in the paragraphs above*) - should be included in the revised SET-Plan, and as a dedicated domain in the EU solar energy strategy, and in general in EU initiatives towards a more affordable, secure and sustainable energy.

ANNEX 7 – Position of Hydropower community on the revamp of the SET Plan

Hydropower as a catalyst and facilitator for the clean, safe and independent energy transition in Europe.

Key Messages:

- **Given Europe's ambition to raise the 45%1 hydropower is critical to ensure Europe's energy system has the necessary renewable electricity and flexibility to protect grid stability from intermittent renewable energy, to sustain the green transition.**
- **While hydropower is the largest renewable non-intermittent electricity supplier in the World and in Europe, there remains significant potential, mainly through refurbishments and pumped hydropower stations.**
- **More funding is needed in research and innovation to deploy solutions at the scale required in support of sustainable solutions that offer win-win situations for the environment and from an operational perspective.**
- **Europe must protect against periods of dunkelflaute by including flexible power generation and dispatchable large capacity renewable storage, like hydropower, in national targets.**
- **To ensure there is enough hydropower to meet Europe's decarbonization goals and maintain energy security, hydropower must have a prominent role within the Strategic Energy Technology (SET) Plan.**
- **The ETIP for hydropower will be an important initiative. Because it is coming after the SET Plan is released, it is important to include provisions for the findings of the ETIP within the SET Plan.**

The important role of hydropower with significant potential

Hydropower is a key technology for the energy transition and the largest renewable energy source in Europe. In 2019, electricity production from hydropower in Europe was 653 TWh/year

(334 TWh/year within the EU). This is equivalent to around 36% of the electricity coming from renewable sources in the EU and 10% of the entire generation mix, contributing significantly to achieving EU targets for energy and climate . Throughout the last century, hydropower has proved a climate-friendly, safe, reliable, and competitive source of renewable power generation and storage.

Today, we have only used 65% of the economically feasible hydropower potential that is available in Europe and Turkey, suggesting there is considerable untapped resource even taking into account that not all of this potential may be developed due to environmental barriers. Many countries rely on hydropower for a significant portion of their electricity generation. In 14 countries the share is between 25 and 50 %, in four more it is between 50 and 90% (Austria, Greenland, Switzerland and Iceland) and in Albania and Norway hydropower provides more than 90% of their electricity. This reveals that in more than half of the countries on the European continent, hydropower contributes an important share of their electricity generation mix and will be critical to support the energy transition . The potential for additional deployment of hydropower in the mid-term can be estimated, rather conservatively for the European Continent, as some 20% increase of the total yearly energy production in an environmentally friendly way, comprising about 10% due to uprating and modernization of existing powerplants and some 10% by new storage powerplants designed as multipurpose projects, including flood and drought protection, flow regime and biotope restoration, leisure activities etc., creating a win-win situation between all involved stakeholders.

Thus, hydropower has all the criteria to serve as a catalyst in achieving the energy transition in Europe, providing a safe and independent supply of renewable electricity.

Hydropower as a catalyst must have a prominent role in the SET Plan

Hydropower is dispatchable, flexible and can store large amounts of renewable energy, making it an important part of any future low carbon energy scenario. **This makes it a superb partner to other renewable sources, and so hydropower must have a prominent role in the SET Plan.**

With an increase in the level of electrification and a larger share of intermittent renewable energy sources, the safety of energy supply and stability of the electrical grid will be a critical challenge to manage. Hydropower and the associated Pump-Storage Systems is the key that can provide the energy system in Europe with the necessary flexibility to address these challenges posed by large shares of wind and solar power sources. Given the intermittency of these sources, hydropower plants can match the fluctuations in energy demand and supply by providing critical energy and flexible power services to electricity networks with long-term reserves. Storage and flexibility from today's existing hydropower plants exceeds all worldwide battery storage available today, including electric vehicles, by a factor of 2 300. 8 According to the ACER electricity market analysis of April 2022, flexibility and storage are key areas that need a European focus. More storage and flexibility are needed and must be provided by complementary technologies, including both hydropower storage and batteries.

Barriers to overcome for hydropower development in Europe

Today potential investors are facing significant hurdles which must be overcome:

- More storage hydropower and pumped storage schemes will be needed to provide energy storage and flexibility to balance volatile renewables, but the need for such system storage and flexibility needs to be acknowledged and prioritised by policy makers.

- Existing, generally acknowledged social and environmental standards and sustainability criteria must be applied in all projects to secure the support of NGOs and civil society. Pan European guidelines and recommendations should be continuously adapted to the newest standard.

- Electricity markets differ from region to region and often, as a result of legacy market arrangements, do not pay for services needed and provided by hydropower. Thus, the markets rules need to be adapted to remunerate flexibility services and storage in a fair way.

- The regulatory situation around water rights, environmental clearances, construction permits and legal opportunities to oppose projects often leads to situations where it can take many years before a decision can be made. For private investors the risk is often too high in the early stages if it is uncertain whether a project can ultimately be implemented. This is simply not an option for many private investors and means the risk needs to be better shared.

- Large hydropower projects require very high initial investments while the technical lifetime spans 50 to 80 years. Predicting energy tariffs over such a long lifetime is involves high uncertainty and water rights are often granted for only half the technical lifetime, thus adding risks and uncertainty for investors. In other sectors, such as offshore wind, long term price visibility and certainty has secured huge amounts of investment in new capacity. A similar approach for hydropower would enable new investment at scale.

Some countries have taken steps to systematically address these barriers by creating conditions to make investments into hydropower more attractive. Other countries have pledged to achieve net zero greenhouse gas emissions, but there is a lack of concrete policies and short-term plans to support such pledges.

Public awareness does not recognise the important role of hydropower

Increasing public awareness about the benefits of hydropower is key to securing the European Green Deal. Information availability, dialogue with society, and strategies towards social acceptance are actions that require immediate attention. It is important to stress that the technology has been updated and that there are sustainable solutions that offer win-win situations for the environment and from an operational perspective

Hydropower contributes immensely to global and EU climate change mitigation and adaptation goals. Hydropower reservoirs provide numerous benefits to mitigating the negative impacts of climate change through energy and non-energy-based applications (e.g., agriculture, drinking

water, cooling of power station, etc.). Among the renewable energy technologies, hydropower has the best climate change indicator, ozone layer depletion indicator, and energy returned on energy invested indicator. Hydropower is also the best suited renewable energy for reducing pressure on mineral resources.6

While being a robust technology, the possibilities to make hydropower safer, more environmentally friendly, sustainable, and efficient are within our reach. Hydropower boasts a wide and vibrant community of researchers, providers, and industrial partners working towards a cleaner, greener future for the sector. Supporting the sector with funding and opportunities is necessary now more than ever. The introduction of digitalization, artificial intelligence, more stringent environmental standards and advancements in hydropower units has unveiled a revitalisation for the sector, at least in Europe and North America. By funding additional research, it would further boost hydropower's immense, sustainable potential.

The recently released Research and Innovation Agendas ,, and Strategic Industry Roadmap confirm the important role of hydropower and potential for further development.

The Hydropower Europe Forum, supported by the European Union's Horizon 2020 Research and Innovation Programme, has prepared a Research and Innovation Agenda (RIA) and a Strategic Industry Roadmap (SIR) that includes recommendations under 18 research themes and 11 strategic directions.

Digitalization will create new economic opportunities for hydropower operators and will potentially reduce the costs and increase the income for the entire lifespan of hydropower assets. Innovative digital technologies will improve turbine yields and productivity while driving down costs in design, operations and maintenance, thereby reducing the cost of energy and enabling more efficient deployment of other renewables such as solar and wind.
Since hydropower is situated at the crossroads of two major issues for development – water and energy – hydropower reservoirs can often deliver services beyond electricity supply. These services include mitigation of freshwater scarcity by providing security during low flow and drought as well as supporting drinking water supply, irrigation, flood control, fish farming and navigation services. Many reservoirs in Europe have created new biotopes and have become a tourist attraction with high potential for leisure activities. Therefore, multipurpose hydropower projects may have an enabling role beyond the electricity sector to secure freshwater availability and thus contribute directly to the Water-Food-Energy NEXUS approach.

Further innovative hydropower deployment is essential to ensure environmentally compatible solutions. To protect flora and fauna, it is necessary to improve innovative freshwater connectivity solutions for biodiversity protection and to better understand the potential effects of improvement in regulated rivers on a "case by case" basis, and to adapt solutions based on specific locations of hydropower sites. Researching and producing solutions to reduce negative impacts of hydropower plants on the environment is of the utmost importance to the hydropower community. Actions to ensure that only sustainable hydropower is developed and

operated will help foster improved public perception and social acceptance of hydropower as a clean, renewable, and environmentally compatible energy source.

Europe must be aware that hydropower is a vital domestic renewable energy source and the backbone to the European energy transition

It is crucial that Europe recognises the role played by hydropower in its own current and future electricity system. Through the sustainable management of water, hydropower has a positive spillover on the handling of water resources needed for public services; these services include irrigation, flood and drought prevention, fish farming, transportation on inland waterways, and water supplies .
Hydropower plays a pivotal role in the framework of the European decarbonisation strategy, helping to prevent and mitigate the impact of global warming and climate change through the generation of renewable energy. Failing to seriously consider hydropower as a safe, flexible, and independent form of electricity supply in the energy transition will make it much harder to ‘keep the lights on’ in a green, secure energy system. Failing to include and recognise hydropower may also make the ambition of the European Green Deal much more difficult to achieve, if not to say impossible.