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## Deliverable 1.6

Interim report & recommendations on cross-cutting and interdisciplinary activities relevant to the SET Plan

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## EXECUTIVE SUMMARY

The purpose of this document is to provide an initial mapping of existing cross-cutting and interdisciplinary topics – both technological and non-technological - and related activities in the SET Plan Implementation Plans (IPs).

The outcome will serve as initial input to a discussion with the EERA Joint Programme Coordinators (JPCs) and other stakeholders on how to enhance added-value links across the IPs, support possible synergies and mutual learning.

The mapping (D1.6) is the first step of Task 1.3 Cross-cutting and interdisciplinary activities. Recommendations, which includes three main steps:

- 1) Initial mapping of existing cross-cutting topics and related activities covered by the IPs and identification of synergies.
- 2) Preliminary discussion with the JPCs on the identified topics and activities and on new potential ones. The mapping has been used as a basis for dialogue. The discussion took place on 3 June 2021 during the JPCs coordinator meeting, the outcomes of the discussion and the inputs received in the subsequent conversations are indicated in Chapter 5 Conclusions and Recommendations.
- 3) Follow-up discussion on identified topics and related activities, proposed prioritisation and recommendations on enabling factors to support their implementation. The discussion will be undertaken at a workshop/webinar involving EERA JPCs (and other Joint Programme members, when relevant), stakeholders from the SET Plan Implementation Working Groups (IWGs) and additional players (e.g. ETIPs, KIC InnoEnergy and other industry-driven platforms, consumer groups, citizens' organisations), when relevant. The mentioned prioritisation will be based on criteria proposed by the SUPEERA consortium partners and discussed with the EERA Joint Programmes ahead of the workshop. Criteria might include relevance across the SET Plan Implementation Plans, need of collaboration, investments and urgency to translate priorities into actionable R&I activities.

This document represents an interim report (SUPEERA Deliverable D1.6), and addresses steps 1 and 2. The final report due on Dec 2022 will cover step 3.

The task is carried out in coordination with Task 2.2. "Systemic and cross-sectorial issues pertaining to the Clean Energy Transition objectives", Task 2.3. "Dialogue for transnational collaboration with industry in support of the NECPs", particularly on facilitating a cross-sectorial dialogue for systemic solutions, and Task 3.2 on policy recommendations.

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## LIST OF ABBREVIATIONS AND ACRONYMS

AC(s)	AC(s) – Associated Country(ies)
CCS	CCS – Carbon Capture and Storage
CCU	Carbon Capture and Utilization
CSP	Concentrated Solar Power
EC	European Commission
EE	Energy Efficiency
EERA	European Energy Research Alliance
ESI	Energy System Integration
ETIP	European Technology and Innovation Platform
EU	European Union
IP	(SET Plan) Implementation Plan
IWG	Implementation Working Group
JP	(EERA) Joint Programme
JPCS	Joint Programme Coordinators
LTS	Long Term Strategy
MS	Member States
NECP	National Energy and Climate Plan
PED	Positive Energy Districts
PV	Photovoltaics
RE	Renewable Energy
RED II	Renewable Energy Directive
RES	Renewable Energy Sources
R&D	Research and Development
R&I	Research and Development and Innovation
SET Plan	Strategic Energy Technology Plan
SETIS	Strategic Energy Technology Information Plan
SMS	Smart Metering Systems
SUPEERA	Support to the coordination of national research and innovation programmes in areas of activities of the European Energy Research Alliance

## I INTRODUCTION

The document provides an initial mapping of existing cross-cutting and interdisciplinary topics – both technological and non-technological - and related activities described in the EU's Strategic Energy Technology Plan (SET Plan) Implementation Plans (IPs).

In 2008 the European Commission launched the SET Plan, as an instrument to boost R&I in the field of low carbon technologies. Building on the SET Plan 10 priorities, 14 Implementation Plans (IPs) were written in order to cover all the Energy Union R&I priority areas, and Implementation Working Groups 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 – Joint Research Centre, European Commission) that provides up-to-date information on its activities covering all R&I priorities of the Energy Union.

The SET Plan aims at giving all stakeholders a clear overview of the current energy research challenges and priorities for the European Union and at displaying a set of targets, consistent with the objective of the Clean Energy Transition. By establishing a long-term framework for collaboration, the SET Plan facilitates the coordination across borders, structures European and national research programmes, and triggers investments on common priorities in low-carbon technologies. Several supporting initiatives added that the SET Plan enables the inclusion of those parties who do not usually participate directly in the policy-making process of the European Union. One of the perceived added values of the SET Plan as a collaborative tool is its role in the acceleration of technology deployment by closing the gap between R&I and the market.

The IPs have been developed and are carried out by 14 Implementation Working Groups (IWGs) comprising national governments, companies and research institutions. Amongst the pillars of the SET Plan, the IWGs are most certainly key: gathering the most relevant stakeholders involved in the development of their respective fields, they embody the necessary dialogue between Member States/Associated Countries and the European Union. Their work intends to enable the outlining of common assets, targets, and research agendas amongst MS/AC as well as the monitoring of current research and industrial activities in order to allow synergies to develop and to deliver on key objectives of the Energy Union.

The IWGs have the task to advance the respective implementation plans, reaching collectively the agreed technological targets. In its yearly report, SETIS also assesses the relevance of the Implementation Plans and their targets and activities according to current technological and political priorities, collects potential needs of revision of these targets and activities, displays a



non-exhaustive list of ongoing R&I project and their funding sources, and analyses ongoing collaborations or potential synergies between IPs.

In that respect, the SETIS report for 2020 analyses that between 2019 and 2020, "all IWGs were advancing with the implementation plans"<sup>1</sup>. Indeed, amongst the 143 activities identified across all IPs, an increasing number of them have projects ongoing, reaching 74% in 2020 (vs. 46% in 2019). The corresponding 1203 projects reported by the IWGs to SETIS have mobilised €13.2 billion since 2017, funded by national, regional, transnational, and/or EU funds.

The document, Deliverable 1.6, is an interim report and will serve as initial input to a discussion with the EERA Joint Programme Coordinators (JPCs) and other stakeholders on enhancing added-value links across the IPs and supporting possible synergies and mutual learning.

## II METHODOLOGY

The mapping stems from the cross-cutting and interdisciplinary topics and activities identified in the IPs (Table 1 below) published by SETIS<sup>1,2</sup>.

Mapping includes both technological and non-technological cross-cutting topics as needs and requirements (technological and non) that are common to multiple sectors and activities. When present in the IPs, the analysis has also included related activities/projects and budget. A number of topics have been identified as enablers, i.e. relevant topics but without a dedicated budget.

Topics that were included are present in at least two IPs.

Implementation Plan (IP) <sup>3</sup>	Abbreviation
IP Bioenergy & Renewable Fuels for Sustainable Transport	IP Bio
IP Initiative for Global Leadership in Photovoltaics	IP PV
IP Initiative for Global Leadership in Concentrated Solar Power	IP CSP
IP Batteries - Become competitive in the global battery sector to drive e-mobility and stationary storage forward	IP Batteries
IP Deep Geothermal	IP Geothermal

<sup>1</sup> [https://setis.ec.europa.eu/implementing-actions/set-plan-documents\\_en#ecl-inpage-50](https://setis.ec.europa.eu/implementing-actions/set-plan-documents_en#ecl-inpage-50)

<sup>2</sup> [https://setis.ec.europa.eu/implementing-actions/set-plan-documents\\_en](https://setis.ec.europa.eu/implementing-actions/set-plan-documents_en)

<sup>3</sup> Nuclear Safety IP is not included in the analysis since SUPEERA Grant Agreement was signed before the respective Implementation Plan has been endorsed

IP Positive Energy Districts - Europe to become a global role model in integrated, innovative solutions for the planning, deployment, and replication of Positive Energy Districts	IP PED
IP Increase the resilience and security of the energy system	IP Energy System
IP Ocean - Initiative for Global Leadership in Ocean Energy	IP Ocean
IP EE for Buildings - Energy Efficiency Solutions for Buildings	IP EE for Buildings
IP CCS & CCU	IP CCS & CCU
IP Wind - Global Leadership in Offshore Wind	IP Wind
IP Energy Consumers - Smart solutions for energy consumers	IP Energy Consumers
IP Make EU industry less energy intensive and more competitive	IP Industry

Table 1: List of Implementation Plans (IPs) and related abbreviation.

The identification of the topics was conducted by SUPEERA project based on the knowledge and experience of the partners and taking into account the work done by other EU funded Coordination and Support Actions, in particular the project SMARTSPEND<sup>4</sup>, to avoid duplications and, whenever possible, complement and build synergies. Complementarity with SMARTSPEND relates mainly to cross-cutting non-technological topics, identified in SMARTSPEND via a project partners brainstorming.

Furthermore, the template named "Common principles guiding temporary Working Groups to prepare Implementation Plans" <sup>2</sup> was considered for the assessment. The document, provided to the Temporary Implementation Working groups, includes a set of common principles and guidelines for the preparation and the presentation of the Implementation Plans. It also contains definitions of the technological and non-technological R&I Activities to be cover by the IPs for the achievement of the targets adopted in their Declarations of Intent. Regarding the non-technological aspects, the template requested information on 1) the activities that address non-technological barriers/enablers; and 2) a description of concrete non-technological barriers/enablers and how they will be overcome. The template does not include further clarifications on the topics that should be considered as non-technological aspects.

It is relevant to mention that most of the IPs do and use the word "cross-cutting", and that the expression is not used in the in the document "Common principles guiding temporary Working Groups to prepare Implementation Plans".

<sup>4</sup> <http://smartspend.eu/>

The analysis conducted by SUPPERA is structured in two main parts, related to technological and non-technological topics, and includes the following aspects:

- Identified cross-cutting technological and non-technological topics
- In how many and in which IPs they are present
- Specifics of the topics, i.e. description of related needs, R&I activities (undertaken or foreseen) and, when available, allocated budget
- Potential synergies between the Ips

### III CROSS-CUTTING TOPICS - TECHNOLOGICAL

Table 2 below outlines the technological cross-cutting topics identified in the IPs. The number of IPs that mention a given topic is indicated in the bottom row in Table 2, and the number of topics in each IP is indicated in the rightmost column in Table 2.

IP	Energy Efficiency	Energy System Integration	High Temperature & Advanced Materials	Energy Storage	Digitalisation	
IP Bio		x	x	x		3
IP PV		x			x	2
IP CSP			x	x		2
IP Batteries		x	x	x		3
IP Geothermal			x			1
IP PED	x	x	x	x	x	5
IP Energy System	x	x	x	x	x	5
IP Ocean						0
IP EE for Buildings	x	x		x	x	4
IP CCS & CCU				x		1
IP Wind			x		x	2
IP Energy Consumers					x	1
IP Industry	x	x		x	x	4
	4	7	7	8	7	

Table 2: technological cross-cutting topics & related IPs. The number of IPs that mention a given topic is indicated in the bottom row, and the number of topics in each IP is indicated in the rightmost column.

Table 3 below helps to qualify the topics, outlining some specifics on the needs and fields of application.

Technological cross-cutting topics SET Plan IPs	
Energy efficiency	In buildings: cost reduction and increase in efficiency of micro-combined heat and power/combined cooling heat and power plants
	In industry: energy efficiency of cross-sector industrial components

Energy System Integration	Integration of renewable fuels/bioenergy in different energy systems - e.g. power-to-gas, power-to-liquid, use of biomass-based energy generation and renewable hydrogen in heating, cooling, and electricity networks; synergies with renewable hydrogen and CO2 streams
	Synergies with building and transport/e-mobility: development of photovoltaic technologies in combination with efficient building materials (Building-Integrated PV); production, consumption and storage of renewable energies in buildings in integration with electromobility infrastructures
	Improving system integration, optimal design, intelligent and flexible operation; integrated energy system design providing an efficient and flexible energy infrastructure
	Hybrid and flexible systems able to integrate different sources of energy (grid despatchability)
High temperature & advanced materials	Development of affordable high-temperature, corrosion-resistant materials or new alloys resistant to extreme conditions for renewable fuels/sustainable transport
	Development of materials processing techniques and components for fast industrialization compatible with current mass production lines in batteries
	Development of effective materials to reducing issues connected with scaling and corrosion, both for low- and high-temperature geothermal applications
	Research on innovative materials and their degradation/failure mechanisms leading to the development of new and improved materials for offshore wind
	For buildings: cost-efficient, intelligent, flexible heat pumps (also thermally-driven) and heat pumps for high temperatures
	Energy storage
Development of compact thermal energy storage materials, components and systems	
Storage and heat exchange of solar energy	
Hybridisation of battery systems for stationary energy storage, integration with other renewable energy systems	
Renewable energy storage	
Development of local storage solutions for energy districts	

	Development of a European CO2 Storage Atlas identifying and characterising all recognised prospective storage sites on a consistent basis - to facilitate site comparison, ranking, and integrated regional and national storage planning and transport development
Digitalisation	Systemic and socio-economic impact of digitalisation in the energy system
	Internet of Things, smart cities & connection with e-mobility
	Cybersecurity & resilience against cyber-attacks (including identification and real-time counteracting)
	Data management/data unification issues (information platform, creation of standards and common data models at EU level)
	Topic linked to non-technological cross-cutting topics such as policy & regulation, standardisation, data management, socio-economic policies & measures

Table 3: Technological cross-cutting topics – specifics.

The above table also highlights synergies within cross-cutting topics, both technological and non-technological: Energy System Integration has ties to other technological topics like Energy Storage and Digitalisation (and vice versa, obviously), and Digitalisation has also ties to the non-technological topics Policy & Regulation, Standardisation, and Socio-economic policies & measures.

Table 2 show that except for Energy Efficiency, the other four topics are well represented as topics across the IPs, and therefore synergies across the IPs should be possible to identify. Some comments on the topics:

- **Energy Efficiency:** This topic appears in IP PED, IP EE for Buildings and IP Industry, which is in line with the areas covered by the mentioned IPs and there is a potential for synergies across these IPs.
- **Energy System Integration:** This topic is identified in IP Bio, IP PV, IP Batteries, IP Energy System, and IP EE for Buildings and Industry. There are clear synergies across the IPs for this topic that should be exploited and perhaps IP Energy System because of the area covered could be the obvious lead on this topic. It is worth noting that IP Wind does not have any activities in this direction. Same lack is noted in Ocean, CSP and Geothermal, which by their nature should have dedicated IP activities for this topic.
- **High Temperature & Advanced Materials:** This topic has a quite narrow definition and could perhaps benefit from a taxonomy expansion to allow for example that advanced

materials research in PV and CCS & CCU get included. The synergies across the IPs for this topic could be easily exploited.

- **Energy Storage:** This is the most active topic, reflecting that energy storage is a key technology for enabling the renewable energies.
- **Digitalisation:** In this topic, there would be clear synergies between the IPs within the sub-topics like smart cities, connection with e-mobility, etc. No one of the IPs refer to Artificial Intelligence, despite the EC is identifying AI as a key digital topic<sup>5</sup>.

Table 3 is complemented by Table 4, below, which provides an overview of the technological cross-cutting topics, the related activities and, when specified in the IPs, of the associated budget/resources.

IP	Cross-cutting topics - technological	Related activities	Allocated budget / resources
IP Bio	Energy Systems Integration	Increased integration of renewable fuels/bioenergy in different energy systems (exemplified by power-to-gas and power-to-liquid pathways + use of biomass-based energy generation and renewable hydrogen in heating, cooling and electricity networks). Included under activity 7 - production of renewable hydrogen from water electrolysis and renewable electricity. R&I activities from TRL2 to TRL9. Projects include: by 2020 showcase with projects the ability of renewable hydrogen to interact with the grid to further enable RES penetration - Timeline: 2020-2030	Total budget for the whole activity: 102 M (TRL 2-6), 60 M (TRL7-8), 250 M (TRL 9) – Amounts correspond to renewable hydrogen production and for electrolyzers to the cost of the renewable part in the electricity mix only
	High temperature & advanced materials	Affordable high-temperature, corrosion-resistant materials or new alloys resistant to extreme conditions. Synergies to renewable hydrogen and CO2 streams.	200 M€ (for the whole activity)
	Energy storage	Renewable energy storage. Under R&I activity 5 - Demonstrate other renewable	MS (25%) / EU (25%) / Industry

<sup>5</sup> [https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age\\_en](https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age_en)

		liquid and gaseous fuels (excluding hydrogen) through thermochemical / chemical / biochemical / electrochemical transformation of energy neutral carriers with renewable energy - TRL6-7 to TRL8 - 10 demo concepts (4 in 2022 + 6 in 2030)	(50%). Implementation instruments: MS grants and other funding, equity, commercial loans, Risk Finance, InnoFund, EFSI, ESIF, H2020 IAs, European Partnership Initiatives
	Energy Systems Integration	Development of Photovoltaic technologies in combination with efficient building materials (Building-Integrated PV), synergy with the building sector	Required: 7-10 M€
IP PV	Digitalisation	Interconnections with e-mobility, internet of things (in buildings and cities): smart city approach. R&I Activity n. 1	Required: 7-10 M€ Required: 30 M€
	High temperature & advanced materials	New designs for high temperature thermal energy storage. R&I Activity n. 1	
IP CSP	High temperature & advanced materials, Energy storage	New designs for high temperature thermal energy storage. R&I Activity n. 1 Hybridisation of battery systems for stationary energy storage, integration with other renewable energy systems. R&I activity n. 3.1	Required: 30 M€ Required: 25 M€
	High temperature & advanced materials	Foster development of materials processing techniques and components for fast industrialization compatible with present mass production lines. R&I activity n. 2.1	Required 50 M€

	Cross-cutting topics - technological	Related activities	Allocated budget/resources
IP Geothermal	Energy Systems Integration	Integration of geothermal heat and power in the energy system and grid flexibility. R&I activity n. 7	11.5 M€
IP PED	Energy efficiency	From Positive Energy Blocks to Districts – activities: development of a TOOLBOX for Positive Energy Blocks upgradable to Districts.	12 M€ (activity n. 9)
	High temperature & advanced materials	Optimal use of advanced materials. No specific activity mentioned (but covered under the definition of a PED)	
	Energy Systems Integration	RHC-ETIP - Industry support - activities: integrated energy system design providing an efficient and flexible energy infrastructure.	€7 M€ (activity n. 11)
	Digitalisation	ECTP – ESA – Digital Modelling of Cities - activities: Stock taking of state of the art space technology; Capacity building at EU level for Digital modelling of cities for energy management including built and natural environments; Development of a portal accessible to cities for physical and thermal mapping. Related to Energy Efficiency	27 M€ (activity n. 10)
	Energy storage	Local energy storage.	No specific activity mentioned (but covered under the definition of a PED)
IP Energy System	Energy Efficiency,	Flagship Initiative 1 "Develop an Optimised European Power Grid" and Flagship Initiative 2 "Develop Integrated Local and Regional Energy Systems" -	350 M€/year (Flagship Initiative 1)

	Energy Systems Integration, Energy Storage, High temperature & advanced materials	This SET plan has two flagships and one set of cross-cutting activities with no budget sub-divisions. The two flagships have links to all cross-cutting technological topics, which is a consequence of its very broad scope.	250 M€/year (Flagship Initiative 2)
	Digitalisation	Cybersecurity of critical energy infrastructure - activities: developing and demonstrating methodologies/tools. Timeline 2018-2022. Expected impact includes large-scale demonstrator for "What if Scenarios" preventing against cyber-attacks	100 M€/year for RD&I on cross-cutting activities
		Process chain for interoperability of ICT systems - activities: share results; national projects; ERA-NET; international cooperation/H2020 projects. Activities include: a joint transnational structure for a European organisation 'IES Europe'; align national, transnational and international activities and funding schemes on interoperability. Timeline 2018-2022.	100 M€/year for RD&I on cross-cutting activities
		Systemic and socio-economic impact of digitalisation in the energy system - instruments: transnational calls (through e.g. ERA-NET Smart Grids Plus), H2020 (incl. COST), bilateral gov-to-gov collaboration/exchange. Activities include: Joint light house project for an HPCC dedicated to the energy domain. Impact: Enable fully functioning next-generation energy system across the value chain. Timeline 2018-2020.	100 M€/year for RD&I on cross-cutting activities

IP EE for Buildings -	Digitalisation	Digital planning and operational optimization; combination of hard- and software to be implemented and running together with or replacing existing building automation systems. Activities 5.1-3 & 5.1-4, mentioned as "specific target" for "New materials and technologies for energy efficient solutions for buildings"	Required: 250 M€ (5.1-3); 150 M€ (5.1-4)
	Energy efficiency	Multi-source District Heating integrating renewable and recovered heat sources, higher temperature District Cooling and optimization of building heating system, to minimize the temperature levels in district heating networks. Activity n. 5.2-2, mentioned as "specific target" for "Cross cutting heating and cooling technologies for buildings"	Required: 145 M€
	Energy efficiency	Cost reduction and increase in efficiency of micro combined heat and power/combined cooling heat and power plants. Activity n. 5.2-3, mentioned as "specific target" for "Cross cutting heating and cooling technologies for buildings"	Required: 30 M€
	Energy storage	Compact thermal energy storage materials, components and systems. Activity n. 5.2-4, mentioned as "specific target" for "Cross cutting heating and cooling technologies for buildings"	Required: 200 M€
	Energy Systems Integration	Synergy with mobility: production, consumption and storage of renewable energies on/in buildings to be considered in integration with electromobility infrastructures.	Mentioned as enabler (no specific activity funded)
IP CCS & CCU	Energy storage	A European CO <sub>2</sub> Storage Atlas identifying and characterising prospective storage sites - the Atlas would facilitate	10 M€ for further appraisal in selected regions

		site comparison, ranking, and help integrating regional and national storage planning. R&I activity 4 and 5	and completion of the Atlas; additional funding for future updates and operational activities
IP Wind	Digitalisation	Digitalization and data analytics - development of new sensors, data processing, machine learning and data analytics methods. R&I activity n. 1	25 M€
	High temperature & advanced materials	New and innovative materials and their degradation and failure mechanisms leading to the development of new and improved materials. R&I activity n. 4	20 M€
IP Energy Consumers	Digitalisation	Interoperability of smart energy solutions; User-friendly interfaces; Energy related sensors and controllers	Enabler (no future budget allocated)
IP Industry	Energy efficiency	Energy efficiency of cross-sector industrial components. Activity n. 5.3	1-2 M€/project
	Energy Systems Integration	Improving system integration, optimal design, intelligent and flexible operation. Suggestion to include under projects in Activity n. 5.2 ("Improving system integration, optimal design, intelligent and flexible operation")	20 M€/project (Activity n. 5.2)
	Digitalisation	New reliable hard and soft sensors; Simulation and modelling capabilities; Increase resilience against cyber-attacks, including identification and real-time counteracting	20 M€/project (Activity n. 5.2)
	Energy storage	Development of micro-grids, including storage and monitoring (under Activity n. 5.2)	20 M€/project (Activity n. 5.2)

Table 4: technological cross-cutting topics – related activities & allocated budget/resources.

## IV CROSS-CUTTING TOPICS NON-TECHNOLOGICAL

Non-technological cross-cutting topics cover a wide range of disciplines that either study the social phenomena that shape interactions humans have with the energy system (e.g. norms, values, perceptions, institutions, practices, etc.), or study fundamental issues in the context of energy such as equity, fairness, duty, faith, ethics, attribution, etc..

Table 5 below outlines the non-technological cross-cutting topics identified in the IPs. The number of IPs that mention a given topic is indicated in the bottom row in Table 5, and the number of topics in each IP is indicated in the rightmost column in Table 5.

IP	Circular economy	Education & training	Policy & regulation	R&I funding programmes & measures	Social awareness, acceptance, engagement	Standardisation	Socio-economic policies and measures	International cooperation	
IP Bio	x		x					x	3
IP PV	x								1
IP CSP			x	x					2
IP Batteries	x	x	x	x					4
IP Geothermal		x		x	x				3
IP PED	x	x		x	x	x		x	6
IP Energy System			x	x					2
IP Ocean			x			x			2
IP EE for Buildings		x			x				2
IP CCS & CCU	x			x			x		3
IP Wind		x					x		2
IP Energy Consumers	x				x	x			3
IP Industry	x				x				2
	7	5	5	6	5	3	2	2	

Table 5: Non-technological cross-cutting topics & related IPs. The number of IPs that mention a given topic is indicated in the bottom row, and the number of topics in each IP is indicated in the rightmost column.

From Table 5 it is evident that there are widespread mentions of Circular Economy, Education & Training, Policy & Regulation, R&I Funding Programmes & Measures and Social Awareness, Acceptance, Engagement. In turn, the ones that are not widely mentioned are Standardisation, Socio-economic Policies and Measures, and International Cooperation. In the same way it is evident that some IPs are not good at including the cross-cutting non-technological topics, effectively only mentioning 1-2 topics. Other IPs are better at including more of the cross-cutting non-technological topics.

Several comments on potential synergies within the topics emerged:

- Circular Economy:** Under this broad remit, IPs PV and Batteries should find synergies in LCA and recycling of materials, while IPs Bio and CCS & CCU are also interlinked (and should have some synergies with IPs Industry and PED as well).

- **Education & Training:** This is a very "soft" topic mainly seen as an enabler without any funding tied to it. IP Wind has funding set aside for Wind Energy Hubs aiming at harmonisation of curricula and training techniques.
- **Policy & Regulation:** Under this topic, there are different needs across the IPs that mention it, but a common theme is a regulatory framework for renewable energy concerning stable, long-term R&I policy, procurement, and competitiveness.
- **R&I Funding Programmes & Measures:** The activities for this topic are quite isolated across the IPs, but some common ground could be found in so-called Regulatory Innovation Zones, implying creation of a European public-private partnership and new transnational research projects. Additionally, financial schemes to reduce financial risks are identified in several Implementation Plans, such as the creation of an EU Insurance and Guarantee Fund, which is indicated in the IP on Ocean Energy.
- **Social Awareness, Acceptance, Engagement:** Given the increasing importance of these aspects in the transition process, it would be beneficial that several IPs find synergies on this topic, e.g. IPs PED, EE for Buildings and Energy Consumers.
- **Standardisation:** The activities for this topic are quite isolated across the IPs, and only IP Ocean has dedicated funding.
- **Socio-economic Policies & Measures:** This topic is only mentioned by IPs CCS & CCU and Wind, and primarily deals with tackling the "not in my back yard" issue. Obvious synergies should be present.
- **International Cooperation:** IP Bio has a long-standing international collaboration with IEA, while IP PED seeks to start a Chinese knowledge transfer.

Table 6 below qualifies the topics, outlining some specifics on the needs and fields of application.

Non-technological cross cutting topics SET Plan IPs	
Circular economy	Broad remit, including LCA and sustainable waste
Education & training	Incl. best practices exchange, dissemination of knowledge and experiences (including modelling of cities)
Policy & regulation	Incl. market design, support to stable, long-term R&I policy framework, pan-European procurement models
	Topic linked to Standardisation, Digitalisation, R&I funding
R&I funding programmes & measures	Incl. access to finance/ad hoc financial schemes (& related risk management), shared certification and shared data models
	Incl. support to industry & to large scale deployment initiatives
	Topic linked to Policy & regulation

Social awareness, acceptance, engagement	Incl. Living Labs, energy technologies & solutions for decarbonized European districts and cities (incl. development of novel economic schemes and social acceptance models)
	Incl. architecture & urban planning
	Incl. development of KPIs to measure consumer benefits
	Topic linked to Education & training, Policy & regulation, R&I funding, Socio-economic policies and measures
Standardisation	Incl. standards and guidelines for technology evaluation and analysis; collaboration on the development of certification and safety standards
	Incl. creation/use of reference architecture and standards, common terminology for new energy services, in particular for data sharing/ICT in future R&I projects, e.g. energy services for smart homes and cities
	Topic linked to regulation, data management, Digitalisation
Socio-economic policies and measures	Incl. analysis of socio-economic motivations for investing in technologies/solutions
	Incl. social, environmental and legal aspects re to infrastructure development
	Topic linked to Social awareness/engagement, Policy & regulation, Education & training
International cooperation	Broad remit, incl. knowledge transfer between academia and companies, capacity building, best practices exchange across countries

Table 6: Non-technological cross-cutting topics – specifics.

The overview above highlights also synergies within cross-cutting topics, both technological and non-technological, as mentioned in the table. The analysis focuses on structural challenges, e.g. access to finance, standardization, regulation, Socio-economic policies and measure, social, environmental and legal aspects related to infrastructure development, and not so much on individual empowerment and the active role of the citizen in the energy transition.

Table 6 is complemented by Table 7, below, providing an overview of the activities and, when specified in the IPs, of associated budget/resources. In most cases, topics and related activities are identified as *enablers*, i.e. relevant topics but without a dedicated budget in the IP.

IP	Cross-cutting topics - non technological	Related activities	Allocated budget / resources
IP Bio	Circular economy	Support of sustainable feedstock mobilisation. Development and use of unexploited sustainable waste, biomass and land resources to supply advanced technologies, with particular emphasis on circular economy	Enabler - no specific budget allocated
	Policy & regulation	Support to the creation of a long-term, stable (i.e. with known targets) policy framework	Enabler - no specific budget allocated
	Policy & regulation	Support emerging technologies at low TRL to increase efficiency; in parallel, continued R&I efforts in high TRL technologies to comply with reduced cost projections, GHG emissions goals and deployment	Enabler - no specific budget allocated
	International cooperation	International cooperation (e.g. Mission Innovation, IEA as well as European schemes within ERA-NET) is also considered crucial from a cooperation and development point of view but the working group agreed that it cannot alone facilitate to reach the targets	Enabler - no specific budget allocated
IP PV	Circular economy	New Technologies & Materials - R&I activities including LCA for whole fabrication route, environmental impact Technologies for silicon solar cells and modules with higher quality - focus on sustainability and recyclability as a commercial performance indicator	15-50 M€ (activity n. 3)
IP CSP	R&I funding programmes & measures	More comprehensive and coordinated approach in terms of financing sources	Enabler - no specific budget allocated
	Policy & regulation	Regulatory Framework initiative: encourage the use of cooperation	Enabler - no specific budget allocated

		mechanisms in the Renewable Energy Directive	
IP Batteries	Circular economy	Develop circular economy and de-bottleneck availability of critical raw materials	Enabler - no specific budget allocated
	R&I funding programmes & measures	Access to finance for upscaling production and large scale advanced battery production and deployment	Enabler - no specific budget allocated
	Policy & regulation	Establish an enabling regulatory framework for competitiveness in the batteries field	Enabler - no specific budget allocated
	Education & training	Improve education and knowledge throughout the entire value chain	Enabler - no specific budget allocated
IP Geothermal	R&I funding programmes & measures	Risk management (for investments) + development of ad-hoc financial schemes	Enabler - no specific budget allocated
	Social awareness, acceptance, engagement	Awareness and social acceptance	Enabler - no specific budget allocated
	Education & training	Knowledge transfer & training (including peer-to-peer learning and research infrastructures), partic. between education/training institutes and companies	Enabler - no specific budget allocated
		Dissemination of best practices	Enabler - no specific budget allocated
IP PED	Circular economy	Sustainable waste; No activity covering it directly (but mentioned in the definition of a PED)	
	Education & training	EUA-EPUE - Capacity Building - activities: build effective PED bottom-up community-level actions; bridge technological and social innovation aspects; capacity building and	5 M€ (Activity n. 7)

		engagement with civil society. Connected to Social awareness, acceptance, engagement	
	R&I funding programmes & measures	PED Labs and Innovation Actions - activities: Planning and execution of calls towards PED Labs and Innovation Actions for PEDs; facilitation of transnational collaboration regarding alignment of national programmes and R&I funding calls towards PEDs; application for ERA-NET or EJP Cofund and subsequent implementation of call activities with focus on digital planning	160 M€ (Activity n. 2 - PED Labs) 475 M€ (Activity n. 2 - IA)
	International cooperation	Activities: assessment of additional international cooperation actions in the topic of PED; preparation of R&I funding and implementation strategy with China as a pilot for international collaboration, followed by workshops, joint R&I calls with China.	35 M€ (Activity n. 8)
IP Energy System	International cooperation	Different types/levels of collaboration frameworks: share results; national and bilateral gov-to-gov collaboration/exchange; transnational - EU (H2020, incl. ERA-NET, COST), international (e.g. Mission Innovation). Timeline 2018-2022. Expected activities incl.: large-scale demonstrator for "What if Scenarios" preventing against cyber-attacks; joint transnational structure for a European organisation 'IES Europe'; Align national, transnational and international activities and funding schemes on interoperability	100 M€/year for RD&I activities on crosscutting activities
	R&I funding programmes & measures	Market design for trading of heterogeneous flexibility products - Timeline 2018-2022. Instruments:	Budget: 10M EUR.

		national, transnational and European calls for RD&I projects. Further collaboration: forum for discussion with relevant stakeholders: network operators, market operators, retailers and aggregators, generators, equipment manufacturers, ICT solution providers, regulatory bodies, R&D institutes, end-user associations, organisations promoting standards	
	R&I funding programmes & measures	Regulatory innovation zones - Timeline 2018-2022. Activities: seminars on future solutions; initiate a European initiative such as "Innovation Deal" for energy transition; evaluate ongoing projects and initiatives. Expected impact incl.: development / modification of existing policy instruments; creation of a European public-private partnership and new transnational research projects	Enabler - no specific budget allocated
IP Ocean	Standardisation	Co-ordinate the development of standards and guidelines for wave technology evaluation and analysis.	Required: 6.5 M€ (activity 1.6)
	R&I funding programmes & measures	Progress the creation of an EU Insurance and Guarantee Fund to underwrite various project risks	Required: 50-70 M€ of private/public funding, which is on top of the resources above (activity 2.1)
	R&I funding programmes & measures	Investigate the potential for creation of an Investment Support Fund for ocean energy farms	Required: 200-300 M€ of private/public funding, which is on top of the

			resources above (activity 2.2)
	Policy & regulation	Support the development of a collaborative procurement model	Required: 24 M€ (activity 2.3)
	Standardisation	Collaboration on the development of certification and safety standards	Required: 8 M€ (activity 2.4)
IP EE for Buildings - (Action 5.1)	Social awareness, acceptance, engagement	Living labs - energy technologies and solutions for decarbonized European quarters and cities. Activity 5.1-4, mentioned as "specific target" for "New materials and technologies for energy efficient solutions for buildings"	Required: 150 M€
		Living labs. Activity 5.2-1, mentioned as "specific target" for "Cross cutting heating and cooling technologies for buildings"	Required: 230 M€
		Living labs. Activity 5.2-2, mentioned as "specific target" for "Cross cutting heating and cooling technologies for buildings"	Required: 145 M€
		Living labs. Activity 5.2-3, mentioned as "specific target" for "Cross cutting heating and cooling technologies for buildings"	Required: 30 M€
		Living labs. Activity 5.2-4, mentioned as "specific target" for "Cross cutting heating and cooling technologies for buildings"	Required: 200 M€
		Architecture; synergies between functionality and aesthetics as criteria in designing and construction processes	Enabler - no specific budget allocated
		Urban planning (also as contribution to optimizing the energy management of buildings)	Enabler - no specific budget allocated
		Education & training	Education and training: from conception to deconstruction, with a particular focus

		on operating life (users, building manager, technicians...)	
IP CCS & CCU	R&I funding programmes & measures	Pilots to ensure fast and cost effective R&D activities within CO2 capture; R&I for next generation CO2 capture, and CCU (CO2 valorisation). Related to R&I Activity 2, 6 and 7.	Costs to be determined
	Circular economy	Life Cycle Assessments (LCA) of the sustainability impact of CCU-derived products, including of the net CO2 reduction	Costs to be determined
	Socio-economic policies and measures	Socio-economic motivation for investing in CCS and CCU. Collaboration across European Institutions, national and regional governments and industry for the development and implementation of strategies, roadmaps and action plans to enable further development and deployment of CCS and CCU in Europe.	Costs to be determined
IP Wind	Socio-economic policies and measures	Feasibility study on offshore research infrastructure development: social, environmental, coexistence and multi-use, legal aspects. Related to R&I 3	Required: EUR 5 million
	Education & training	Wind Energy Hubs - Harmonisation of curricula and training techniques in close cooperation between Vocational Education and Training centres and industry	Required: EUR 5 million
IP Energy Consumers	Circular economy		Enabler - no specific budget allocated
	Standardisation	Standards for smart appliances	Enabler - no specific budget allocated

	Standardisation	Development and use of reference architecture and standards, common terminology for new energy services, in particular for data sharing/ICT in future R&I projects. Related to activities 1-5 (no budget allocated)	Enabler - no specific budget allocated
	Social awareness, acceptance, engagement	Development of KPIs to measure consumer benefits. No budget defined. Related to activities 6-7	Enabler - no specific budget allocated
	Social awareness, acceptance, engagement	Innovative organisational and services models, improve decision-making strategy	Enabler - no specific budget allocated
	Social awareness, acceptance, engagement	Consumer engagement and acceptance. No budget defined. Related to Activity 7	Enabler - no specific budget allocated
IP Industry	Circular economy	Circular economy in the context of improving system integration: Activity 5.3 - 'Improving exchange of technological, economic, behavioural and social knowledge; training, capacity building and dissemination, to enhance sustainable energy management'	1-2 M€/project
	Social awareness, acceptance, engagement	Humans in the loop. Suggestion to be included within projects in Activity 5.2 (Improving system integration, optimal design, intelligent and flexible operation); Horizon2020 projects (ended/on-going)	20 M€/project (recommendation)

Table 7: Non-technological cross-cutting topics – related activities & allocated budget/resources

## V CONCLUSIONS AND RECOMMENDATIONS

The document represents an interim report and provides an initial mapping of existing cross-cutting and interdisciplinary topics – both technological and non-technological - and related

activities described in the EU's Strategic Energy Technology Plan (SET Plan) Implementation Plans (IPs).

The document starts by outlining the technological cross-cutting topics identified in the IPs and by presenting the number of IPs that mention a given topic and synergies across cross-cutting topics, both technological and non-technological; e.g. that Energy System Integration has ties to other technological topics like Energy Storage and Digitalisation.

The second section describes the non-technological cross-cutting topics identified in the IPs, namely: Circular Economy, Education & Training, Policy & Regulation, R&I Funding Programmes assures, Social Awareness-Acceptance-Engagement, Standardisation, Socio-economic Policies & Measures, and International Cooperation.

The conclusions and recommendations are based on the following aspects:

- Template provided to the IWGs for drafting the IPs
- Identified technological cross-cutting issues
- Identified non-technological cross-cutting issues
- Feedback received by the Joint Programmes Coordinators

#### Template: conclusions and recommendations

Despite all the IWGs have been provided with the same set of principles and requirements for drafting the IPs, the information collected and the activities addressed by the IWGs appeared to be quite different. This makes it difficult for both IWGs groups and relevant stakeholders to identify synergies across the respective IPs.

SUPEERA partners recommend therefore that the template should be clearer and more detailed in order to collect uniformised and comparable data between different IPs.

In specific, there should be a clear definition of what can be entailed with the expression cross-cutting issues (both technological and non-technological) in order to have a common understanding of which activities could be relevant and the level of details that should be collected. These aspects should not be underestimated taking into consideration the role played by the IPs in accelerating the energy transition.

SUPEERA is working at the development of a "Template for identification and categorisation of cross-cutting issues in energy" as part of deliverable 2.2. The template will offer a coordinated input to decision-makers for addressing systemic and cross-sectorial solutions in the energy

sector to support the Clean Energy Transition. It will set a framework for defining and classifying identified cross-cutting issues.

### Technological cross-cutting issues: conclusions and recommendations

By analysing collected data for the technological cross-cutting topics the main conclusions are as follows:

1. **Energy Efficiency.** Energy efficiency aspects are not strongly included in the IPs, even if the Union's energy efficiency targets are essential towards the low-carbon economy. Energy efficiency is seen important in relation to buildings and industry, even if it should be taken into account in all IPs.
2. **Energy System Integration.** Energy system integration as a horizontal topic to all IPs is present in the majority of the IPs (7), and synergies between different technologies are identified. In order nonetheless to make EU energy system sufficiently flexible to accommodate renewable energy sources, energy system integration aspects should be covered by all the IPs and the cooperation across the IP should be their integral part.
3. **High Temperature & Advanced Materials.** Development of materials for energy applications play a minor role in the IPs, even if they are mentioned in 7 out of the 13 analysed IPs. The applications are different from IP to IP, but the cooperation on materials development could produce technological benefits for several IPs.
4. According to the feedback received by EERA JP coordinators, advanced materials are at the core of the technological innovations needed to reach a sustainable and climate-neutral economy and society. Developing materials resistant to high temperature and chemical/mechanical effects of interaction with fluids (refrigerants or fuels) is common to several energy technologies in which increasing the temperature implies increasing the efficiency of the process (i.e., nuclear, concentrated solar, bioenergy, geothermal energy, hydrogen production and combustion, etc.). The comprehensive coverage of energy materials will embrace all materials issues relating to future energy needs. In this context, EERA will host a series of workshops on "Energy Materials for Innovation (EM4I)" in order to bring materials science to the forefront of Europe's energy research landscape.
5. **Energy Storage.** Energy storage is mentioned in 8 out of the 13 analysed IPs. It is a strong and relevant area with several technologies; material, component and system development needs are well mentioned. Energy storage represents a key technology for enabling renewable energies and synergies between different IPs should be exploited.
6. **Digitalisation:** The current IPs almost do not mention new digital technologies, such as AI, blockchain and internet of things. Those are key technologies driving the next wave of the digital transformation and could enhance existing processes, create entirely new

business models, and develop innovative products and services for a new generation of consumers. Therefore, the revised IPs should consider them.

It is interesting noticing that collected data for the technological cross-cutting topics at first glance seem very specific to an individual sector, but when analysing them in a more consistent way, relevant synergies with other fields are emerging.

### *Non-technological cross-cutting issues: conclusions and recommendations*

As far as collected data for the non-technological cross-cutting topics regards, the main conclusions are:

1. **Circular Economy.** Despite many IPs are referring to Circular Economy, it is only the IP PV that mentions that funding has been set aside for this activity. Other IPs should consider doing the same, in particular considering the current challenges for IP Batteries and IP Wind, where critical next steps are exactly related to performing thorough LCA analyses, end-of-life usage and decommission, and sustainable production and use of raw materials. A similar recommendation can be made for IP CCS & CCU, where the circular carbon economy is also going to be a central aspect when developing the technologies further.
2. **Education & Training.** Despite many IPs are mentioning Education and Training it is not always clear which type of activities are implemented, moreover in most of the cases there is no funding tied to this activity. It could be relevant to, e.g., map education and skills needed in evolving energy fields, and to address the education gaps.
3. **Policy & Regulation.** Most of the IPs mention the presence of regulatory bottlenecks at both EU and National level. The IP CSP highlights the need for a “transparent and stable regulatory environment guaranteeing investor's confidence” as a necessary condition to achieve the identified target.
4. **R&I Funding Programmes and measures.** The allocation of R&I Funding and a budget is a necessary precondition for addressing many of the activities indicated in the IPs. Information such as the implementation instruments (funding programmes) to be mobilised and their associated indicative financing contribution to support R&I activities should be mentioned in the Implementation Plans by their corresponding Implementation Working Groups. This is a complex exercise since there are a variety of funding opportunities available at European, national and regional levels. Therefore, this information is scattered through different funding agencies and databases, resulting in partial and non-uniformised information across the different Implementation Plans. As stated in the Implementation Plan on CSP, a much more comprehensive and coordinated approach in terms of financing sources is needed in order to ensure co-financing by SET

Plan countries and the EC and a better coordination with structural funds. A common database including information about the most relevant programmes at European, national and regional level would be of great interest and added value for the whole SET Plan community.

Additionally, one instrument mentioned in several IPs for the alignment of public and private financing is the creation of public-private partnerships.

Eventually, risk financing is also identified as a common barrier in several Implementation Plans. Development of ad-hoc financial schemes could be promoted in order to improve access to loans for R&D projects with high uncertainty/risk.

5. **Social Awareness-Acceptance-Engagement.** In order to achieve the EU goals towards a climate neutral future for Europe in terms of speed, effectiveness and equality, specific actions to engage with citizens in novel ways and improve societal relevance and impact are needed. Therefore, all revisions to SET Plan Implementation Plans should have dedicated sections related to Social Sciences and Humanities (SSH), including tangible recommendations. The Offshore Wind Implementation Plan could be utilised as an example since it includes a section on the contributions of SSH research and innovation to offshore wind. In addition, they should move beyond social awareness/ acceptance/ engagement and consider all relevant aspects of SSH, such as early participation of stakeholders in meaningful ways; learning from innovative bottom-up approaches, and the recognition of the important roles of professionals in the energy system (not just 'end-users')<sup>6</sup>.
6. **Standardisation.** By documenting and sharing information on state-of-the-art technology and by providing a framework for technology-related policies, standardisation represents an important tool for policy-makers in defining and supporting national legislation and regulation for renewable energy. Only one IP, IP Oceans, addresses standardisation in a consistent way. The other do not mention standardisation. It is difficult to understand the reasons behind it. A clear requirement to the IW groups to address this point would be relevant.
7. **International cooperation.** International cooperation is seen as having a key role in contributing to the achievement of the targets indicated in the IPs. On the other side, the expression “international cooperation” covers many types of cooperation. It can be more effective for the achievement of the actions described in the IP if references to the specific types and scales of collaborations are included: e.g. transnational, European, bilateral, gov-to-gov collaboration/exchange.

Feedback received by the Joint Programmes Coordinators

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<sup>6</sup> <https://energy-shifts.eu/>



It is also relevant to mention that the comments of the JPCs are specific for the different areas and may be applicable only for certain technologies. However, it is essential that the dialogue between different energy technologies described in the IPs and the presence of cross-cutting issues is maintained in order to find the best solutions and benefits that could be applied to several IPs.

## VI NEXT STEPS

Based on the feedback received from the JPCs and the conclusions from the desktop analysis the following steps are now taken into consideration for drafting the Deliverable 1.7 “Final report & recommendations on cross-cutting and interdisciplinary activities relevant to the SET Plan”:

- Follow-up discussion on the identified topics and related activities, proposed prioritisation and recommendations on enabling factors to support their implementation. The discussion will be undertaken at a workshop/webinar involving EERA JPCs (and other Joint Programme members, when relevant), stakeholders from the SET Plan Implementation Working Groups (IWGs) and additional players (e.g. ETIPs, KIC InnoEnergy and other industry-driven platforms, consumer groups, citizens' organisations), when relevant. The mentioned prioritisation will be based on criteria proposed by the SUPEERA consortium partners and discussed with the EERA Joint Programmes ahead of the workshop. Criteria might include relevance across the SET Plan Implementation Plans, need of collaboration, investments and urgency to translate priorities into actionable R&I activities.
- Analysis of the new versions of the IPs. The analysis conducted is based on the IPs published by SETIS<sup>7</sup> and endorsed in the period 2017-2019. It appears that the IPs are currently being updated. Unfortunately, SUPEERA has not been able to get hold of the draft versions. The development of the cross-cutting issues in the new versions can be analysed by SUPEERA. In the analysis more focus will be given to: the relevance of the identified topics in the MS and the presence of dedicated funding mechanism, and on identifying research and technology needs to support the identified topics and activities and to facilitate the scale-up to commercial size.
- Follow up on the series of workshops on "Energy Materials for Innovation (EM4I)" organised by the EERA Joint Programme on Advanced Materials and Processes for Energy Applications (JP AMPEA), together with the EERA Joint Programme on Nuclear Materials (JP NM) and the transversal Joint Programme Digitalisation for Energy (tJP DfE). The workshops will cover the integral stages of materials research, from discovery to scale-up productions, device development, industrial integration and sustainability, as well as cross-cutting technologies supporting these actions.

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<sup>7</sup> [https://setis.ec.europa.eu/implementing-actions/set-plan-documents\\_en#ecl-inpage-50](https://setis.ec.europa.eu/implementing-actions/set-plan-documents_en#ecl-inpage-50)

<sup>8</sup> [https://setis.ec.europa.eu/implementing-actions/set-plan-documents\\_en](https://setis.ec.europa.eu/implementing-actions/set-plan-documents_en)

## 1. ANNEX I

SupEERA - Task 1.3 Cross-cutting and interdisciplinary activities

Sub-task 1) Initial mapping of existing activities under the Implementation Plans & identification of synergies

Total 13 IPs (Nuclear excluded)

IP	Cross-cutting topics - technological	Related activities	Allocated budget/resources	countries	relevant JP(s)	other potentially interested JPs (and related IPs) - initial input
IP Bioenergy & Renewable Fuels for Sustainable Transport	Energy Systems Integration	Increased integration of renewable fuels/bioenergy in different energy systems (exemplified by power-to-gas and power-to-liquid pathways + use of biomass-based energy generation and renewable hydrogen in heating, cooling and electricity networks). Included under activity 7 - production of renewable hydrogen from water electrolysis and renewable electricity. R&I activities from TRL2 to TRL9	Total budget for the whole activity: 102 M (TRL 2-6), 60 M (TRL7-8), 250 M (TRL 9) – Amounts correspond to renewable hydrogen production and for electrolyzers to the cost of the renewable part in the electricity mix only		JP Bio, JP FCH	JP ES, JP ESI, JP AMPEA, JP Smart Grids
	Energy Systems Integration	Projects include: by 2020 showcase with projects the ability of renewable hydrogen to interact with the grid to further enable RES penetration - Timeline: 2020-2030		N/A		
	High temperature & advanced materials	Affordable high-temperature, corrosion-resistant materials or new alloys resistant to extreme conditions. Synergies to renewable hydrogen and CO2 streams.	0,2bn EUR (for the whole activity)	N/A		JP AMPEA, JP FCH
	Energy storage	Renewable energy storage. Under R&I activity 5 - Demonstrate other renewable liquid and gaseous fuels (excluding hydrogen) through thermochemical/chemical/ biochemical/electrochemical transformation of energy neutral carriers with renewable energy - TRL6-7 to TRL8 - 10 demo concepts (4 in 2022 + 6 in 2030)	MS (25%)/EU (25%)/Industry (50%). Implementation instruments: MS grants and other funding, equity, commercial loans, Risk Finance, InnoFund, EFSI, ESIF, H2020 IAs, European Partnership Initiatives	N/A		JP ES
IP PV - Initiative for Global	Energy Systems Integration	Development of Photovoltaic technologies in combination with efficient building materials (Building-Integrated PV), synergy with the building sector	Required: 7-10 M€	AT, BE, DK, FR, DE, IT, NL,	JP Smart Cities	JP Smart grids, JP ES

IP	Cross-cutting topics technological	Related activities	Allocated budget/resources	countries	relevant JP(s)	other potentially interested JPs (and related IPs) - initial input
Leadership in Photovoltaics	Digitalisation	Interconnections with e-mobility, internet of things (in buildings and cities): smart city approach. R&I Activity n. 1		NO, SP, SW, CH, (and Canada, Japan, Korea)		
IP CSP - Initiative for Global Leadership in Concentrated Solar Power	High temperature & advanced materials	New designs for high temperature thermal energy storage. R&I Activity n. 1	Required: 30M€	FR, PT, IT	JP Energy Storage	
IP Batteries - Become competitive in the global battery sector to drive e-mobility and stationary storage forward	Energy storage	Hybridisation of battery systems for stationary energy storage, integration with other renewable energy systems. R&I activity n. 3.1	Required 25 M€	DE, ES, FR, IT, TR	JP Wind, JP PV, JP CSP	
	High temperature & advanced materials	Foster development of materials processing techniques and components for fast industrialization compatible with present mass production lines. R&I activity n. 2.1	Required 50M€	DE, ES, FR, IT, NO, TR		
IP Deep Geothermal	Energy Systems Integration	Integration of geothermal heat and power in the energy system and grid flexibility. R&I activity. N. 7	€11.5m	CH, IS, IT, PT, TR, EU	Geothermal	ESI, Smart Grids
IP Positive Energy Districts (PED)	Energy efficiency	From Positive Energy Blocks to Districts - development of a TOOLBOX for Positive Energy Blocks upgradable to Districts.	12 M€ (Activity n. 9)		Smart cities	
	High temperature & advanced materials	Optimal use of advanced materials. No specific activity mentioned (but covered under the definition of a PED)				AMPEA
	Energy Systems Integration	Integrated energy system design providing an efficient and flexible energy infrastructure. Activity n. 11: RHC-ETIP - Industry support	€7m			ESI, Smart Grids
	Digitalisation	ECTP – ESA – Digital Modelling of Cities - activities: Stock taking of state-of-the-art space technology; Capacity building at EU level for Digital modelling of cities for energy management including built and natural environments; Development of a portal accessible to cities for physical and thermal mapping. Related to Energy Efficiency	27 M€ (activity n. 10)			

IP	Cross-cutting topics technological	- Related activities	Allocated budget/resources	countries	relevant JP(s)	other potentially interested JPs (and related IPs) - initial input
	Energy storage	Local energy storage. No specific activity mentioned (but covered under the definition of a PED)				Energy Storage
IP Increase the resilience and security of the energy system	Energy Efficiency Systems Integration Energy Storage High temperature & advanced materials	Flagship Initiative 1 "Develop an Optimised European Power Grid" and Flagship Initiative 2 "Develop Integrated Local and Regional Energy Systems" - This SET plan has two flagships and one set of cross-cutting activities with no budget sub-divisions. The two flagships have links to all cross-cutting technological topics, which is a consequence of its very broad scope.	350 M€/year (Flagship Initiative 1) 250 M€/year (Flagship Initiative 2)			
	Digitalisation	Cybersecurity of critical energy infrastructure - activities: share results; national projects; ERA-NET; international cooperation/H2020 projects. Timeline 2018-2022. Expected impact includes large-scale demonstrator for "What if Scenarios" preventing against cyber-attacks	100 M€/year for RD&I on cross-cutting activities	see under "related activities"		potentially all
	Digitalisation	Process chain for interoperability of ICT systems - activities: share results; national projects; ERA-NET; international cooperation/H2020 projects. Activities include: a joint transnational structure for a European organisation 'IES Europe'; align national, transnational and international activities and funding schemes on interoperability. Timeline 2018-2022.	100 M€/year for RD&I on cross-cutting activities	see under "related activities"		potentially all
	Digitalisation	Systemic and socio-economic impact of digitalisation in the energy system - activities: share results; national projects; ERA-NET; international cooperation/H2020 projects. Activities include: Seminars on visionary future solutions with ongoing projects and initiatives; assess ongoing projects and initiatives. Expected impact incl.: development or modification of existing policy instruments; working towards a European public-private partnerships and new transnational research projects.	100 M€/year for RD&I on cross-cutting activities	see under "related activities"		potentially all
		Instruments: transnational calls (through e.g. ERA-NET Smart Grids Plus), H2020 (incl. COST), bilateral gov-to-gov collaboration/exchange		see under "related activities"		potentially all

IP	Cross-cutting topics technological	- Related activities	Allocated budget/resources	countries	relevant JP(s)	other potentially interested JPs (and related IPs) - initial input
		Further collaboration: forum for discussion with all relevant stakeholders: Network operators, market operators, retailers and aggregators, generators, equipment manufacturers, ICT solution providers, regulatory bodies, R&D institutes, end-user associations, organisation promoting standards. Timeline 2018-2022.		see under "related activities"		potentially all
IP EE for Buildings - Energy Efficiency Solutions for Buildings	Digitalisation	Digital planning and operational optimization; combination of hard- and software to be implemented and running together with or replacing existing building automation systems. Activities 5.1-3 & 5.1-4, mentioned as "specific target" for "New materials and technologies for energy efficient solutions for buildings"	Required: 250 M€ (5.1-3); 150 M€ (5.1-4)	BE, AT, DE, IT, SE, FR	Smart cities, energy systems integration	
	Energy efficiency	Multi-source District Heating integrating renewable and recovered heat sources, higher temperature District Cooling and optimization of building heating system, to minimize the temperature levels in district heating networks. Activity n. 5.2-2, mentioned as "specific target" for "Cross cutting heating and cooling technologies for buildings"	Required: 145 M€	BE, AT, DE, IT, SE	Smart cities, Carbon capture and storage, Energy systems integration	
	Energy efficiency	Cost reduction and increase in efficiency of micro combined heat and power/combined cooling heat and power plants. Activity n. 5.2-3, mentioned as "specific target" for "Cross cutting heating and cooling technologies for buildings"	Required: 30 M€	AT, DE, IT, SE	Smart cities, Carbon capture and storage, Energy systems integration	
	Energy storage	Compact thermal energy storage materials, components and systems. Activity n. 5.2-4, mentioned as "specific target" for "Cross cutting heating and cooling technologies for buildings"	Required: 200 M€	AT, DE, IT, SE, BE, CH, ES, FR, NL, TI, TR	Energy storage	Smart cities, Carbon capture and storage, Energy systems integration

IP	Cross-cutting topics technological	Related activities	Allocated budget/resources	countries	relevant JP(s)	other potentially interested JPs (and related IPs) - initial input
	Energy Systems Integration	Synergy with mobility: production, consumption and storage of renewable energies on/in buildings to be considered in integration with electromobility infrastructures. Mentioned as enabler (no specific activity funded)				potentially all
IP CCS & CCU	Energy storage	A European CO2 Storage Atlas identifying and characterising prospective storage sites - the Atlas would facilitate site comparison, ranking, and help integrating regional and national storage planning. R&I activity 4 and 5	€10 M for further appraisal in selected regions and completion of the Atlas; additional funding for future updates and operational activities	NO, CZ, FR, GE, HU, NL, SP, SE, UK	JP Carbon Capture and Storage	Potentially all
IP Wind - Global Leadership in Offshore Wind	Digitalisation	Digitalization and data analytics - development of new sensors, data processing, machine learning and data analytics methods. R&I activity n. 1	25 M€	NA	JP Wind	Potential all
	High temperature & advanced materials	New and innovative materials and their degradation and failure mechanisms leading to the development of new and improved materials. R&I activity n. 4	20 M€	NA		
IP Energy Consumers - Smart solutions for energy consumers	Digitalisation	Interoperability of smart energy solutions. Enabler (no future budget allocated)		General commitment/interest: AT, DE, FI, IT, PT, SE, TR	JP e3s	JP ESI, JP Smart Grids
	Digitalisation	User-friendly interfaces				
	Digitalisation	Energy related sensors and controllers. Enabler				
IP Make EU industry less energy intensive and more competitive	Energy efficiency	Energy efficiency of cross-sector industrial components. Activity n. 5.3	1-2 M€/project	Activity 5.3: EUA-EPUE (European Platform of Universities in Energy Research and Education), AT, BE, CH, DE,		

IP	Cross-cutting topics technological	- Related activities	Allocated budget/resources	countries	relevant JP(s)	other potentially interested JPs (and related IPs) - initial input
				ES, IT, NL, NO, PL, SE		
	Energy Systems Integration	Improving system integration, optimal design, intelligent and flexible operation. Suggestion to include under projects in Activity n. 5.2 ("Improving system integration, optimal design, intelligent and flexible operation")	20 M€/project (Activity n. 5.2)	Activity 5.2: AT, BE, CH, DE, ES, FI, FR, IT, NL, PL, PT, SE, SK, TR		
	Digitalisation	New reliable hard and soft sensors (under Activity n. 5.2)	20 M€/project (Activity n. 5.2)			
	Digitalisation	Simulation and modelling capabilities (under Activity n. 5.2)	20 M€/project (Activity n. 5.2)			
	Digitalisation	Increase resilience against cyber-attacks, including identification and real-time counteracting (under Activity n. 5.2)	20 M€/project (Activity n. 5.2)			
	Energy storage	Development of micro-grids, including storage and monitoring (under Activity n. 5.2)	20 M€/project (Activity n. 5.2)			

## 2. ANNEX II

SupEERA - Task 1.3 Cross-cutting and interdisciplinary activities

Sub-task 1) Initial mapping of existing activities under the Implementation Plans & identification of synergies

Cross-cutting topics - non technological	Related activities	Allocated budget/resources	countries	relevant JP(s)	other potentially interested JPs (and related IPs) - initial input
Circular economy	Support of sustainable feedstock mobilisation. Development and use of unexploited sustainable waste, biomass and land resources to supply advanced technologies, with particular emphasis on circular economy	Enabler - no specific budget allocated	N/A		
Policy & regulation	Support to the creation of a long-term, stable (i.e. with known targets) policy framework	Enabler - no specific budget allocated	N/A		
Policy & regulation	Support emerging technologies at low TRL to increase efficiency; in parallel, continued R&I efforts in high TRL technologies to comply with reduced cost projections, GHG emissions goals and deployment	Enabler - no specific budget allocated	N/A		
International cooperation	International cooperation (e.g. Mission Innovation, IEA as well as European schemes within ERA-NET) is also considered crucial from a cooperation and development point of view but the working group agreed that it cannot alone facilitate to reach the targets	Enabler - no specific budget allocated	N/A		
Circular economy	New Technologies & Materials - R&I activities including LCA for whole fabrication route, environmental impact Technologies for silicon solar cells and modules with higher quality - focus on sustainability and recyclability as a commercial performance indicator	15-50 M€ (activity n. 3)	AT, BE, DK, FR, DE, IT, NL, NO, SP, SW, CH, (and Canada, Japan, Korea)	JP Smart Cities	JP Smart grids, JP ES
R&I funding programmes & measures	More comprehensive and coordinated approach in terms of financing sources	Enabler - no specific budget allocated			

Cross-cutting topics - non technological	Related activities	Allocated budget/resources	countries	relevant JP(s)	other potentially interested JPs (and related IPs) - initial input
Policy & regulation	Regulatory Framework initiative: encourage the use of cooperation mechanisms in the Renewable Energy Directive	Enabler - no specific budget allocated			
Circular economy	Develop circular economy and de-bottleneck availability of critical raw materials	Enabler - no specific budget allocated			
R&I funding programmes & measures	Access to finance for upscaling production and large scale advanced battery production and deployment	Enabler - no specific budget allocated			
Policy & regulation	Establish an enabling regulatory framework for competitiveness in the batteries field	Enabler - no specific budget allocated	DE, ES, FR, IT, SE		
Education & training	Improve education and knowledge throughout the entire value chain	Enabler - no specific budget allocated	DE, ES, FR, IT, SE		
R&I funding programmes & measures	Risk management (for investments) + development of ad-hoc financial schemes	Enabler - no specific budget allocated	CH, FR, IT, NL, PT, EU		
Social awareness, acceptance, engagement	Awareness and social acceptance	Enabler - no specific budget allocated	FR, IS, IT, PT, EU		
Education & training	Knowledge transfer & training (including peer-to-peer learning and research infrastructures), in particular between education/training institutes and companies	Enabler - no specific budget allocated			
	Dissemination of best practices	Enabler - no specific budget allocated			
Circular economy	Sustainable waste; No activity covering it directly (but mentioned in the definition of a PED)				Bioenergy

Cross-cutting topics - non technological	Related activities	Allocated budget/resources	countries	relevant JP(s)	other potentially interested JPs (and related IPs) - initial input
Education & training	EUA-EPUE - Capacity Building - activities: build effective PED bottom-up community-level actions; bridge technological and social innovation aspects; capacity building and engagement with civil society. Connected to Social awareness, acceptance, engagement	5 M€ (Activity n. 7)			
R&I funding programmes & measures	PED Labs and Innovation Actions - activities: Planning and execution of calls towards PED Labs and Innovation Actions for PEDs; facilitation of transnational collaboration regarding alignment of national programmes and R&I funding calls towards PEDs; application for ERA-NET or EJP Cofund and subsequent implementation of call activities with focus on digital planning	160 M€ (Activity n. 2 - PED Labs) 475 M€ (Activity n. 2 - IA)			
International cooperation	Activities: assessment of additional international cooperation actions in the topic of PED; preparation of R&I funding and implementation strategy with China as a pilot for international collaboration, followed by workshops, joint R&I calls with China.	35 M€ (Activity n. 8)			
International cooperation	Different types/levels of collaboration frameworks: share results; national and bilateral gov-to-gov collaboration/exchange; transnational - EU (H2020, incl. ERA-NET, COST), international (e.g. Mission Innovation). Timeline 2018-2022. Expected activities incl.: large-scale demonstrator for "What if Scenarios" preventing against cyber-attacks; joint transnational structure for a European organisation 'IES Europe'; Align national, transnational and international activities and funding schemes on interoperability	100 M€/year for RD&I activities on crosscutting activities - 350 M€/year for RD&I activities on Flagship Initiative n.1 (electricity and energy networks); 250 M€/year for RD&I activities on Flagship Initiative n.2 (local and regional networks)	AT, BE, DE, ES, IT, NL, NO, SE, TR, UK (see "related activities" for country involvement per activity)	JP Smart Grids, JP ESI	potentially all

Cross-cutting topics - non technological	Related activities	Allocated budget/resources	countries	relevant JP(s)	other potentially interested JPs (and related IPs) - initial input
R&I funding programmes & measures	Market design for trading of heterogeneous flexibility products- Timeline 2018-2022. Instruments: national, transnational and European calls for RD&I projects. Further collaboration: forum for discussion with relevant stakeholders: network operators, market operators, retailers and aggregators, generators, equipment manufacturers, ICT solution providers, regulatory bodies, R&D institutes, end-user associations, organisations promoting standards	Budget: 10M EUR.	see under "related activities"		potentially all
R&I funding programmes & measures	Regulatory innovation zones- Timeline 2018-2022. Activities: seminars on future solutions; initiate a European initiative such as "Innovation Deal" for energy transition; evaluate ongoing projects and initiatives. Expected impact incl.: development/modification of existing policy instruments; creation of a European public-private partnership and new transnational research projects		see under "related activities"		potentially all
Standardisation	Co-ordinate the development of standards and guidelines for wave technology evaluation and analysis.	Required: 6.5 M€ (activity 1.6)	EU, MS		potentially all
R&I funding programmes & measures	Progress the creation of an EU Insurance and Guarantee Fund to underwrite various project risks	Required: 50-70 M€ of private/public funding, which is on top of the resources above (activity 2.1)	EU, MS		potentially all
R&I funding programmes & measures	Investigate the potential for creation of an Investment Support Fund for ocean energy farms	Required: 200-300 M€ of private/public funding, which is on top of the resources above (activity 2.2)	EU, MS		potentially all
Policy & regulation	Support the development of a collaborative procurement model	Required: 24 M€ (activity 2.3)	EU, MS		potentially all

Cross-cutting topics - non technological	Related activities	Allocated budget/resources	countries	relevant JP(s)	other potentially interested JPs (and related IPs) - initial input
Standardisation	Collaboration on the development of certification and safety standards	Required: 8 M€ (activity 2.4)	EU, MS		potentially all
Social awareness, acceptance, engagement	Living labs - energy technologies and solutions for decarbonized European quarters and cities. Activity 5.1-4, mentioned as "specific target" for "New materials and technologies for energy efficient solutions for buildings"	Required: 150 M€	AT, DE, IT, SE, FR	Smart cities, Carbon capture and storage, Energy systems integration	
	Living labs. Activity 5.2-1, mentioned as "specific target" for "Cross cutting heating and cooling technologies for buildings"	Required: 230 M€	BE, AT, DE, IT, SE	Smart cities, Carbon capture and storage, Energy systems integration	
	Living labs. Activity 5.2-2, mentioned as "specific target" for "Cross cutting heating and cooling technologies for buildings"	Required: 145 M€	BE, AT, DE, IT, SE	Smart cities, Carbon capture and storage, Energy systems integration	
	Living labs. Activity 5.2-3, mentioned as "specific target" for "Cross cutting heating and cooling technologies for buildings"	Required: 30 M€	AT, DE, IT, SE	Smart cities, Carbon capture and storage, Energy systems integration	
	Living labs. Activity 5.2-4, mentioned as "specific target" for "Cross cutting heating and cooling technologies for buildings"	Required: 200 M€	AT, DE, IT, SE, BE, CH, ES, FR, NL, TI, TR	Energy storage	Smart cities, Carbon capture and storage,

Cross-cutting topics - non technological	Related activities	Allocated budget/resources	countries	relevant JP(s)	other potentially interested JPs (and related IPs) - initial input
					Energy systems integration
	Architecture; synergies between functionality and aesthetics as criteria in designing and construction processes	Enabler - no specific budget allocated			potentially all
	Urban planning (also as contribution to optimizing the energy management of buildings)	Enabler - no specific budget allocated			potentially all
Education & training	Education and training: from conception to deconstruction, with a particular focus on operating life (users, building manager, technicians...)	Enabler - no specific budget allocated			potentially all
R&I funding programmes & measures	Pilots to ensure fast and cost-effective R&D activities within CO2 capture; R&I for next generation CO2 capture, and CCU (CO2 valorisation). Related to R&I Activity 2, 6 and 7	Costs to be determined		JP Carbon Capture and Storage	potentially all
Circular economy	Life Cycle Assessments (LCA) of the sustainability impact of CCU-derived products, including of the net CO2 reduction	Costs to be determined	UK, SE	Potential all	
Socio-economic policies and measures	Socio-economic motivation for investing in CCS and CCU. Collaboration across European Institutions, national and regional governments and industry for the development and implementation of strategies, roadmaps and action plans to enable further development and deployment of CCS and CCU in Europe.	Costs to be determined	NO, CZ, FR, GE, HU, NL, SP, SE, UK	Potential all	
Socio-economic policies and measures	Feasibility study on offshore research infrastructure development: social, environmental, coexistence and multi-use, legal aspects. Related to R&I 3	Required: EUR 5 million	NA	JP Wind	
Education & training	Wind Energy Hubs - Harmonisation of curricula and training techniques in close cooperation between Vocational Education and Training centres and industry	Required: EUR 5 million	NA	JP Wind	
Circular economy		Enabler - no specific budget allocated	General commitment/interest: AT, DE, FI, IT, PT, SE, TR	JP e3s	JP ESI, JP Smart Grids

Cross-cutting topics - non technological	Related activities	Allocated budget/resources	countries	relevant JP(s)	other potentially interested JPs (and related IPs) - initial input
Standardisation	Standards for smart appliances	Enabler - no specific budget allocated			
Standardisation	Development and use of reference architecture and standards, common terminology for new energy services, in particular for data sharing/ICT in future R&I projects. Related to activities 1-5 (no budget allocated)	Enabler - no specific budget allocated			
Social awareness, acceptance, engagement	Development of KPIs to measure consumer benefits. No budget defined. Related to activities 6-7	Enabler - no specific budget allocated			
Social awareness, acceptance, engagement	Innovative organisational and services models, improve decision-making strategy	Enabler - no specific budget allocated			
Social awareness, acceptance, engagement	Consumer engagement and acceptance. No budget defined. Related to Activity 7	Enabler - no specific budget allocated			
Circular economy	Circular economy in the context of improving system integration: Activity 5.3 - 'Improving exchange of technological, economic, behavioural and social knowledge; training, capacity building and dissemination, to enhance sustainable energy management'	1-2 M€/project	Activity 5.3: EUA-EPUE (European Platform of Universities in Energy Research and Education), AT, BE, CH, DE, ES, IT, NL, NO, PL, SE		
Social awareness, acceptance, engagement	Humans in the loop. Suggestion to be included within projects in Activity 5.2 (Improving system integration, optimal design, intelligent and flexible operation); Horizon2020 projects (ended/on-going)	20 M€/project (recommendation)	Activity 5.2: AT, BE, CH, DE, ES, FI, FR, IT, NL, PL, PT, SE, SK, TR		