



# Strategic Energy Technology Plan

## Implementation Plan

Final Version – 15.01.2018

Temporary Working Group 4

## **Increase the resilience and security of the energy system**





# Executive Summary

## Introduction and Process

The present document constitutes the Implementation Plan (IP) in actuation of the European Stakeholders Declaration for Action 4 “Increase the resilience and security of the energy system” (19 November 2016). It gathers the consensus of 15 country representatives (Figure 1) about the R&I actions to be implemented in coordination, in order to achieve the challenging targets set in the Declaration. Based on the mandate given to the Temporary Working Group 4 (TWG4), this IP reconsiders and completes the formulation of the targets aligning them to the Energy Union and SET-Plan goals, and shapes them to be concrete, output based, innovation oriented and technology neutral. Extensive interactions of TWG4 with the main stakeholders of the European energy system (e.g. several ETIPs, associations, experts etc.) resulted in the formulation of two complementary Flagship initiatives, as shown in Figure 2 namely: Flagship 1 “Develop an optimised European power grid” and Flagship 2 “Develop Integrated Local and Regional Energy Systems”.



Figure 1: Participating Countries TWG A4

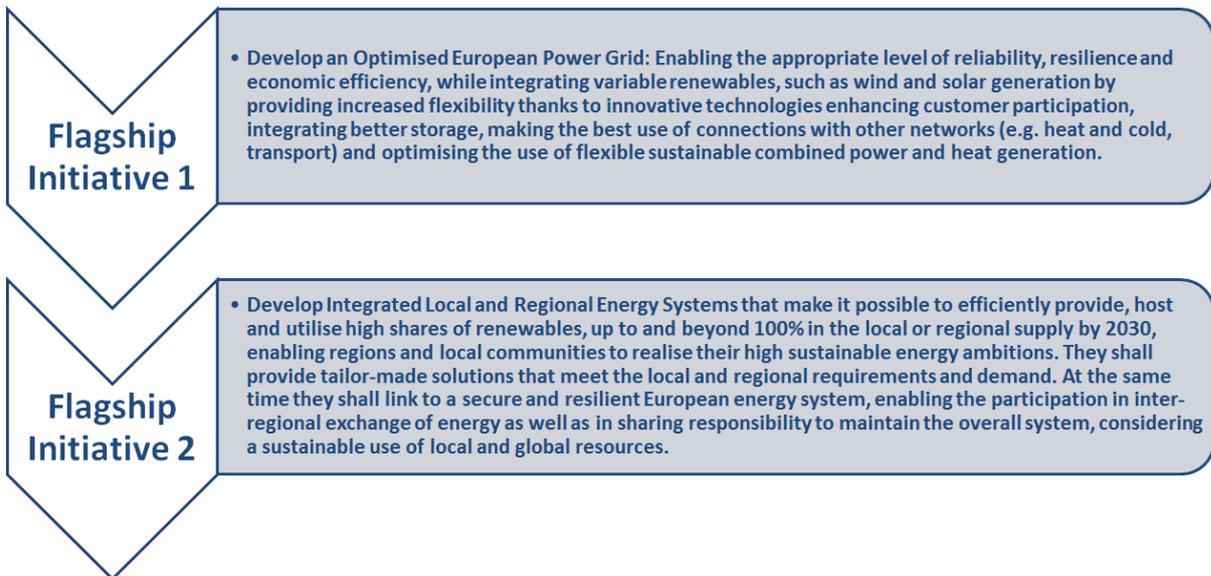


Figure 2: Flagship Initiatives for Action 4

The flagship initiatives are complemented by a crosscutting layer, covering enabling aspects such as digitalisation (including cybersecurity), new regulatory and market approaches enhancing the value of field experiments and the concept of living labs. Flagship initiatives have been substantiated into 27 Innovation Fiches (5 crosscutting, 12 on Flagship 1 and 10 on Flagship 2). The process undertaken is illustrated in Figure 3.

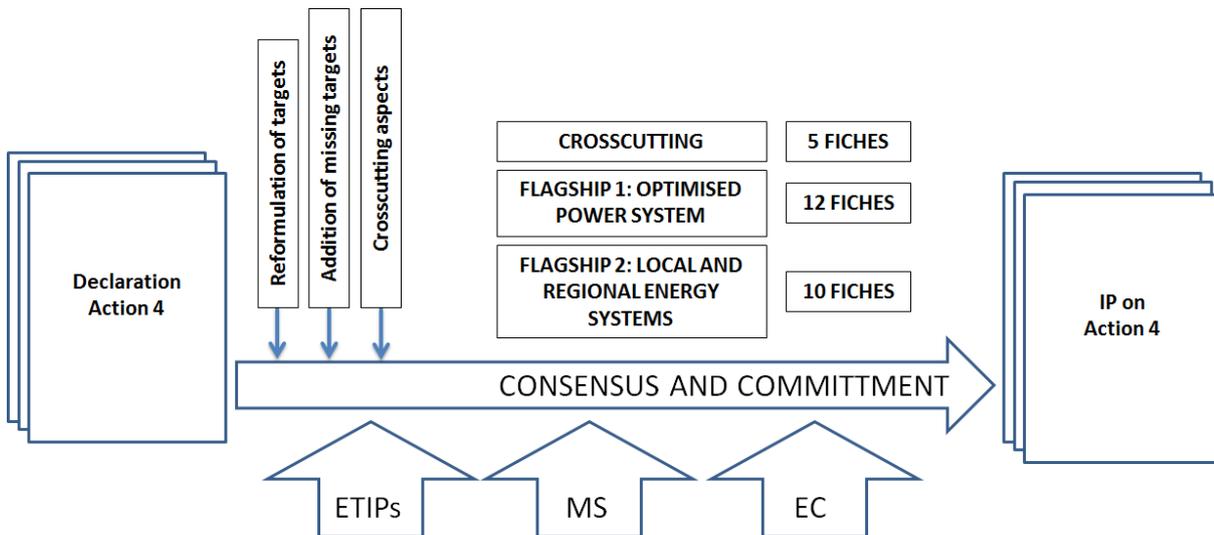


Figure 3: Process for the development of the Implementation Plan for Action 4

## R&I activities needed to achieve the targets for a resilient and secure European energy system

The overarching goals driving the SET-Plan Implementation plan for Action 4 are the development and operation of energy systems showing an appropriate level of resilience, reliability, energy and economic efficiency, leveraging the use and integration of all types of bulk and local resources, with special reference to integrating variable renewables at all-time scales.

The variability of renewables, the stochastic nature of loads, the necessity to integrate different energy vectors according to different energy scenarios rise the necessity to develop a strong attribute: FLEXIBILITY. Flexibility in the power sector can be achieved by means of innovative technologies enhancing customer participation, integrating better storage, making the best use of connections between electricity grids at all voltage levels and other networks (e.g. gas, heat and cold, transport) and optimising the use of flexible sustainable combined power and heat generation.

A further level of flexibilisation can be obtained from centralised and decentralised thermal power generation technologies, including for the combined production of heat and power, sector regulation, effective TSO/DSO interaction, market design, dynamic pricing, empowerment and integration of end-users by increasing connectivity and data accessibility. The implementation of smart and integrated energy systems is not only a technological practice, but also a social, cultural, commercial and political practice where cooperation and coordination are pivotal ingredients. It entails a change in the relationship between production, distribution, consumption and storage, going beyond capacity optimisation. For what pertains to local and regional energy systems, innovation targets had to be formulated according to the strategic targets given in the stakeholder declaration, which are referring to the necessary innovation in the heating networks, in order being able to play their role in an integrated regional energy system, further the key issue of developing innovative solutions that make optimal use of a mix of energy sources as well as available technologies and infrastructures, and last but not least the overcoming of innovation barriers by establishing innovation environments to develop smart services for local and regional energy systems.

The targets formulated are illustrated in Figure 4. The detailed targets are illustrated in Table 2 and Table 3 of the main text together with a quantification



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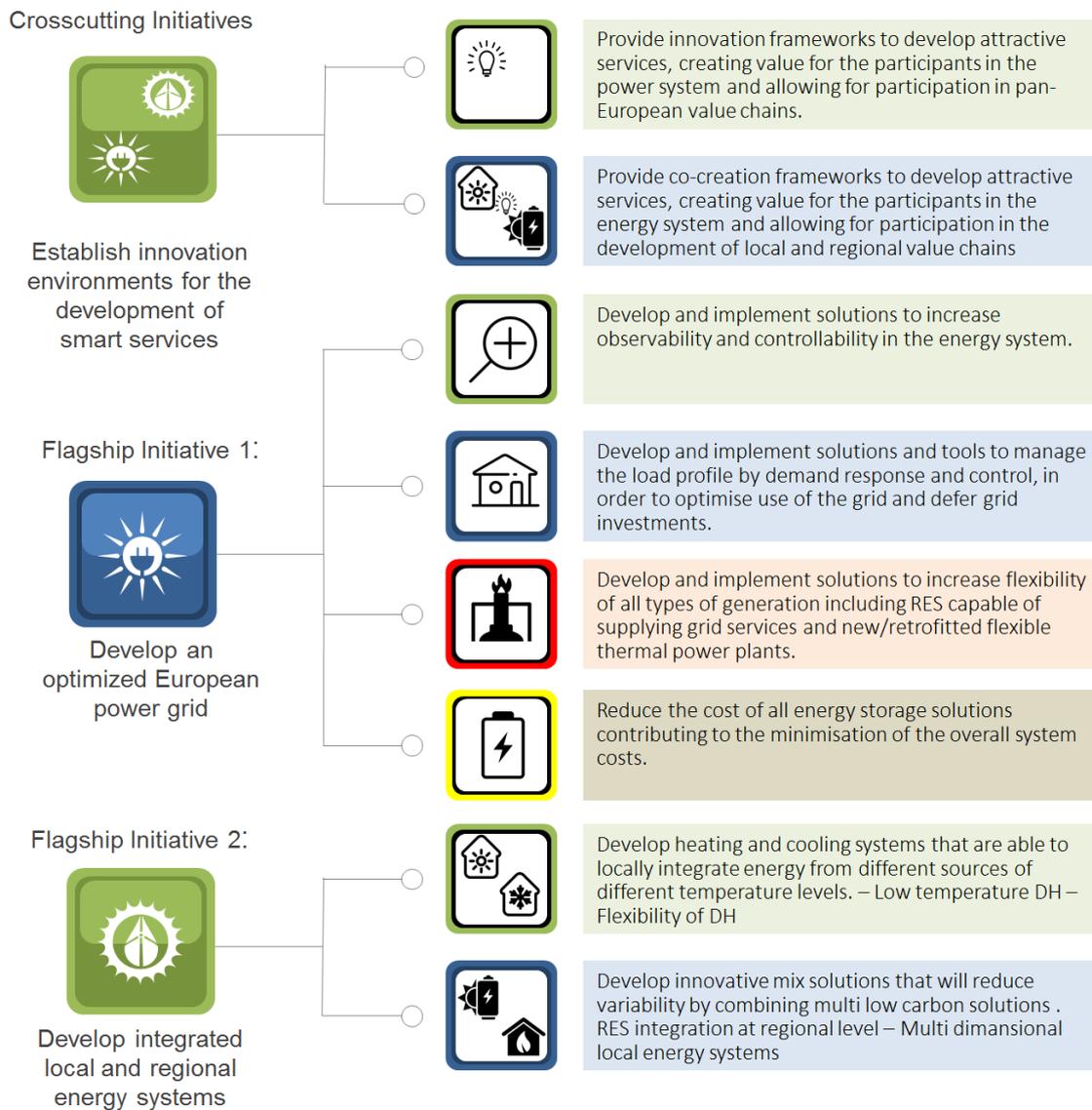


Figure 4: Targets formulated for Action 4

## Joint activities and collaboration framework

All TWG A4 members were asked to propose activities contributing to the revised targets from the declaration of intent. A total number of 27 Innovation Fiches were proposed by the TWG A4 participants:

- 5 fiches on the crosscutting activities
- 12 fiches on Flagship Initiative 1: “Develop an Optimised European Power Grid”:

The Innovation activities have been largely inspired by the ETIP SNET Final 10-year roadmap covering 2017-26<sup>1</sup> and the ETIP SNET implementation plan 2017-2020<sup>2</sup>. Ample reference is explicitly made to the R&I clusters and functional objectives of the ETIP reference documents.

- 10 fiches on Flagship Initiative 2: “Develop Integrated Local and Regional Energy Systems:



Innovation activities were therefore prepared based on the experience of several of the members, in coordination with representatives from ETIPS (and in particular from ETIP SNET and ETIP RHC) and further external stakeholders

Table 1 reports **the list of fiches developed and indicates the level of relevance of each Innovation fiche** for the different member countries. As can be seen by the table, not all countries indicated the level of relevance of the activities. The ETIP SNET showed interest in all activities related to the Flagship Initiative 1 and the crosscutting activities on ICT and cybersecurity; ETIP PV showed interest about the crosscutting activity on socio-economic impacts and the living labs concepts, while ETIP DHC has shown high interest in all activities related to the Flagship Initiative 2

In terms of collaboration frameworks, the following have generally been identified:

- Share results: at this level of collaborations projects share results also using the instruments already in place at European level, i.e the knowledge management platforms BRIDGE, GridInnovationonline.eu, Expera. Participation to related working groups, discussion papers, living documents etc. can also be envisaged. Resources can be provided by national and regional program managements as well as via the ERA Net Smart Energy Systems<sup>3</sup> Knowledge Community.
- National projects: at this level the participants intend to launch National call for proposals/projects whose main results can be shared with other stakeholders to increase the speed of network innovation
- Transnational-Europe: at this level the participants intend to organise joint calls, such as those organised in the frame of the ERA-net or joint programming activities such as those active in the frame of EERA
- International: at this level the participants intend to cooperate in the international context (e.g Mission Innovation) considering a global program setting, together with countries outside Europe
- H2020 complement: at this level, participants foresee the coordination between the national/transnational planning and the European planning e.g. through the H2020/FP9 program or others (e.g. NER300).

Table 2 reports, for each of the fiches developed, indicates the **type of collaboration envisaged** by the different member countries. As can be seen by the table, not all countries indicated the level of relevance of the activities.

Table 3 reports a preliminary planning of the activities and the collaborative framework. The timeframe indicated is coherent with that reported in the roadmaps and implementation plans of the different ETIPs consulted, whenever addressing R&I activities of similar scope.

## Budget

The **evaluation of the financing needs and funding sources** for the activities included in this IP is very complex. Unlike other technological frameworks, the sector of the energy system involves infrastructures for the delivery of primary public services and regulated players, in addition to research centres and technology and services providers. Based on the indications from the ETIPs involved, the programmes of the recent ERANETs, the benchmarks and planning related to Mission Innovation, the following budgetary indications can be given:

- **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)**

<sup>3</sup> ERA.Net Smart Grids has lately evolved into “ERA-Net Smart Energy Systems (SES)”, a sustainable member states joint programming platform covering the topics of ET-Plan Action 4. The platform integrates the former “ERA-Net Smart Grids Plus”, that has already implemented three joint calls over the last three years as well as the new upcoming initiative on Integrated Regional Energy Systems (RegSys), starting its first joint call in 2018. The initiative receives EC co-funding under the H2020 ERA-Net co-fund scheme (Co-fund action “ERA-Net Smart Grids Plus” and co-fund action “ERA-Net SG+ RegSys”)



EXECUTIVE SUMMARY

Table 1: Innovation fiches and level of relevance for the TWG4 participants

		AT	BE	CY	DE	EI	ES	FI	FR	IT	LV	NL	NO	SE	TR	UK
<b>Cross cutting</b>	A4-IA0-1 Systemic and socio-economic impact of digitalisation in the energy system	●	●		●		●			●			●	●	●	
	A4-IA0-2 Cybersecurity of critical energy infrastructure				●		●			●			●	●	●	●
	A4-IA0-3 Market design for trading of heterogeneous flexibility products		●				●					●	●	●	●	●
	A4-IA0-4 Regulatory innovation zones	●	●		●		●					●	●	●	●	
	A4-IA0-5 Process chain for interoperability of ICT systems	●	●				●			●		●		●	●	●
<b>Flagship 1</b>	A4-IA1.1-1 Increased observability and controllability of MV and LV networks with high penetration of distributed energy resources	●	●		●		●			●			●	●	●	
	A4-IA1.1-2 Smart and flexible grid design, planning and operation based on an enhanced transmission grid observability in uncertain framework		●		●		●			●		●	●	●	●	●
	A4-IA1.2-1 Customer participation and new markets and business models		●		●		●					●	●	●	●	●
	A4-IA1.2-2 EV/PHEV charging infrastructure and integration in smart energy system		●		●		●					●	●	●	●	
	A4-IA1.2-3 Demand response engineering				●		●					●	●	●	●	●
	A4-IA1.3-1 Interactions between flexible generation and the power system: control strategies, ancillary services in scenarios in presence of very large penetration of renewables and low mechanical inertia	●	●		●		●					●	●	●	●	●
	A4-IA1.3-2 Adaptation and improvement of technologies to novel power-to-gas and power-to-liquid concepts		●		●		●			●			●	●	●	
	A4-IA1.3-3 Developing the next generation of flexible hydro power plants	●					●							●		
	A4-IA1.3-4 Developing the next generation of flexible thermal power plants		●		●		○			●			○	○	●	
	A4-IA1.3-5 Increase the flexible generation by mean of the use of integrated storage in generation assets		●		●		●			●			○	○	●	
	A4-IA1.4-1 Multiservice storage applications to enable innovative synergies between system operators and market players	●	●		●		●			●		●	●	●	●	●
	A4-IA1.4-2 Advanced energy storage technologies for energy and power applications		●		●		●								●	●
	<b>Flagship 2</b>	A4-IA2.1-1 Reduction of return temperatures in current DH networks		●		●		●			●			●	●	●
A4-IA2.1-2 Optimised low temperature and highly flexible (micro) DH and DC networks		●	●		●		●			●			●	●	●	
A4-IA2.1-3 Increasing the short-term flexibility of DH networks and enabling its efficient utilisation			●		●		●						●	●	●	
A4-IA2.1-4 Increasing the long-term flexibility of heating and cooling systems			●		●		●			●			●	●	●	
A4-IA2.2-1 Transnational joint programming platform on smart, integrated, regional energy systems		●	●		●		●						●	●	●	
A4-IA2.2-2 Creating and linking living labs for integrated local and regional energy systems			●		●		●						●	●	●	
A4-IA2.2-3 Cross-linking of large demonstration projects		●	●		●		●							●	●	
A4-IA2.2-4 Optimised planning, managing and monitoring of integrated regional energy systems		●	●		●		●						●	●	●	
A4-IA2.2-5 Families of living labs to develop technology- service systems for direct use of PV energy on an aggregated level of multifamily buildings, districts or communities		●	●				●						●	●	●	
A4-IA2.3-1 Create an innovation environment for smart services in cooperation with ICT platform providers		●	●		●		●						●	●	●	
●	HIGHEST RELEVANCE															
○	LOVEST RELEVANCE															



Table 2: Interest of the different countries in the different action and type of collaboration envisaged

		AT	BE	CY	DE	EI	ES	FI	FR	IT	LV	NL	NO	SE	TR	UK
Cross cutting activities	A4-IA0-1 Systemic and socio-economic impact of digitalisation in the energy system	●	●		●		●			●		●	●	●	●	●
	A4-IA0-2 Cybersecurity of critical energy infrastructure				●		●			●		●		●	●	●
	A4-IA0-3 Market design for trading of heterogeneous flexibility products		●				●			●		●		●		●
	A4-IA0-4 Regulatory innovation zones	●	●	●								●				
	A4-IA0-5 Process chain for interoperability of ICT systems						●			●		●			●	●
Flagship Initiative 1	A4-IA1.1-1 Increased observability and controllability of MV and LV networks with high penetration of distributed energy resources	●	●		●		●			●			●		●	●
	A4-IA1.1-2 Smart and flexible grid design, planning and operation based on an enhanced transmission grid observability in uncertain framework				●		●			●			●	●		●
	A4-IA1.2-1 Customer participation and new markets and business models		●		●		●					●	●	●		●
	A4-IA1.2-2 EV/PHEV charging infrastructure and integration in smart energy system		●		●		●					●	●	●	●	●
	A4-IA1.2-3 Demand response engineering			●	●		●					●	●	●	●	●
	A4-IA1.3-1 Interactions between flexible generation and the power system: control strategies, ancillary services in scenarios in presence of very large penetration of renewables and low mechanical inertia	●	●	●	●		●							●	●	●
	A4-IA1.3-2 Adaptation and improvement of technologies to novel power-to-gas and power-to-liquid concepts		●		●		●			●					●	●
	A4-IA1.3-3 Developing the next generation of flexible hydro power plants	●						●						●		●
	A4-IA1.3-4 Developing the next generation of flexible thermal power plants			●	●		●			●					●	●
	A4-IA1.3-5 Increase the flexible generation by mean of the use of integrated storage in generation assets		●		●		●			●						●
	A4-IA1.4-1 Multiservice storage applications to enable innovative synergies between system operators and market players	●	●	●	●		●			●		●		●	●	●
	A4-IA1.4-2 Advanced energy storage technologies for energy and power applications		●		●		●			●					●	●
	Flagship Initiative 2	A4-IA2.1-1 Reduction of return temperatures in current DH networks		●		●		●			●			●		●
A4-IA2.1-2 Optimised low temperature and highly flexible (micro) DH and DC networks		●	●		●		●			●			●	●	●	●
A4-IA2.1-3 Increasing the short-term flexibility of DH networks and enabling its efficient utilisation			●		●		●			●			●	●	●	●
A4-IA2.1-4 Increasing the long-term flexibility of heating and cooling systems					●		●			●			●			●
A4-IA2.2-1 Transnational joint programming platform on smart, integrated, regional energy systems		●	●		●		●						●		●	●
A4-IA2.2-2 Creating and linking living labs for integrated local and regional energy systems		●	●	●			●						●	●		●
A4-IA2.2-3 Cross-linking of large demonstration projects		●	●		●		●							●	●	●
A4-IA2.2-4 Optimised planning, managing and monitoring of integrated regional energy systems		●	●	●	●		●						●			●
A4-IA2.2-5 Families of living labs to develop technology- service systems for direct use of PV energy on an aggregated level of multifamily buildings, districts or communities		●	●	●			●							●	●	●
A4-IA2.3-1 Create an innovation environment for smart services in cooperation with ICT platform providers		●	●		●		●						●	●		

● Share Results    ● National Project    ● EU-Project (ERA-NET)    ● H2020 Compliment



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Table 3: Preliminary time planning envisaged by the TWG4 participants for the different innovation activities

		2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
<b>Cross cutting activities</b>	A4-IA0-1 Systemic and socio-economic impact of digitalisation in the energy system													
	A4-IA0-2 Cybersecurity of critical energy infrastructure													
	A4-IA0-3 Market design for trading of heterogeneous flexibility products													
	A4-IA0-4 Regulatory innovation zones													
	A4-IA0-5 Process chain for interoperability of ICT systems													
<b>Flagship 1</b>	A4-IA1.1.-1 Increased observability and controllability of MV and LV networks with high penetration of distributed energy resources													
	A4-IA1.1-2 Smart and flexible grid design, planning and operation based on an enhanced transmission grid observability in uncertain framework													
	A4-IA1.2-1 Customer participation and new markets and business models													
	A4-IA1.2-2 EV/PHEV charging infrastructure and integration in smart energy system													
	A4-IA1.2-3 Demand response engineering													
	A4-IA1.3-1 Interactions between flexible generation and the power system: control strategies, ancillary services in scenarios in presence of very large penetration of renewables and low mechanical inertia													
	A4-IA1.3-2 Adaptation and improvement of technologies to novel power-to-gas and power-to-liquid concepts													
	A4-IA1.3-3 Developing the next generation of flexible hydro power plants													
	A4-IA1.3-4 Developing the next generation of flexible thermal power plants													
	A4-IA1.3-5 Increase the flexible generation by mean of the use of integrated storage in generation assets													
	A4-IA1.4-1 Multiservice storage applications to enable innovative synergies between system operators and market players													
	A4-IA1.4-2 Advanced energy storage technologies for energy and power applications													
	<b>Flagship 2</b>	A4-IA2.1-1 Reduction of return temperatures in current DH networks												
A4-IA2.1-2 Optimised low temperature and highly flexible (micro) DH and DC networks														
A4-IA2.1-3 Increasing the short-term flexibility of DH networks and enabling its efficient utilisation														
A4-IA2.1-4 Increasing the long-term flexibility of heating and cooling systems														
A4-IA2.2-1 Transnational joint programming platform on smart, integrated, regional energy systems														
A4-IA2.2-2 Creating and linking living labs for integrated local and regional energy systems														
A4-IA2.2-3 Cross-linking of large demonstration projects														
A4-IA2.2-4 Optimised planning, managing and monitoring of integrated regional energy systems														
A4-IA2.2-5 Families of living labs to develop technology- service systems for direct use of PV energy on an aggregated level of multifamily buildings, districts or communities														
A4-IA2.3-1 Create an innovation environment for smart services in cooperation with ICT platform providers														



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## Interactions

The TWG A4 interacted with different stakeholder groups on European and national level to provide scientific and technical soundness, ensure consensus and endorsement and inspiration from the wide experience and already ongoing R&I monitoring, road mapping and prioritisation. In particular the ETIP SNET and its working groups, as constant partners in the development of the TWG A4, work for all aspects pertaining to the power system and its interactions. During the development of specific chapters of the implementation plan, frequent contacts were also ensured with ETIP RHC, ETIP PV, ETIP SNET and other initiatives including national stakeholder platforms.

## Future work

The involvement and collaboration framework created among European countries in the development of the implementation plan for smart energy systems has a great value and should be leveraged in a continued effort. The Implementation plan has identified subjects of common interest and priorities around which the participating countries have shown interested and have been motivated to actively collaborate. Moreover, especially in the field of local and regional networks and systems, new developments and approaches that consider not only the technologies and their application but also the tools and processes for the conduction of the innovation activities have been brought to light and consolidated at European level for the first time: concepts such as Innovation Regulatory Zones, Living Labs, Multilayer Activities (combining technology, market and adoption approaches) have been experimented in some countries but are in the present IP raised at the European level and have generated interest. Last but not least, the bridge between the TWG and the interested ETIPs (with particular reference to ETIP SNET and ETIP RDH) has created a strong link between public financing agencies, member states representatives and the industrial stakeholders. This is a very important opportunity that must be leveraged. In this context the established National Stakeholders Coordination Group in the framework of ETIP SNET provides a useful platform to systematically reach out to and involve stakeholders from the national and regional level.

The Innovation fiches included in this IP have gathered consensus and interest but need in the future to be better focussed, budgeted, implemented and monitored. Several fiches need more applicative details (deliverables, planning etc.) to be fit for their direct use in joint calls or in collaboration activities among member countries. Several fiches, especially those dedicated to Flagship Initiative 1 need a close coordination with the Implementation plan of the ETIP SNET to leverage its full potential, bringing together the value expected by the public authorities to that from network operators and technology and services providers. This is in view of a higher layer of collaboration and coordination between national funding, private funding and European funding. A more precise planning of the collaborative framework needs also to be set up, through the design of the knowledge sharing frameworks (or the use of the available frameworks such as the Expera platform or the GridInnovationonline.eu), workshops shall be planned, joint calls on the interesting subjects shall be organised, possibly leveraging the positive experience achieved through the ongoing ERA-Net Smart Grids Plus initiative. In the field of Flagship Initiative 2, the ETIP RHC needs to be systematically involved and planning should go along in collaboration.

Another aspect linked to the future work is linked to the existence of the TWG4 itself. In the specific framework of the ETIP SNET the National Stakeholder Coordination Group has been set to be a sounding board for the stakeholders, with special reference to the national and regional industry stakeholders, key research institutes, programs and policy makers as well as experts from regulators. It needs to be discussed if this is the best framework in which to continue the very positive and intensive work carried out until now.



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# 1. Introduction and Context

The European energy system will be structured to allow integrating efficient energy supplies from various sustainable and variable sources and securing optimal utilisation of the pan-European as well as local and regional infrastructures and resources. Systems at all levels will be tightly connected among them and to the associated digital system, contributing to its stability, resilience and flexibility. A new systemic approach needs to be developed gathering electricity, gas, heating and cooling grids, end-use technologies in buildings and other infrastructures (e.g. water supply and sewage systems, transport system etc.), thus combining and integrating different kinds of generation, end-users and management of energy conversion. By using energy management, monitoring systems and smart technologies, synergies between different energy vectors and infrastructures will be leveraged in order to achieve optimal solutions for the European energy systems at all levels (overall, regional and local).

The transport sector is also challenged to integrate more renewables: electric vehicles are an opportunity for using renewable electricity and the related infrastructure can be part of the local or regional system. Production of renewable fuels (e.g. bio-fuels, power to gas/fuels) is another opportunity for integration between different energy systems.

The present document constitutes the SET Plan implementation plan related to the "Increase the resilience and security of the energy system". It gathers the consensus of 15 country representatives about the R&I actions to be implemented in coordination, in order to achieve the challenging targets, set in the declaration endorsed in November 2016. The following chapters will describe in detail the context and path followed to reach this objective.

## 1.1 The Energy Union

The Energy Union is a European political priority project aimed at accelerating the modernisation of Europe's entire economy, making it low carbon and efficient in energy and resources, while leveraging social wealth and fairness.

In its communication on an "**Energy Union**"<sup>4</sup>, the EC stresses the need for a fundamental transformation of our energy systems towards a sustainable, low carbon and climate-friendly economy that is designed to last. Strong, innovative and competitive European companies shall provide the technology and services needed to deliver energy efficiency and low carbon technologies inside and outside Europe and a European labour force shall have the skills to build and manage the energy systems of tomorrow. The European Union shall become a leader in renewable energy, reducing its dependency on fossil fuels and has committed to cut CO<sub>2</sub> emissions by at least 40% by 2030. The EU is well placed to use its research, development and innovation policies to turn this transition into a concrete industrial opportunity. By mobilising up to 177 billion euros of public and private investment per year from 2021, it will generate up to 1% increase in GDP over the next decade and create 900,000 new jobs.

**Consumers** are seen as being **at the centre** of this Energy Union. Energy is a critical commodity, absolutely essential for full participation in modern society. The clean energy transition needs to be delivered fairly for all sectors, regions or vulnerable parts of society. It is intended that citizens shall take ownership of the energy

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<sup>4</sup> COM(2015) 80 final, ENERGY UNION PACKAGE, A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy, Brussels, 25.2.2015



transition, benefit from the technologies and actively participate in the markets. Consumers shall participate in and support the transition.

The Energy Union is founded on the following **five** closely interlinked **pillars**:

- Energy security, solidarity and trust;
- Fully integrated European energy market;
- Energy efficiency contributing to moderation of demand;
- Decarbonising the economy;
- Research, innovation and competitiveness.

As can be perceived, the Energy Union overtakes the dimensions of energy and climate alone: its ultimate goal is to make sure that Europe's consumers, workers and businesses evolve towards more sustainable paths leveraging, at all levels, the early mover advantage for new technologies and business models.

## 1.2 The research, innovation and competitiveness dimension of the Energy Union

In 2016 the EC presented a comprehensive research, innovation and competitiveness strategy, which supports the objectives of the Energy Union. This is outlined in the communication, "Accelerating Clean Energy Innovation" <sup>5</sup>, adopted as part of the Energy Union package Clean Energy for all Europeans<sup>6</sup>, where research and innovation has been recognised as a driver for the three overarching goals: "Energy efficiency first", "Europe as a global leader in renewables" and "A fair deal for consumers".

In its second State of the Energy Union<sup>7</sup>, the Commission addressed the advancement of the project and acknowledged that European industry, research institutes and academic innovative actors are overall well positioned in the global energy landscape. With 30% of global patents in renewables, the European Union is a leader in low carbon key technology innovation, still needing momentum to quickly and successfully bring these innovations to the market and turn them into growth and job opportunities by addressing internal and export markets. The total research and innovation investment (public and private) in the EU28 has increased in 2014 by 22% since 2010 in the Energy Union research and innovation priorities. The private sector is responsible for this increase with the sustainable transport sector representing the highest share of all private investment with 43%, while public national investment has slightly decreased (both in absolute terms and as a share of the Gross Domestic Product (GDP)), except in the sector of smart energy systems.

The research and innovation actions of this strategy are supported by the Strategic Energy Technology (SET) Plan and Strategic Transport Research and Innovation Agenda (STRIA).

## 1.3 The Set Plan in support of the Energy Union

The SET Plan coordinates low-carbon research and innovation activities in EU Member States and other participating countries (Iceland, Norway, Switzerland and Turkey) and helps structuring European and national research programmes triggering investments on common priorities in low-carbon technologies. The SET-Plan has adapted its structure and processes to effectively accelerate the transformation of the EU's energy system in line with this new focus, putting forward:

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<sup>5</sup> COM (2016) 763 final; Accelerating Clean Energy Innovation

<sup>6</sup> COM (2016) 860 final; Clean Energy For All Europeans

<sup>7</sup> COM (2017) 53 final; Second Report on the State of the Energy Union



- A more targeted focus: ten actions structured around the research and innovation priorities of the Energy Union have been developed;
- An integrated approach, moving away from a technology-specific focus to look at the energy system as a whole;
- A new management structure to increase transparency, accountability and monitoring of progress, as well as a result-oriented approach;
- A strengthened partnership between the Commission, the SET-Plan countries (28 EU Member States, Iceland, Norway, Switzerland and Turkey) and stakeholders, including research organisations and industry.

The Set Plan is governed through the EU Steering Group on Strategic Energy Technologies (SET- Plan Steering Group), which consists of high-level representatives from EU countries, as well as Iceland, Norway, Switzerland, and Turkey. The group ensures better alignment between the different research and innovation programmes at EU and national level, as well as the SET Plan priorities and aims at increasing the cooperation between national programmes to avoid duplication and heightens the impact of public investment.

The main instruments of the SET Plan are the European Technology and Innovation Platforms (ETIPs), the European Energy Research Alliance (EERA) and the Set Plan Information System (SETIS).

The ETIPs were created to support the implementation of the SET Plan by bringing together EU countries, industry, and researchers in key areas. They promote the market uptake of key energy technologies by pooling funding, skills, and research facilities. At present the following ETIPs are active:

- ETIP Wind
- ETIP PV
- Ocean Energy Europe
- European Geothermal Energy Council
- Smart Networks for Energy Transition (SNET)
- Renewable Heating and Cooling
- European Biofuels Technology Platform
- CCS Platform
- Sustainable Nuclear Energy Technology Platform

Additionally, the European Innovation Partnership on Smart Cities and Communities marketplace EIP-SCC is a stakeholder in the process.

The EERA aims to accelerate new energy technology development by cooperation on pan-European programmes. It brings together more than 175 research organisations from 27 countries, involved in 17 joint programmes. It plays an important role in promoting coordination among energy researchers along the SET Plan objectives and in the technology transfer to the industry.

The SETIS provides information on the state of low-carbon technologies. It also assesses the impact of energy technology policies, reviews the costs and benefits of various technological options, and estimates implementation costs.



## 1.4 The ten key actions of the SET Plan

The SET Plan has identified 10 actions for research and innovation, based on an assessment of the energy system's needs and on their importance for the energy system transformation and their potential to create growth and jobs in the EU.

The ten actions of the SET Plan are the following:

- **Number one in RES**
  1. Develop performant renewable technologies integrated in the energy system
  2. Reduce the cost of key renewable technologies
- **Consumer at the centre of the future energy system**
  3. Create new technologies and services for consumers
  4. Increase the resilience and security of the energy system
- **Efficient energy systems**
  5. Develop energy efficient materials and technologies for buildings
  6. Improve energy efficiency for industry
- **Sustainable transport**
  7. Become competitive in the global battery sector (e-mobility)
  8. Strengthen market take-up of renewable fuels
- **Other aspects**
  9. Drive ambition in carbon capture and storage/use deployment
  10. Increase safety in the use of nuclear energy

In view of the implementation of the actions, a consultative process was launched in 2016 identifying key priorities and setting targets for each of the ten key actions, which led to the endorsement of highly ambitious goals by the SET-Plan community. The process for setting the targets has been highly participative engaging the SET Plan countries and a large number of stakeholders from research and industry. This joint ownership of decisions on prioritisation has enhanced the SET Plan's legitimacy regarding strategic discussion on clean energy innovation at European level. Countries started to recognise the targets as a strategic input to their energy programmes and policies. It is expected that this greater ownership will translate in a higher level of alignment between EU and national efforts, resulting in a higher impact regarding public investments as well as leverage of private investments.

## 1.5 Stakeholder declaration for action 4: “Increase the resilience and security of the energy system”

Representatives of the European Commission services, of the EU Member States as well as of Iceland, Norway, Turkey and Switzerland, and representatives from the SET-Plan stakeholders most directly involved in energy systems activities, on the implementation of the actions contained in the SET-Plan communication, and specifically the strategic targets for the priority "Action 4 – Increase the resilience, security, smartness of the energy system" reached, on October 19th, 2016 a consensus setting targets for the deployment of smart solutions towards a resilient and secure European energy system and endorsed the “Declaration on Strategic Targets in the context of an Initiative on Energy Systems”.



## 1.6 The SET Plan implementation plan for action 4: “Increase the resilience and security of the energy system”

The SET-Plan Steering Group appointed the Temporary Working Group on Action 4 (TWG A4) on resilience, security, smartness of the energy system with the following missions:

- to revise the formulation of innovation targets on power systems (shifting from input-based targets towards output-based ones)
- to formulate targets in the area of integrated, regional energy systems
- to elaborate plans for concrete joint activities among participating countries to contribute achieving the targets set.

To this aim the present Set Plan implementation plan was prepared.

The stakeholder declaration is the starting point and the framework for the work of the TWG A4. In this implementation plan the original wording from the declaration is used as much as possible, in order to make the implementation plan a complete document that can stand for itself. The complete text from the stakeholder declaration, which remains still valid in describing the topics in more detail, can be found in the annex of this document. This implementation plan however supersedes the stakeholder declaration in regards of the formulated innovation targets, which are presented here in their final and complete version.

The TWG A4 is composed of representatives from 15 countries (AT, BE, CY, DE, ES, FI, FR, IE, IT, LV, NL, NO, SE, TR, UK), is led by

- **Michael Hübner**, Senior Expert, Austrian Ministry of Transport, Innovation and Technology (Michael.Huebner@bmvit.gv.at) and by
- **Michele de Nigris**, Director Dept. Sustainable Development and Energy Sources, Ricerca sul Sistema Energetico - RSE S.p.A Italy (Michele.deNigris@rse-web.it)

and is guided by the responsible EC officer

- **Remy Denos**, Policy Officer, Unit C2 – New energy technologies, innovation and clean coal DG Energy (Remy.Denos@ec.europa.eu).

The members of the TWG A4 are listed in Annex 1

SET Plan countries are committed to use their energy R&I national programmes and policies to implement some of the R&I activities that will be selected; and are preferably interested in developing and pursuing joint research with other countries. Country representatives in the TWG A4 are government representatives, or nominated persons by their governments.

The TWG A4 interacted with different stakeholder groups to provide scientific and technical soundness, ensure consensus and endorsement and inspiration from the wide experience and already ongoing R&I monitoring, road mapping and prioritisation. In particular the ETIP SNET and its working groups, as constant partners in the development of the TWG A4, work for all aspects pertaining to the power system and its interactions. During the development of specific chapters of the implementation plan, frequent contacts were also ensured with ETIP RHC, ETIP PV, ETIP SNET and other initiatives.



## 2. Overarching goals and Flagship Initiatives

The overarching goals driving the SET-Plan Implementation plan for Action 4 are the development and operation of energy systems showing an appropriate level of **resilience, reliability, energy and economic efficiency**, leveraging the use and integration of **all types of bulk and local resources**, with special reference to **integrating variable renewables** at all-time scales. The system **flexibility** is essential to respond to the variability and uncertainty of variable renewable generation and new variable loads (in a short time scale), to the adaptation to different possible energy scenarios (long time scale). The required flexibility can be achieved by means of innovative technologies enhancing **customer participation**, integrating better **storage**, making the best use of **connections between electricity grids** at all voltage levels **and other networks** (e.g. gas, heat and cold, transport) and optimising the use of **flexible sustainable combined power and heat generation**. A further level of flexibilisation can be obtained from **centralised and decentralised thermal power generation technologies**, including for the combined production of heat and power, sector **regulation, effective TSO/DSO interaction, market design, dynamic pricing, empowerment and integration of end-users** by increasing **connectivity and data accessibility**.

The implementation of smart and integrated energy systems is not only a technological practice, but also a **social, cultural, commercial and political practice** where cooperation and coordination are pivotal ingredients. It entails a change in the relationship between production, distribution, consumption and storage, going beyond capacity optimisation.

The temporary working group on action 4 developed innovation activities in the focus areas identified in the stakeholder declaration. The innovation activities concentrate on two flagship initiatives:

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- **Flagship Initiative 1: Develop an Optimised European Power Grid**

Enabling the appropriate level of reliability, resilience and economic efficiency, while integrating variable renewables, such as wind and solar generation by providing increased flexibility thanks to innovative technologies enhancing customer participation, integrating better storage, making the best use of connections with other networks (e.g. heat and cold, transport) and optimising the use of flexible sustainable combined power and heat generation.

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- **Flagship Initiative 2: Develop Integrated Local and Regional Energy Systems**

that make it possible to efficiently provide, host and utilise high shares of renewables, up to and beyond 100% in the local or regional supply by 2030, enabling regions and local communities to realise their high sustainable energy ambitions. They shall provide tailor-made solutions that meet the local and regional requirements and demand. At the same time they shall link to a secure and resilient European energy system, enabling the participation in inter-regional exchange of energy as well as in sharing responsibility to maintain the overall system, considering a sustainable use of local and global resources.

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## 2.1 Develop an optimised European power grid

The **European power grid** has a central role to play and is seen as the starting point to progress towards an energy system approach. Indeed, today, it integrates already a high share of renewables (26% of renewables in 2013, 10% being variable renewables) with high growth perspectives and offers a number of possibilities to connect to heat and transport networks (e.g. through energy storage or with electric vehicles). The energy transition will be based mainly on dispersed sustainable electricity generation and distributed load controls.

A **system approach** is therefore needed to guide research and innovation activities in view of designing and developing a portfolio of appropriate solutions. The optimised power system must enable a greater flexibility and effective capacity of the electricity system which, in turn, allows connecting effectively and efficiently an ever-increasing share of variable renewables (wind and solar) and coping with new consumption profiles coming, for instance, from electric vehicles. Conversely, system flexibility can be reached in several ways: Upgrading of the entire electricity value chain (generation, transmission, distribution and customers, and energy storage), reinforcing / creating new links with other energy networks, via for example power to heat/cold, power to gas / liquid and connections with the electrical components of the transport network and increasing the capabilities of RES through the improvement of their predictability and mechanism development for the future systems network services.

In order to meet the identified challenges in the power system, technologies, systems and services for more flexibility should therefore be developed in the following areas:

- Energy grids and systems (including interconnections),
- Storage, connections with other energy networks
- Demand response, integration of prosumers
- Flexible and sustainable backup and generation
- Optimised integration of renewables

Not only should the flexibility of the system be enhanced but also its economic efficiency.

### Flexibility

The power system must be more flexible by enhancing the grid hosting capacity for RES and by responding to variability and uncertainty of operational conditions from short time scale resulting from new variable loads and variable renewable generation to long time scales resulting from a wide range of possible energy scenarios. Enabling the needed flexibility calls for the following:

Grid smartening in the sense of grid observability and controllability, which brings to the system improved forecasting and operation. Benefits will be the potential for less curtailment of distributed generation resources such as photovoltaic or small wind installations, for improved management of distribution losses and voltages, and for reducing negative effects or durations of interruptions due to equipment failure. This requires substations at high, medium and low voltage levels (HV, MV and LV) equipped with remotely accessible monitoring and control devices.

Tools for managing the variability and uncertainty of operational conditions at several timescales. Since distributed generation replaces central generation, self-consumption becomes increasingly important affecting the load profile supplied from the integrated grid. With distributed generation and storage growing in the energy mix and at prosumers' sites, more and more customers can support the paradigm change where loads follow variable generation through demand response, instead of having generation following load as practiced today. Examples of the R&I that can contribute to management of variability and uncertainty include work on



transmission and distribution planning under uncertainty, on forecasting methods especially applied on local conditions, on synthetic inertia, or on market design for demand response and for the interaction between different partial markets and different grids.

Increased grid hosting capacity for renewable generation. This acknowledges that the electricity system including especially the grids is, together with Information and Communication Technology (ICT), the platform where the innovations described in this paper come together and create value for customers. The challenge lies to a large extent in the distribution systems where a combination of network reinforcements, congestion management, energy storage, demand response, market and system operational improvements are needed. Finding the right balance for each region between reinforcements and improved market, storage, demand response and operations tools will have significant economic effects. Examples of R&I activities that can contribute to increased use of the grid infrastructure are development of methodologies, software, models for planning, market and network assessment, monitoring schemes to extend the life time of the networks, use of new power technologies, integration of energy storage and the ICT platforms to support all these developments.

A further flexibilisation of centralised and decentralised thermal power generation technologies, including for the combined production of heat and power. Flexibilisation in this sense includes not only the speed to adapt to changes in demand and volatile RES generation, but also the ability to integrate the storage and use of excess energy via power-to-heat and power-to-gas, the further development of hybrid solutions combining vRES with the reliability of dispatchable energy sources, an increased fuel flexibility supporting a switch from fossil to renewable sources, a better integration of industrial combined production of heat and power into the overall system and an increased used of sustainable combined production of power and heat/cold (e.g. from biomass, solar, waste, geothermal, heat pumps). A key challenge in this is the efficient use of data from the system to run the plants and have them react efficiently and minimising the environmental and climate impact.

Increase the capability of RES to provide services to the energy system. This include improvements in the accuracy of the forecast of production, the development of technologies, tools and services like combining locally RES production with storage or/and power to gas facilities so as to reduce the variability of the production and enable RES to be a market player and to provide services to the grid.

### **Economic efficiency**

Economic efficiency is tied strongly on one hand to technological and cost reduction progress – in particular for technologies such as energy storage and flexible thermal generation which support flexibility – and on the other hand to market design and dynamic pricing. R&I is needed to accompany progress in these fields. At the same time, network operators must face a technology transition in the years to come. Keeping the system reliable, at the likely different levels requested by the different economic agents, means a power system that is observable and controllable while welcoming a growing number of such agents, using dynamic prices and customer-centric market design. The existing power system has been designed by implementing a "cyber ICT layer" on the top of a "hardware (equipment) layer". The future power system's cyber layer will cover the whole continent, and, at the same time, will reach, whenever possible, each agent in order to observe and help them optimising their behaviours. This new cyber layer may also contribute to mitigate/delay infrastructure investments, thanks to integrated intelligent infrastructure monitoring strategies enabling life extension and exploitation.



## 2.2 Develop integrated local and regional energy systems

**Regional and local energy systems and networks** are composed of locally and regionally available energy sources, built infrastructure, specific production and consumption characteristics as well as user and consumer structures from different sectors, including the transportation system. They have an important role to play in reaching the Energy Union targets. They are part of the living environment of citizens, including, in some cases, highly ambitious clean energy goals of specific communities and regions. They provide appropriate services to consumers, customers and citizens as well as to the overall European energy system to help ensure the security of supply, maximise the primary energy efficiency and deliver a high share of renewable energy.

Local and regional energy systems will have to cope with a fundamental transformation in the coming years, responding to actual drivers such as the increasing uptake of new and improved technologies for decentralised energy systems, the boosting digitalisation and associated business models as well as current societal trends. In that respect, regional and local innovation ecosystems will be very important<sup>8</sup>. Solutions could be tailor made for regions below the size of a NUTS 2 region (which is 800.000 inhabitants and more). It could be the case that a smaller political and planning entity (starting from 150.000 inhabitants. i.e. NUTS 1) will better fit the needs when developing a regional energy system. Especially in rural contexts, smaller regions often allow for better involving the right stakeholders and creating the necessary buy-in.

In its "Clean Energy for All Europeans" legislative proposals (the so called "**Winter Package**"<sup>3</sup>, covering energy efficiency, renewable energy, the design of the electricity market, security of electricity supply and governance rules for the Energy Union), the EC particularly highlights specific drivers and elements of regional and local energy systems. Not the least, the EC Winter Package recognises the potential of regional approaches, when it calls for "methodologies to assess security of supply and to identify crisis scenarios in the Member States and on a regional level, to conduct short-term adequacy assessments, to establish risk preparedness plans and to manage crisis situations."

### **The three dimensions of integration**

Implementing smart and integrated energy systems requires not only technological innovation, but also organisational innovation, new business models, new or reconfigured value chains, new actors in the research and business landscape of energy services and technologies as well as a better integration of different types of end-users into the energy system. A variety of entrepreneurial initiatives and partnerships among multiple actors are needed to speed up the implementation of smart and integrated energy in society. Integrated initiatives are needed to support social, institutional, organisational and market innovation in the energy sector including the intersections between energy supply, energy efficiency, and new user practices. Integration can be described along the following three dimensions:

Smart energy system integration. From a technical perspective, new solutions must optimise the integration of renewable energy, provide infrastructure that can host a large number of distributed generation units, increase flexibility by efficiently integrating different energy carriers as well as utilising (local) storage, supply side coordination and demand side response. They should also provide technology service systems that support highly dynamic business processes with a large number of participants enabling the implementation of complex business models serving different market participants such as individual consumers and prosumers or customer groups as well as system operators, facility managers, energy suppliers, service providers and aggregators.

Innovation ecosystem integration (Integration with local & regional development). We need to better understand local and regional processes and the implementation paths of innovative energy systems. Beyond

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<sup>8</sup> Regional Innovation Ecosystems, Learning from EU Cities and Regions, Committee of the Regions, EU, 2016



the well-established research and development division (RDD) stakeholders from industry, research institutes and universities, key players of the local and regional energy and innovation eco-system will have to be involved. Supporting new cooperative approaches as well as common standards will not only strengthen local and regional transition dynamics and entrepreneurship, but also enable steps towards EU level solutions in the integration of energy systems. This will help sustain European industrial leadership in sustainable energy solutions worldwide while paving the way to a low-carbon economy.

Cross sectoral integration. On a local or regional level, smart energy activities often involve multiple economic sectors. Particularly that means cross sectoral integration of smart energy systems and energy transition processes with transport (e.g. distribution grids for optimal charging of e-mobility vehicles and using the storage capacities of e-mobile fleets) or industry and trade (e.g. data centres requiring electricity and providing waste heat, enterprises or stores using their large thermal stores for excess electricity and balancing the electricity grid), or municipal infrastructure (e.g. heating and cooling networks, water supply and sanitation, public transport, buildings, street lightening) or agriculture (e.g. farms as facilities to generate or store energy).



## 3. Innovation Targets

### 3.1 The principles for the formulation of the final targets

With the mandate given by the SET-Plan Steering Group, the initial work of the TWG A4 was oriented to the re-formulation and completion of the innovation targets from the stakeholder declaration, along the following main lines:

- Referring to Energy Union and SET-Plan goals
- **Output based targets** – e.g. not the development or implementation of a specific technology is a goal in itself, but the effects that shall be achieved by applying technology
- **Innovation oriented targets** – research and innovation activities and measures are the primary means to reach the goal
- **Technology neutral targets** – there is still an open question how technologies and solutions will exactly look like, that will have to be answered by innovation (research and development, technology learning curves, market competition, etc.)
- **Concrete targets** – the formulation must balance the openness according to the above four high level principles with the fact, that by setting the focus of SET-Plan key action 4, as described in the stakeholder declaration, there is already agreement on some preconditions according to technology and solutions (e.g. the important role of flexibility for the electricity grid, the insight that information flows and communication are important enabler, the way how heating and cooling systems have to be developed further, etc.). In that respect targets shall be as concrete as possible to guide the development in the set direction
- The original quantification of the targets as described in the stakeholder declaration shall serve as a **benchmark in the new formulation**

The process adopted for the re-formulation of the targets involved the different stakeholders, with special reference to TWG A4 members, ETIP SNET and its working groups, national stakeholders' coordination group, ETIP RHC, ETIP PV and ETIP DG.



## 3.2 The final Innovation Targets

According to the requirements set by the Set Plan Steering Group, the initial targets were re-evaluated and classified as follows:

- Crosscutting Innovation Targets for Flagship Initiatives 1 & 2;
- Innovation Targets for Flagship Initiative 1: Develop an optimised European power grid;
- Innovation Targets for Flagship Initiative 2: Develop integrated, regional energy systems.

For what pertains to the optimised European power grid, four main priorities were selected, according to the strategic targets "Flexibility by 2030" and "Economic Efficiency" given in the stakeholder declaration, namely:

- Observability and controllability;
- Load management and demand response;
- Flexibility of the generation;
- Reduction of costs of storage.

For each area, output based targets were assessed, giving numerical values in the form of benchmark. The discussion started from the targets formulated in the stakeholder declaration, reflecting and reformulating them in the light of the principles in section 3.1 of this implementation plan. The targets are reported in the table below.

For what pertains to local and regional energy systems, innovation targets had to be formulated according to the strategic targets given in the stakeholder declaration, which are referring to the necessary innovation in the heating networks, in order being able to play their role in an integrated regional energy system, further the key issue of developing innovative solutions that make optimal use of a mix of energy sources as well as available technologies and infrastructures, and last but not least the overcoming of innovation barriers by establishing innovation environments to develop smart services for local and regional energy systems. The following priorities were selected:

- Low temperatures and flexibility for heating grids
- RES integration including different energy vectors
- Multi-dimensional local systems for energy communities
- Smart service co-creation frameworks to develop local and regional value chains

The strategic target regarding smart service development was identified as relevant for both flagship initiatives. Crosscutting targets address therefore the dimension of establishing innovation environments for the development of smart services. According to this, resulting innovation activities make special references to digitalisation (including cybersecurity), new regulatory approaches enhancing the value of field experiments and the concept of living labs.

The following tables give an overview on the formulated innovation targets, according to the strategic targets given in the stakeholder declaration.



Table 1: Formulated innovation targets, according to the strategic targets given in the stakeholder declaration – Flagship Initiatives 1 and 2

Crosscutting innovation targets for Flagship Initiatives 1 and 2	
Strategic Target	Innovation Target
<b>A4-T1.5 &amp; A4-T2.3:</b> <b>Establish innovation environments for the development of smart services</b>	<p><b>A4-T1.5.-1:</b> Provide innovation frameworks to develop attractive services, creating value for the participants in the <b>power system</b> and allowing for <b>participation in pan-European value chains</b>.</p> <p><b>A4-T2.3.-1:</b> Provide co-creation frameworks to develop attractive services, creating value for the participants in the <b>energy system</b> and allowing for <b>participation in the development of local and regional value chains</b> (from investments to customer services)</p> <p>Services have to be scalable, customisable and replicable from a very local to an interregional and global level, leveraging synergies by building on digital platforms. Solution should be able to address customers from small communities up to 100.000 and more (households, commercial, etc.).</p> <p>Services require advanced ICT systems, which have to account for security, privacy requirements and trade-offs.</p>

Table 2: Formulated innovation targets, according to the strategic targets given in the stakeholder declaration – Flagship Initiative 1

Flagship Initiative 1: Develop an optimized European power grid	
Strategic Target	Innovation Target
<b>A4-T1.1:</b> <b>Flexibility of the system by 2030</b>	<p><b>A4-T1.1.-1:</b> Develop and implement solutions to <b>increase observability and controllability in the energy system</b>.</p> <p>Solutions should enable at least the same level of observability and controllability as would be achievable by equipping 80% of the HV and MV substations and 25% of LV substations with remotely accessible monitoring and control devices.</p> <hr/> <p><b>A4-T1.1.-2:</b> <b>Develop and implement solutions and tools to manage the load profile by demand response and control, in order to optimise use of the grid and defer grid investments.</b></p> <p>Solutions should have load modulation capabilities equivalent to those that enable a peak load reduction at system level of 25% with respect to the projections in the scenario of TYNDP 2016 of ENTSOe.</p> <hr/> <p><b>A4-T1.1.-3:</b> <b>Develop and implement solutions to increase flexibility of all types of generation</b></p> <p><b>Sub-Target 1.1.-3.1:</b> <b>Develop and implement solutions to enable Renewable Energy Sources to provide grid services.</b></p>



	<p>Solutions should be equivalent to those providing balancing services, dispatch, contribution to the stability, 'smart' connection with the grid or improving accuracy of forecasting models for aggregated RES plant power production by 10 %.</p> <p><b>Sub-Target A4-T1.1.-3.2:</b> Develop and implement solutions to <b>improve the flexibility capabilities for new as well as retrofitted thermal power plants.</b></p> <p>Solutions should be equivalent to 50% of all thermal power plants fulfilling the following requirements:</p> <ul style="list-style-type: none"> <li>• Doubling of average ramping-rates (the speed at which output can be increased or decreased).</li> <li>• 2) Halving efficiency losses for part-load operations.</li> <li>• 3) Reducing minimum load by 30% compared to the average of today (avoiding plant switch-off).</li> </ul>
<b>A4-T1.2: Economic Efficiency</b>	<p><b>A4-T1.4.-1: Reduce the cost of all energy storage solutions contributing to the minimisation of the overall system costs.</b></p> <p>The range of cost reduction is depending on the specific technologies, covering the whole range including batteries, pumped hydro, the interaction of heat and electricity networks, power-to-heat and power-to-gas/fuel concepts, interaction of gas, heat and electricity networks.</p> <p><b>Sub-Target A4-1.4.-1.1:</b> Solutions for <b>short-term storage</b> should enable the reduction of the specific storage costs by at least 50% to 70%.</p>

Table 3: Formulated Innovation Targets, according to the strategic targets given in the stakeholder declaration – Flagship Initiative 2

Flagship Initiative 2: Develop integrated, local and regional energy systems	
Strategic Target	Innovation Target
<b>A4-T2.1: Develop heating and cooling systems that are able to locally integrate energy from different sources of different temperature levels</b>	<p><b>A4-T2.1.-1: Low temperatures for the efficient integration of different sources</b></p> <p>Develop and/or demonstrate technologies, systems and solutions for matching the system temperatures with local available low-carbon sources, including the set-up of new networks with low (e.g. 35-50°C) and very low (e.g. 10-30°C) supply temperatures and the reduction of the temperatures in existing networks.</p> <p>Solutions should enable buildings to operate with low supply and/or return temperatures in a cost-effective and sustainable manner (for example by improving the building side installations incl. substations and domestic hot water). Further on, the system design/operation should be adapted to the lower temperatures, including the integration of heat pumps, cooling options and storages. Suitable business models involving building owner and end customers should also be addressed.</p> <p>Aim is to develop detailed and replicable concepts and/or implementation projects for decreasing the return temperature by &gt;5°C in significant network sections or for networks low/very low supply temperatures having a return on investment (ROI) of &lt;20 years at minimum influence on the costs and comfort of the end customer.</p>



**A4-T2.1.-2: Flexibility**

Develop and/or demonstrate technologies, systems and solutions for increasing the short (hours to days) and long (weeks to months) term flexibility of district heating networks. Aim is to minimise the mismatch between the load and supply profiles of alternative heat sources (incl. power-to-heat) and in turn reduce the use of fossil fuels in peak load and winter times and avoid supply competition in summer times.

Solutions should improve the costs–benefit ratio of storage options and/ or improve the customer side integration in case of building side flexibility options.

To develop detailed and replicable concepts and/or implementation projects for cost effective large-scale penetration of flexibility measures (ROI <20 years for long and ROI <5 years for short-term) in a concrete urban DH network, shifting at least 15% of the yearly / 25% of the daily energy demand

**A4-T2.2:**  
**Develop innovative mix solutions that will reduce variability** by combining multi low carbon solutions (e.g. wind, solar, renewable heat production combined with energy storage)

**A4-T2.2.-1: RES integration at regional and local levels, including different energy vectors.**

Develop and demonstrate technologies, systems and solutions that make it possible to efficiently provide, host and utilise high shares of renewables, up to and beyond 100% in the local or regional supply, by following a holistic view on the energy system, linking different energy domains (electricity, heat/cold, gas, mobility) at different scales while considering system, market and organisational aspects, allowing for making optimal use of renewable energy sources and recovered energy.

**A4-T2.2.-2: Multi-dimensional local energy systems**

Develop methodologies, tools and technologies that enable local energy communities to operate multi-dimensional energy systems that are optimally integrating regional infrastructures and facilities (swimming pools, greenhouses, steel factory, etc.). These shall also enable local energy communities to actively contribute to the energy markets and to the resilience, stability and flexibility of the overall system.

Solutions have to consider the layers:

- Technology (physical and digital),
- market and adoption in order to increase efficiency above the established European target,
- keep quality of supply on established levels.



## 4. Elaboration on Targets

### 4.1 Observability and controllability

The final target of the RD&I activities are to upgrade and smarten the power system operation at all voltage levels in order to maintain an adequate quality of supply in a more uncertain and more interconnected system, considering variable RES and DER, demand response, storage and the interface with other energy and transport/mobility networks, new technologies and the evolution of European energy market and new business models. This target requires a stronger controllability of the power system at all geographical scales (from the pan-European level down to the national, regional and local levels) and at all time scales (from the seasonal scale linked with hydroelectricity down to the milliseconds scale linked with the power system stability).

The prerequisite of this increased controllability is also tightly linked with the capability of a timely observability of the continuously changing conditions of the systems, by means of adequate sensors (from PMUs at transmission and distribution levels down to electricity demand through smart energy meters, equipment conditions and diagnostics, communication system states, including weather forecasts for RES production and resilience etc.), communication and data exchanges protocols and platforms.

### 4.2 Load management and demand response

Demand response is potentially one of the most powerful tools for power system flexibility. Load control solutions, such as peak shaving, load profile management, and the related energy savings potential can span over the entire range of energy users: from very large-scale industry, to the tertiary sector and single end-consumers. Shaping the demand profile based on the availability of energy in the different regions and at all time scales can be a strong enabler for the integration of RES and DER and a powerful means of system efficiency. Implementing demand response for large numbers of residential and small commercial consumers requires providing end users with information on their consumption and the ability to modify their consumption in response to, for example, time-based prices signals and other types of incentives, so as to provide system services for DSOs through new market players such as aggregators and storage operators.

The main targets of the RD&I activities are to address the different aspects of the customer participation at all levels in the evolution of a demand response flexibility model based on a robust market model, and in particular:

- The quantification and assessment of the flexibility and efficiency potentially enabled by demand response;
- the definition and boundaries of a customer-centric model, the role of the different parties and the motivation of the consumers;
- the definition of main focus/market of the business models;
- the analysis of the technologies and solutions that can be applied in this field (e.g. blockchain);
- the forecast of demand (and residual loads) accounting for the new loads and the demand-response activities of new market players;
- the necessity of regulation changes to enable these business models;
- with special reference to the potential very wide diffusion of electric vehicles, the necessity to assess the impact of the charging systems on the grid operation and development and its mitigation through intelligent solutions.



### 4.3 Flexibility of the generation

With a growing share of renewable power, especially when having priority access to the grid, all types of generation connected to the grid must increase the level of operation flexibility.

Thermal power plants must shift their role from providing base-load power to providing fluctuating back-up power to meet unpredictable and short-notice demand peaks. In this context, flexibility is understood as the ability to complement the variable renewable generation quickly and at lowest emission level, ensuring the necessary reliable electricity and heat/cold supply (start-up/shut down rate, ramp-rate and reduced minimum load). This also includes fuel flexibility (capacity to switch between renewable-based fuel as well as conventional, including different rates of mixtures, reacting to availabilities of carbon-neutral synthetic fuels like synthetic methanol or methane, hydrogen, ammonia, biomass derived from waste, etc.).

CHP (combined heat and power) are among the most efficient flexible generation alternatives. However, they are challenged when the need of electricity and heat do not match, reducing their potential application. Using excess renewable energy at times of low demand through the integration of storage – be it electrical, thermal, mechanical or chemical – into thermal power plants can help optimise their operations. Decoupling heat and electricity generation will allow for a more efficient energy use via flexibilisation of demand response to the different consumers.

Renewables themselves, when equipped with integrated storage, can make the fluctuating renewable resources a dispatchable, predictable, flexible generation asset, able to provide any generation and network system requirements. The major challenge here is to combine storage with a fluctuating renewable asset (e.g. wind, solar, marine) with a positive business case, having more responsibility in dispatching energy and participating in ancillary services markets.

Power-to-Gas and Power-to-Liquid are promising solutions for the future using excess energy at the times of low demand and providing a “green” fuel that can be used in flexible thermal power plant systems. More broadly, synthetic liquid or gaseous fuels can be used in this way to support the synergies between transport and power sector by cycling the CO<sub>2</sub> and therefore making CO<sub>2</sub> neutral fuels available. The main challenges are the adaptation of the combustion to the new gases as well as the cost-efficiency of the full process chain.

The main targets of the RD&I activities are to address the different technological, environmental, economic, and regulatory aspects that will foster the use of flexible generation of all types to enable the most extensive integration of variable renewables in the energy system.

### 4.4 Reduction of costs of storage

Among the different tools available in the portfolio of network operators for real-time balancing of generation and demand, different technologies of storage will be crucial to support system stability.

Energy storage technologies for energy and power applications seem to be still far to meet technical and economic targets. For example, while current available storage technology is proving their effectiveness in fast balancing services, there is still a strong need to optimise and demonstrate storage technologies able to cover the intraweek and seasonal modulation needs. Moreover, the total cost of storage systems, including all the subsystem components, installation, and integration costs need to be cost competitive with other non-storage options available to electric utilities.



The principal challenges to be addressed by the RD&I activities are:

- Identify use cases of storage in the various services it may provide to the grid, individually and in multiple or “stacked” services, where a single storage system has the potential to capture several revenue streams to achieve economic viability.
- Cost competitive energy storage technology - Achievement of this goal requires attention to factors such as life-cycle cost and performance (round-trip efficiency, energy density, cycle life, degradation, etc.) for energy storage technology as deployed. Long-term success requires both cost reduction and the capacity to realise revenue for all grid services storage provides.
- Validated reliability and safety - Validation of the safety, reliability, and performance of energy storage is essential for user confidence.
- Equitable regulatory environment - Value propositions for long-term grid storage depend on reducing institutional and regulatory hurdles to levels comparable with those of other grid resources.

## 4.5 Heating and cooling systems: integration from different sources of different temperature levels

District heating and cooling (DHC) have proven to hold a formidable potential for enhancing the energy system flexibility and efficiency, especially at local level. Depending on the location of the area (country/city, underground condition, nearby industries or sewage water ducts, available areas for solar energy, surplus heat from industry or natural cooling, large storage capacities etc.) different sources for heating and cooling are locally available and can be utilised. The efficient exploitation of locally available resources requires the design of efficient DHC networks (>10% reduction of heat losses compared to standard grids and >80% of utilisation of the sources).

DHC networks traditionally operate with high supply temperatures in order to reduce the investment costs by reaching the required transport capacity with small pipe diameters and using cost effective customer installations. Whereas new networks can be designed for the temperature level of the local available heat source a priori, existing networks require major adaptations. The integration of renewables and waste heat sources require return temperatures at relatively low levels (>5°C).

The RD&I activities aim at addressing the technological aspects of DHC as a means to enhance the flexibility of the energy system as well as elaborating business models generating appropriate incentives for all involved stakeholders, especially building owners and final consumers. Network related actions that are needed; the use of more standardised efficient and cost-effective construction materials and components play an important role (specific numerical target to be added if possible). Measures to achieve these targets need to consider the economic viability and supply security as key aspects.

## 4.6 RES integration including different energy vectors

Systems need to be developed which bring together multiple low carbon solutions (e.g. wind, solar, renewable heat production combined with energy storage, the transport system, etc.), combining different energy vectors, technologies and infrastructures.

In a new systemic approach, all the elements such as electricity, gas, heating and cooling grids, end-use technologies in buildings and other infrastructure (e.g. water supply and sewage systems, transport system etc.), different kinds of end-users and management of energy conversion will be combined and integrated in an innovative way. Through this, these systems will allow integration of energy supply from various sustainable and variable sources and will secure optimal utilisation of the limited local and regional infrastructure and resources. By using energy management, monitoring systems and smart technologies, synergies between different energy vectors and pieces of infrastructure



will be used to achieve optimal solutions for the regional or local energy systems. At the same time, the regional and local systems will connect to the overall energy and associated digital system, contributing to its stability, resilience, flexibility and efficiency.

## 4.7 Multi-dimensional local systems for energy communities

In the "Clean Energy for All Europeans" legislative proposals (covering energy efficiency, renewable energy, the design of the electricity market, security of electricity supply and governance rules for the Energy Union), the EC particularly highlights specific drivers and elements of regional and local energy systems. It highlights the fact that solar and wind technology prices have declined respectively by 80% and 30-40% between 2009 and 2015. Such cost-reduction are enabling consumers to produce and store their own renewable energy.

According to the legislative proposal consumers shall benefit from increased allowances to produce their own electricity. They shall be allowed to organise themselves into renewable energy communities to generate, consume, store and sell renewable energy and feed any excess production back to the grid. This includes incentives for self-consumption of locally and regionally produced energy as well as for flexibility to help stabilise the overall electricity system. In the proposal for the internal electricity market<sup>9</sup> a specific role is given to "Energy Communities"<sup>4</sup>. 'Local energy communities' (LEC) there means "associations, cooperatives, a partnership, a non-profit organisation or other legal entity which is effectively controlled by local shareholders or members...."

According to the proposal, "community energy offers an inclusive option for all consumers to have a direct stake in producing, consuming and or sharing energy between each other within a geographically confined community network ...". In the light of the overarching goal to develop integrated, regional and local energy systems, this approach is taken to the wider scope of multi-dimensional energy systems, in which the power system could play a mayor enabling role.

## 4.8 Smart service co-creation frameworks to develop local and regional value chains

In addition to innovative technologies, developing and implementing smart and integrated energy systems requires organisational and regulatory innovation, new business models, new or reconfigured value chains, new actors in the research and business landscape of energy services and technologies as well as a better integration of different types of end-users into the energy system. (As an example: local energy communities should be encouraged taking into account the overall system optimisation. This means that appropriate markets should be developed to facilitate and remunerate LECs contribution to the overall system security and optimisation.)

A variety of entrepreneurial initiatives and partnerships among multiple actors is needed to speed up the implementation of smart and integrated energy in society. Integrated initiatives are needed to support social, institutional, organisational and market innovation in the energy sector, including the intersections between energy supply, energy efficiency, and new user practices. New cooperative approaches will not only strengthen local and regional transition dynamics and entrepreneurship, but will also develop EU level solutions to the integration of energy systems. This will help sustain European industrial leadership in sustainable energy solutions worldwide while paving the way for a low-carbon economy.

Due to digitisation, enabling an exponential growth in number of active users and participants in the current energy system, the development of related automatized business processes and services is a key requirement in the design of future energy system. While energy management solutions for single family houses or single energy customers are already entering the market, solutions for multifamily buildings, communities and regions still need to be developed.

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<sup>9</sup> COM(2016) 864 final, Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on common rules for the internal market in electricity



Their complexity together with the required "service depth" make it difficult for potential providers to see a market and for potential users and buyers to find appropriate development partners. In order to take a leading role within international developments, European innovation ecosystems should be created around the regional and local energy systems that will enable the potential buyers, developers and providers to work together in co-creation processes, to develop attractive services serving the requirements of the different participants and of the overall system. This includes (e.g.):

- Data accessibility for pilot initiatives in cooperation with ICT infrastructure providers,
- Initiation of developer platforms for digital business processes,
- Development of cooperation formats that facilitate the participation of start-ups and SMEs.



## 5. Overview of the Proposed Innovation Activities

All TWG A4 members were asked to propose activities contributing to the revised targets from the declaration of intent.

A total number of 27 Innovation Fiches were proposed by the TWG A4 participants:

- 5 fiches on the crosscutting activities
- 12 fiches on Flagship Initiative 1: “Develop an Optimised European Power Grid”:

The Innovation activities have been largely inspired by the ETIP SNET Final 10-year roadmap covering 2017-26 and the ETIP SNET implementation plan 2017-2020. Ample reference is explicitly made to the R&I clusters and functional objectives of the ETIP reference documents.

- 10 fiches on Flagship Initiative 2: “Develop Integrated Local and Regional Energy Systems:

Innovation activities were therefore prepared based on the experience of several of the members, in coordination with representatives from ETIPS (and in particular from ETIP SNET and ETIP RHC) and further external stakeholders

The following table reports the list of fiches developed:

Table 4: Overview on proposed cross cutting activities

Innovation Target	Innovation Activity
<b>Crosscutting Activities</b>	A4-IA0-1 Systemic and socio-economic impact of digitalisation in the energy system
	A4-IA0-2 Cybersecurity of critical energy infrastructure
	A4-IA0-3 Market design for trading of heterogeneous flexibility products
	A4-IA0-4 Regulatory innovation zones
	A4-IA0-5 Process chain for interoperability of ICT systems



Table 5: Overview on proposed Flagship Initiatives 1

Innovation Target	Innovation Activity
<b>A4-T1.1.-1:</b> Develop and implement solutions to <b>increase observability and controllability</b> in the energy system	A4-IA1.1.-1 Increased observability and controllability of MV and LV networks with high penetration of distributed energy resources
	A4-IA1.1.-2 Smart and flexible grid design, planning and operation based on an enhanced transmission grid observability in uncertain framework
<b>A4-T1.1.-2:</b> Develop and implement solutions and tools to <b>manage the load profile by demand response and control</b> , in order to optimise use of the grid and defer grid investments.	A4-IA1.2.-1 Customer participation and new markets and business models
	A4-IA1.2.-2 EV/PHEV charging infrastructure and integration in smart energy system
	A4-IA1.2.-3 Demand response engineering
<b>A4-T1.1.-3:</b> Develop and implement solutions to increase <b>flexibility of all types of generation</b>	A4-IA1.3.-1 Interactions between flexible generation and the power system: control strategies, ancillary services in scenarios in presence of very large penetration of renewables and low mechanical inertia
	A4-IA1.3.-2 Adaptation and improvement of technologies to novel power-to-gas and power-to-liquid concepts
<b>A4-T1.1.-3.1:</b> Develop and implement solutions to enable <b>Renewable Energy Sources to provide grid services.</b>	A4-IA1.3.-3 Developing the next generation of flexible hydro power plants
	A4-IA1.3.-4 Developing the next generation of flexible thermal power plants
<b>A4-T1.1.-3.2:</b> Develop and implement solutions to <b>improve the flexibility capabilities for new as well as retrofitted thermal power plants</b>	A4-IA1.3.-5 Increase the flexible generation by mean of the use of integrated storage in generation assets
	A4-IA1.4.-1 Multiservice storage applications to enable innovative synergies between system operators and market players
<b>A4-T1.4.-1:</b> Reduce the cost of <b>all energy storage solutions</b> contributing to the minimisation of the overall system costs	A4-IA1.4.-2 Advanced energy storage technologies for energy and power applications



Table 6: Overview on proposed Flagship Initiatives 2

Innovation Target	Innovation Activity
<b>A4-T2.1.-1: Low temperatures</b> for the efficient integration of different sources	A4-IA2.1-1 Reduction of return temperatures in current DH networks
	A4-IA2.1-2 Optimised low temperature and highly flexible (micro) DH and DC networks
<b>A4-T2.1.-2: Flexibility</b>	A4-IA2.1-3 Increasing the short-term flexibility of DH networks and enabling its efficient utilisation
	A4-IA2.1-4 Increasing the long-term flexibility of heating and cooling systems
<b>A4-T2.2-1: RES integration at regional and local levels,</b> including different energy vectors	A4-IA2.2-1 Transnational joint programming platform on smart, integrated, regional energy systems
	A4-IA2.2-2 Creating and linking living labs for integrated local and regional energy systems
	A4-IA2.2-3 Cross-linking of large demonstration projects
	A4-IA2.2-4 Optimised planning, managing and monitoring of integrated regional energy systems
<b>A4-T2.2-2: Multi-dimensional local energy systems</b>	A4-IA2.2-5 Families of living labs to develop technology- service systems for direct use of PV energy on an aggregated level of multifamily buildings, districts or communities
A4-T2.3.-1: Provide co-creation frameworks to develop attractive services, creating value for the participants in the <b>energy system</b> and allowing <b>for participation in the development of local and regional value chains</b> (from investments to customer services))	A4-IA2.3-1 Create an innovation environment for smart services in cooperation with ICT platform providers



## 6. Relevance and Collaboration Framework

### 6.1 Budget

The **evaluation of the financing needs and funding sources** for the activities included in this IP is very complex. Unlike other technological frameworks, the sector of the energy system involves infrastructures for the delivery of primary public services and regulated players, in addition to research centres and technology and services providers. In terms of public funding, support provided by Member States need to comply with the EU's State aid rules<sup>4</sup>. Commitment from public financing agencies is moreover complicated by the fact that national calls in the field of energy cover a wide spectrum of activities, among which the energy networks are only a chapter. Actual financing is then delivered depending on the winning project proposals, which may (or may not) cover some of the here stated priorities for the development of energy systems. Based on the indications from the ETIPs involved, the programmes of the recent ERANETs, the benchmarks and planning related to Mission Innovation, the following budgetary indications can be given:

- **100 M€/year for RD&I activities on crosscutting activities**
- **350 M€/year for RD&I activities on Flagship Initiative 1 (electricity and energy networks)**
- **250 M€/year for RD&I activities on Flagship Initiative 2 (local and regional networks)**

### 6.2 Relevance and Collaboration

The following table shows the relevance and possible collaboration activities of the contributing countries.

- The level of relevance ranges from 1 to 5, where 1 indicates a low level of relevance, while 5 stands for a high level of relevance
- In terms of collaboration frameworks, the following have generally been identified:
  - Share results: at this level of collaborations projects share results also using the instruments already in place at European level, i.e. the knowledge management platforms BRIDGE, GridInnovationonline.eu, expera. Participation to related working groups, discussion papers, living documents etc. can also be envisaged
  - National projects: at this level the participants intend to launch National call for proposals/projects whose main results can be shared with other stakeholders to increase the speed of network innovation
  - Transnational-Europe: at this level the participants intend to organise joint calls, such as those organised in the frame of the ERA-net or joint programming activities such as those active in the frame of EERA
  - International: at this level the participants intend to participate in the international context (e.g. Mission Innovation) considering a global program setting, together with countries outside Europe
  - H2020 complement: at this level, participants foresee the coordination between the national/transnational planning and the European planning e.g. through the H2020/FP9 program or others (e.g. NER300).



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Table 7: Relevance and Collaboration framework on cross cutting activities

Cross cutting activities										
	Relevance					Collaboration framework				
	1	2	3	4	5	Share results	National project	Transnational - Europe (ERA-NET)	International (e.g. Mission Innovation)	H2020 complement
<p><b>1 low relevance</b></p> <p><b>5 strong relevance</b></p>										
A4-IA0-1 Systemic and socio-economic impact of digitalisation in the energy system				NO, SE	DE, ES, ETIP-PV, IT, TR, AT, BE(FL)	DE, NO, IT, TR, AT, ES	DE, IT, TR, BE(FL), ES, SE	DE, AT, TR, BE(FL), ES, SE	IT, SE	IT, AT, TR, ES, SE
A4-IA0-2 Cybersecurity of critical energy infrastructure				DE	UK, ES, NO, TR, ETIP, SE, SNET, IT	UK, IT, TR, ES	DE, IT, TR, ES, SE	DE, TR, ES, SE	IT, SE	NO, IT, TR,
A4-IA0-3 Market design for trading of heterogeneous flexibility products		TR		UK, NO, SE, BE(FL),	BE(W), ES	UK, BE(FL) BE(W)	BE(FL) BE(W), ES	BE(FL)		NO, ES
A4-IA0-4 Regulatory innovation zones		TR, ES	AT, NL, DE	BE(FL), SE	NO	SE, NL, DE, BE(FL)	SE	AT	AT, SE	BE(FL)
A4-IA0-5 Process chain for interoperability of ICT systems			BE(FL)	UK, IT, ES, TR, BE(W) SE	AT	UK, IT, ES	IT, ES	ES	NO, IT,se	IT, TR,



Table 8: Relevance and Collaboration framework on Flagship Initiatives 1

"Innovation Actions 4.1 - An Optimized European Power Grid"										
	Relevance					Collaboration framework				
	1	2	3	4	5	Share results	National project	Transnational - Europe (ERA-NET)	International (e.g. Mission Innovation)	H2020 complement
<i>1 low relevance</i> <i>5 strong relevance</i>										
<b>A4-T1.1.-1: Develop and implement solutions to increase observability and controllability in the energy system</b>										
A4-IA1.1-1 Increased observability and controllability of MV and LV networks with high penetration of distributed energy resources			ETIP-SNET NO, AT, SE	BE(FL)	DE, IT, TR, ES, BE(W)	DE, ES, CY, NO, IT, AT, TR, BE(FL)	DE, IT, TR, ES, BE(FL), BE(W)	DE, CY, TR, BE(FL), ES	TR	CY, IT, TR, ES
A4-IA1.1-2 Smart and flexible grid design, planning and operation based on an enhanced transmission grid observability in uncertain framework			ETIP-SNET, NO, SE	UK TR	DE, IT, ES, BE(FL)	UK, ES, DE, NO, IT, SE	DE, IT, ES, SE	DE, ES, SE		TR, ES
<b>A4-T1.1.-2: Develop and implement solutions and tools to manage the load profile by demand response and control, in order to optimise use of the grid and defer grid investments.</b>										
A4-IA1.2-1 Customer participation and New Markets and Business Models		BE(FL)	ETIP-SNET, NO, SE	UK, DE, TR	NL, ES	UK, BE(FL), NL, ES	DE, NO, NL, SE, ES	NO, NL, SE, ES		TR, ES
A4-IA1.2-2 EV/PHEV charging infrastructure and integration in smart energy system			ETIP-SNET	DE, NO, BE(FL), UK, SE	TR, NL, ES	BE(FL), NL, UK, ES	DE, TR, BE(FL), NL, SE, ES	NO, BE(FL), NL, SE, ES		TR, ES
A4-IA1.2-3 Demand response engineering			ETIP-SNET, NO	UK, DE	TR, NL, ES	UK, DE, CY, TR, NL, ES	DE, TR, NL, ES	DE, CY, NO, NL, ES		CY, TR, ES

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	1	2	3	4	5	Share results	National project	Transnational - Europe (ERA-NET)	International (e.g. Mission Innovation)	H2020 complement
<b>A4-T1.1.-3: Develop and implement solutions to increase flexibility of all types of generation</b>										
A4-IA1.3-1 Interactions between flexible generation and the power system: control strategies, ancillary services in scenarios in presence of very large penetration of renewables and low mechanical inertia			ETIPSNET, NO, SE	DE, AT, TR	BE(FL), ES, UK	CY, AT, ES, UK, SE	DE, AT, BE(FL), ES, SE	DE, CY, NO, AT, BE(FL), ES, SE		CY, TR, ES
A4-IA1.3-2 Adaptation and improvement of technologies to novel Power-to-Gas and Power-to-Liquid concepts		NO, SE,	ETIP SNET, BE(W)	DE, IT, BE(FL), ES	TR,	IT, ES, TR, BE(FL),	DE, IT, TR, BE(FL), ES	DE, TR, BE(FL), ES		TR, ES
<b>A4-T1.1.-3.1: Develop and implement solutions to enable Renewable Energy Sources (RES)</b>										
A4-IA1.3-3 Developing the next generation of flexible hydro power plants			, SE	AT, ES		AT, ES, SE		SE		
<b>A4-T1.1.-3.2: Develop and implement solutions to improve the flexibility capabilities for new as well as retrofitted thermal power plants</b>										
A4-IA1.3-4 Developing the next generation of flexible thermal power plants	NO, ES, SE	BE(FL)	ETIP-SNET	DE, IT,	TR	IT, TR,	DE, IT, TR,	DE, TR,	TR	TR,
A4-IA1.3-5 Increase the flexible generation by mean of the use of integrated storage in generation assets	NO, SE	BE(W)	ETIP SNET, BE(FL)	DE, IT, TR	ES	IT, ES	DE, IT, BE(FL), ES	DE, BE(FL), ES		TR, ES
<b>A4-T1.4.-1: Reduce the cost of all energy storage solutions contributing to the minimisation of the overall system costs</b>										
A4-IA1.4-1 Multiservice storage applications to enable innovative synergies between system operators and market players		NO	ETIP-SNET, TR	DE, IT, BE(FL)	AT, ES, UK, SE	CY, AT, NL, ES, IT, TR, BE(FL), UK, SE	DE, BE(FL), NL, TR, IT, ES, SE	DE, CY, AT, BE(FL), NL, TR, ES, SE		CY, AT, BE(FL), TR, ES, SE
A4-IA1.4-2 Advanced energy storage technologies for energy and power applications		BE(W)	ETIP-SNET, ES	DE, BE(FL)	UK, TR	UK, TR, ES	DE, TR, ES	DE, TR, BE(FL), ES	TR	TR, BE(FL)



Table 9: Relevance and Collaboration framework on Flagship Initiative 2

"Innovation Actions 4.2 - Integrated local and regional energy systems"											
1 <i>low relevance</i>  5 <i>strong relevance</i>	Relevance					Collaboration framework					
	1	2	3	4	5	Share results	National project	Transnational - Europe (ERA-NET)	International (e.g. Mission Innovation)	H2020 complement	
<b>A4-T2.1.-1: Low temperatures for the efficient integration of different sources</b>											
A4-IA2.1-1 Reduction of return temperatures in current DH networks		NO, ES	BE(FL)	DE, IT, SE	ETIP RHC, TR	NO, IT, TR, ES	ES, DE, IT, TR	DE, TR, BE(FL)	TR	TR	
A4-IA2.1-2 Optimised low temperature and highly flexible (micro) DH networks		NO,	NO, BE(FL)	DE, IT, AT, ES, SE	ETIP RHC, TR	NO, IT, AT, TR, ES, SE	DE, IT, AT, TR, ES, SE	DE, AT, TR, ES, SE	TR, SE	TR, ES	
<b>A4-T2.1.-2: Flexibility</b>											
A4-IA2.1-3 Increasing the short-term flexibility of DH networks and enabling its efficient utilisation		NO,		DE, ES, BE(FL), SE	ETIP RHC, TR	NO, TR, ES, SE	DE, TR, ES	DE, TR, BE(FL), ES	TR	TR, ES	
A4-IA2.1-4 Increasing the long-term flexibility		NO, BE(FL)		DE, IT, TR, ES	ETIP RHC	NO, IT, ES	DE, IT, ES	DE, ES		TR, ES	

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	1	2	3	4	5	Share results	National project	Transnational - Europe (ERA-NET)	International (e.g. Mission Innovation)	H2020 complement
<b>Develop innovative mix solutions (e.g. wind, solar, renewable heat production combined with energy storage) that will reduce variability.</b>										
A4-IA2.2-1 Joint Projects on Smart, Integrated, Regional Energy Systems			NO,	TR, BE(FL)	DE, AT, ES, SE	DE, ES	DE,	DE, NO, BE(FL), ES		TR
A4-IA2.2-2 Living labs for integrated regional and local energy systems		DE	NO, SE	ES	ETIPRHC, TR, BE(FL)	ES	AT, ETIP RHC	NO, AT, ETIP RHC, BE(FL), ES, SE		AT, ETIP RHC, TR, SE
A4-IA2.2-3 Cross-Linking of Large Demonstration Projects			BE(FL)	ES, SE	DE, AT, TR	DE, ES, TR, BE(FL), AT, SE	DE, TR, SE	ES, AT, SE		TR
A4-IA2.2-4 Optimised planning, managing and monitoring of integrated regional energy systems			NO, AT, SE	TR, ES	ETIPRHC, BE(FL), DE	DE, ES	DE,	DE, NO, AT, ETIP RHC, BE(FL), ES		AT, ETIP RHC, TR
<b>A4-T2.2-2: Multi-dimensional local energy systems</b>										
A4-IA2.2-5 Families of living labs to develop technology-service systems for direct use of PV energy on an aggregated level of multifamily buildings, districts or communities		NO,	BE(FL)	ES, SE	ETIP PV, AT, NO, TR	ES, AT, SE	SE	BE(FL), ES, AT, SE		TR, SE
<b>A4-T2.3.-1: Provide co-creation frameworks to develop attractive services, creating value for the participants in the energy system and allowing for participation in the development of local and regional value chains (from investments to customer services)</b>										
A4-IA2.3-1 Create an innovation environment for Smart Services in cooperation with data platform providers			DE, TR	NO, SE	AT, ES, BE(FL)	ES, AT	ES	DE, NO, BE(FL), ES, AT, SE		



### 6.3 Timetable

Table 10: Preliminary time planning envisaged by the TWG4 participants for the different innovation activities

Cross cutting activities	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
<b>A4-IA0-1 Systemic and socio-economic impact of digitalisation in the energy system</b>													
<b>A4-IA0-2 Cybersecurity of critical energy infrastructure</b>													
<b>A4-IA0-3 Market design for trading of heterogeneous flexibility products</b>													
<b>A4-IA0-4 Regulatory innovation zones</b>													
<b>A4-IA0-5 Process chain for interoperability of ICT systems</b>													
"Innovation Actions 4.1 - An Optimized European Power Grid"	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
<b>A4-IA1.1.-1 Increased observability and controllability of MV and LV networks with high penetration of distributed energy resources</b>													
<b>A4-IA1.1-2 Smart and flexible grid design, planning and operation based on an enhanced transmission grid observability in uncertain framework</b>													
<b>A4-IA1.2-1 Customer participation and new markets and business models</b>													
<b>A4-IA1.2-2 EV/PHEV charging infrastructure and integration in smart energy system</b>													
<b>A4-IA1.2-3 Demand response engineering</b>													
<b>A4-IA1.3-1 Interactions between flexible generation and the power system: control strategies, ancillary services in scenarios in presence of very large penetration of renewables and low mechanical inertia</b>													
<b>A4-IA1.3-2 Adaptation and improvement of technologies to novel power-to-gas and power-to-liquid concepts</b>													
<b>A4-IA1.3-3 Developing the next generation of flexible hydro power plants</b>													



A4-IA1.3-4 Developing the next generation of flexible thermal power plants													
A4-IA1.3-5 Increase the flexible generation by mean of the use of integrated storage in generation assets													
A4-IA1.4-1 Multiservice storage applications to enable innovative synergies between system operators and market players													
A4-IA1.4-2 Advanced energy storage technologies for energy and power applications													
<b>"Innovation Actions 4.2 - Integrated local and regional energy systems"</b>	<b>2018</b>	<b>2019</b>	<b>2020</b>	<b>2021</b>	<b>2022</b>	<b>2023</b>	<b>2024</b>	<b>2025</b>	<b>2026</b>	<b>2027</b>	<b>2028</b>	<b>2029</b>	<b>2030</b>
A4-IA2.1-1 Reduction of return temperatures in current DH networks													
A4-IA2.1-2 Optimised low temperature and highly flexible (micro) DH and DC networks													
A4-IA2.1-3 Increasing the short-term flexibility of DH networks and enabling its efficient utilisation													
A4-IA2.1-4 Increasing the long-term flexibility of heating and cooling systems													
A4-IA2.2-1 Transnational joint programming platform on smart, integrated, regional energy systems													
A4-IA2.2-2 Creating and linking living labs for integrated local and regional energy systems													
A4-IA2.2-3 Cross-linking of large demonstration projects													
A4-IA2.2-4 Optimised planning, managing and monitoring of integrated regional energy systems													
A4-IA2.2-5 Families of living labs to develop technology- service systems for direct use of PV energy on an aggregated level of multifamily buildings, districts or communities													
A4-IA2.3-1 Create an innovation environment for smart services in cooperation with ICT platform providers													



## 7. Annex

The Annex of the implementation plan contains the following information:

- Details on Innovation Actions
  - Crosscutting Innovation Actions
  - Innovation Actions - Action 4.1
  - Innovation Actions – Action 4.2
- Stakeholder declaration
- Countries and stakeholder overview



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## 7.1 Innovation Actions

### 7.1.1 Crosscutting Innovation Actions

A4-IA0-1 Systemic and socio-economic impact of digitalisation in the energy system

Implementation Plan – Activity Fiche
<b>Innovation Target:</b> Crosscutting Activity
<b>Innovation Activity Number:</b> A4-IA0-1
<b>Title:</b> Systemic and socio-economic impact of digitalisation in the energy system
References to ETIP SNET Implementation plan 2017-2020: Topics: T4 -T9 Functional objectives addressed: T15-T21, D1, D2, D10, D11, and D12.
<p>Smart energy systems should allow the enhanced monitoring, automation and control of the existing system while ensuring that all involved stakeholders (regulated and market players) can interact. This will be made possible by a full digitalisation of all parts within the system. As of today, digitalisation is already under implementation in transmission networks and distribution networks (mainly MV) of the power grid, as well as for some market applications. However, digitalisation of other parts of the energy system, as e.g. the heating network or the LV distribution grids, are either in progress or expected in the near future.</p> <p>Owing to the new possibilities and risks due to digitalisation, the guiding principles for the further development of the energy system need to be revised. Alongside the original guiding principles of security of energy supply and delivery, energy for a reasonable price, and the reduction of carbon dioxide output, several new aspects need to be taken into account. This includes such vital topics as data protection and cyber security, resilience of a fully digitalised system, as well as the economical trade-off between traditional and digital solutions.</p> <p>This activity aims to address some of the urgent overarching scientific questions concerning the needed balance between the above-mentioned aspects, the relevant criteria to compare different scenarios, as well as the impact of new participation models and roles within the energy market.</p>
<p><b>Description of RD&amp;I or Programming Activities:</b></p> <p>The following RD&amp;I topics should be addressed in order to help pave the way to a full digitalisation of the energy system:</p> <ul style="list-style-type: none"> <li>• Identification of suitable digitalisation scenarios that will enable the energy transition while maintaining the quality of service in the energy provision;</li> <li>• Socio-economic analysis of suitable digitalisation scenarios, taking into account security and resilience aspects and avoiding over-investments, over-reserve capacity, sub-optimal solutions and "technological lock-in"</li> <li>• Analysis of future energy market designs, taking into account new market participants and roles due to digitalisation.</li> <li>• Identification of system-wide stress situations through multi-risk analysis to provide an adequacy assessment of the digitalised energy system, explicitly taking into account sector coupling.</li> <li>• Analysis and development of grid planning tools and metrics within an uncertainty framework, i.e. using probabilistic approach, no regret options and risk analysis/risk management perspective.</li> <li>• Development of power system planning methods and criteria that combine electricity market analysis, sector coupling, production capacities, demand response capacities and infrastructure, storage and environmental constraints, both at the transmission and distribution levels.</li> </ul>
<p><b>Joint Activities:</b></p> <p>JI - 1: A joint COST or Coordination &amp; Support activity within the H2020 program            Joint action to generate updated overviews of policies and analyse the many options available as new roles emerge in the energy system and markets.</p>



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JI -2: A joint light house (or research infrastructure) project for an HPCC dedicated to the energy domain. Proposal for a joint initiative towards joining resources, information and analyse scenarios for the future energy systems. Building upon existing initiatives like the DER-Labs, additional computer power is needed with knowledge of and dedicated to the energy domain. A high-performance computer centre (HPCC) should have a distributed set (linked to other centres) supporting with (real time) simulation and virtualisation the research into system integration and the socio-economic impact of different architectures.

JI - 3: Government to Government information exchange  
Exchange of information Government to Government on priorities and planning to anticipate and avoid doubling expenditures.

JI -4: Workshops on GIS interfaces  
Joint workshops on shared digital information sources based on (geographic Information systems) GIS interfaces to monitor, inform and plan the energy transition and determine the public and private services.

JI - 5: Transnational calls  
Initiation of one or more transnational calls for RD&I projects on the above given topics. The ERA-Net Smart Grids Plus might offer the fitting framework for the implementation of such a call.

Further collaboration ideas  
Bilateral actions between public authorities to create a legal framework (MoU) concerning topical information exchange.

- Impact of the RD&I Activities:**
- Significant economic benefits related to the digitalisation of the assets, customer services and overall system.
  - Enabling a full functioning of the next generation of the energy system across the value chain.
  - Significant shortening of the learning curve in the energy sector.

**TRL:** 4-7

Expected deliverables	Timeline
	2018-2020



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## A4-IA0-2 Cybersecurity of critical energy infrastructure

Implementation Plan – Activity Fiche
<b>Innovation Target:</b> Crosscutting Activity
<b>Innovation Activity Number:</b> A4-IA0-2
<b>Title:</b> Cybersecurity of critical energy infrastructure
References to ETIP SNET Implementation plan 2017-2020: TOPIC: T9 - Functional objectives addressed: T21, D11
<p><b>Targets:</b></p> <p>Computer security, including cyber security and information security, refers to the protection of IT systems from theft or damage to the hardware, software, and the information on them, as well as from disruption or misdirection of the services they provide. This includes controlling physical access to the hardware, as well as protecting against harm that may come via network access, data and code injection, and malpractice by operators, whether intentional, accidental, or due to being tricked into deviating from secure procedures.</p> <p>This field is of growing importance due to the increasing reliance on computer systems in most industrial sectors and societies. Computer systems now include a wide variety of "smart" devices, including smartphones, televisions and tiny devices, as part of the IoT, and networks include the Internet and private data networks.</p> <p>In the specific case of distribution networks, the challenges associated to cybersecurity have an additional feature: the connection to smart meters (end-users) which brings threats in terms of data protection and possible access to the DSO ICT infrastructures through these connection points.</p> <p>From the practical points of view, the targets aimed at are the following:</p> <ul style="list-style-type: none"> <li>• Implications on sharing of information across borders, across companies, defining many points of contact POC (Points of Contact). Support relevant parties in this picture with special reference to the entering into force of the NIS Directive by May 2018</li> <li>• Processing in data centres with centralised processing power environmentally outweighing sensitivity concerns.</li> <li>• Cybersecurity of critical energy infrastructures, in the broadest sense, including among others power plants and distribution, electric high and medium voltage substations, electronic equipment, data centres.</li> <li>• Provide safety data provision to different stakeholders with different permission levels, in a centralised data centre.</li> </ul>
<p><b>Description of RD&amp;I or Programming Activities:</b></p> <p>Activities should focus on developing and demonstrating methodologies/tools to ensure the cybersecurity of the critical infrastructures of the energy system.</p> <p>In particular, activities should address some or all of the following aspects:</p> <ul style="list-style-type: none"> <li>• Safety interconnection to security concerns.</li> <li>• The progress of computer power and energy use.</li> <li>• Newfound cryptography solutions.</li> <li>• Quantum Processing as a game changer.</li> <li>• Sensitivity and priority of data categories.</li> <li>• Cost / Benefits methodologies.</li> <li>• Global database for best practices sharing.</li> <li>• Societal impact.</li> </ul>
<p><b>Impact of the RD&amp;I Activities:</b></p> <ul style="list-style-type: none"> <li>• Supporting the energy transition while maintaining the system secured and robust.</li> <li>• Significant economic benefits related to cybersecurity secured system against costly attacks.</li> <li>• Enabling a full functioning robust next generation of the energy system across the value chain.</li> </ul>



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<ul style="list-style-type: none"><li>• A large-scale demonstrator for “What if Scenarios” preventing against cyber-attacks</li></ul>	
<b>TRL:</b>	
<b>Expected deliverables</b>	<b>Timeline</b>
	2018 - 2022



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### A4-IA0-3 Market design for trading of heterogeneous flexibility products

Implementation Plan – Activity Fiche
<b>Innovation Target:</b> Crosscutting Activity
<b>Innovation Activity Number:</b> A4-IA0-3
<b>Title:</b> Market design for trading of heterogeneous flexibility products
References to ETIP SNET Implementation plan 2017-2020: TOPIC: T2 - Functional objectives addressed: T17
<p><b>Targets:</b></p> <p>There is a growing need for flexibility products (such as energy storage, cross-border interconnectors, electric vehicles, DR, interfaces between energy networks and novel market products) in the energy market to balance intermittent renewables, to provide short-, medium- and long-term flexibility, to provide black-start reserve power and to address balancing market failures. Nowadays, balancing services are still mainly provided through conventional fossil-fuel based generation units. To help achieve the EU emission and climate targets, other flexibility products should be introduced in the balancing market. Given that 'flexibility' is a heterogeneous product operating in and relevant to e.g. different locations in the network, applicable to different end-users and operational in different time scales, and potentially affecting several energy markets, a new market design needs to be developed. This new design should allow the trading of the different cost-effective flexibility products while ensuring operational security, quality and stability. Of particular relevance is to assess how the commercialisation of these products affects the different energy markets (electricity, gas and, where existing, heat) when there is a conversion in the energy carriers, e.g. the impact in the electricity and gas price at wholesale and, especially, retail level on a windy day when a lot of electricity coming from wind farms is pulled into the gas network through P2G technologies</p> <p>To facilitate and increase the liquidity of the flexibility market and increase the demand for flexibility, all heterogeneous flexibility users and products could be combined under a new flex-market concept</p>
<p><b>Description of RD&amp;I or Programming Activities:</b></p> <p>Developing a flex market concept and design for the various markets (electricity, heat and gas markets) that allows the trading of 'heterogeneous' flexibility products (including the ones provided by energy sector coupling), taking into account the specific capabilities of each resource. This research topic involves the following steps:</p> <ol style="list-style-type: none"> <li>1. developing a flex market concept for the multi-resource balancing market that allows the trading of cost-effective 'heterogeneous' flexibility products and determine how to market and commoditise heterogeneous flexibility while ensuring operational security, quality and stability;</li> <li>2. translating the markets concept into a dynamic simulation model of the system to understand their coordinated behaviour, define balancing responsibilities and enable implementation,</li> <li>3. Integration of the new concept in the energy markets across the EU.</li> </ol> <p>ICT activities for developing platforms and other tools for the trading of flexibility products and interconnection of the energy markets are not within the scope of this topic.</p>
<p><b>Joint Activities:</b></p> <p>JI-1 Transnational Calls National, Transnational and European calls for RD&amp;I projects on the above given topics.</p> <p>Further collaboration: Promotion of forum for discussion taking into account all relevant stakeholders: Network operators, market operators, retailers and aggregators, generators, equipment manufacturers, ICT solution providers, regulatory bodies, R&amp;D institutes, end-user associations, organisation promoting standards.</p>
<p><b>Impact of the RD&amp;I Activities:</b></p> <ul style="list-style-type: none"> <li>• Increase market participation of a wide range of flexibility products, both short and long-term, through remuneration in multiple balancing/flex markets</li> <li>• Improve market conditions of flexibility products at both supply and demand sides to ensure balancing and</li> </ul>



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<p>ancillary service provision in the markets.</p> <ul style="list-style-type: none"> <li>• Improve the integration and cooperation between the different energy markets (electricity, gas and heat)</li> </ul>	
<b>TRL:</b> 3-5	
<b>Total budget required:</b> JI-1: 10 Million Euro	
<b>Expected deliverables</b>	<b>Timeline</b>
	2018-2022



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#### A4-IA0-4 Regulatory innovation zones

Implementation Plan – Activity Fiche
<b>Innovation Target:</b> Crosscutting Activity
<b>Innovation Activity Number:</b> A4-IA0-4
<b>Title:</b> Regulatory innovation zones
<p><b>Targets:</b></p> <ul style="list-style-type: none"> <li>Stimulate the development of areas where the "impossible is possible"</li> <li>Establishment of an international learning and networking-process between actors of the energy sector, public administration (e.g. municipalities in a smart city context) and other stakeholders</li> <li>Facilitation of an exchange between projects on “lessons learned” and new innovative ideas in a Community of practice.</li> <li>Facilitation of an exchange between the projects on current legislative and regulatory procedures as well as new recommendations concerning those aspects, including legal advice</li> <li>Community of practice joint meetings/activities</li> <li>Evaluation of effectiveness of projects, which already implement elements of regulatory innovation zones and comparative studies outside of the energy field</li> </ul> <p>The development of solutions for smart energy systems has reached a level, which now raises the question of replicability and deployment. Further supporting this with publicly financed policy instruments however goes beyond the established set of research technology and innovation policy instruments and what can be categorised by the Technology Readiness Level (TRL) narrative.</p> <p>On the one side support goes towards the intensive search for business models and investment models to apply innovative technologies. On the other side, however a deficit can be identified with respect to adequate forms of policy support regarding adequate institutional frameworks (including regulation, market structures, infrastructure investment mechanism ...).</p> <p><b>Description of RD&amp;I or Programming Activities:</b></p> <p>Regulatory innovation zones (RIZ) can be framed as an orchestrated set/mix of complementary policy actions combining R&amp;I instruments and instruments of energy policy, regional policy etc. on the one side and concrete economic activities including (public and private) investment and innovation (infrastructures, products and services) on the other side. RIZ would provide an arena for innovation based on intentional interventions in regulatory frameworks (e.g. energy law, tariffs, building regulations, zoning rules etc.) and/or other framework conditions (e.g. creating an atmosphere of active participation). The intervention need not be permanent but can be of temporary nature. The regulatory framework might be influenced in the one extreme by setting specific game rules (laws) or on the other side by explicitly eliminating legal or institutional restrictions. As this is a new kind of mixed policy intervention with complex governance issues between public and private actors, efforts have to be made and resources provided to develop an adequate instrument / instrumental mix.</p> <p>Topics (examples):</p> <ul style="list-style-type: none"> <li>Taxation on electricity and energy trade</li> <li>Energy community / local and regional markets</li> <li>Peer to peer exchange of energy, flexibility, etc. (blockchain)</li> <li>Infrastructure ownership and responsibility</li> </ul> <p><b>Joint Activities:</b></p> <p>The aim of this activity is to establish an information exchange and learning between several of projects in a community of practice through joined meetings and activities. This shall include the exchange of experiences with different approaches, governance processes as well as an exchange about national legislation and other regulatory frameworks.</p> <p>The planned meetings and activities shall be facilitated by a stronger coordination of financial and personnel resources among the different projects and/or the accompanying national actions. This is achieved through a strong</p>



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collaboration between the different involved ministries and/or the involved national funding agencies.

JI-1: Seminars on visionary future solutions with ongoing projects and initiatives

- Discuss disruptive solutions beyond daily business and incremental steps.
- Present and discuss experiences from ongoing projects and initiatives.
- Involve policy makers and regulators.

JI-2: Initiate a European initiative like "Innovation Deal" for energy transition

- Investigate the possibility to establish an Innovation Deal in order to speed up the Energy Transition and implementing the EC's better regulation agenda.
- Initiate an "Innovation Deal" on energy transition after positive evaluation.

JI-3: Evaluate ongoing projects and initiatives

- Evaluate ongoing projects and programs (see below) in cooperation with ERA-net SG+ knowledge Community and ISGAN Annex 7.

#### Impact of the RD&I Activities:

Development or modification of existing policy instruments (such as demonstration projects, accompanying research, innovation oriented public procurement or a mix of instruments) to match the needs of industry and public administration (e.g. municipalities) to develop and test innovative solutions in a real-world context under real regulatory, institutional and economic conditions. This increases the effectiveness of project results, and technological and regulatory recommendations toward national and regional governments. Initiation of European public-private partnerships and new transnational research projects.

Expected deliverables	Timeline
	2018-2022

#### Ongoing R&I Activities (Flagship activities or not): relevant to this new activity proposal

Name	Description	Timeline	Location/Part y	Budget
SINTEG	The German innovation program SINTEG provides a unique regulatory framework for experimenting in large scale projects set up cross-regional covering several countries. The „SINTEG demonstration law“ (Experimentierklausel im KWK-/EEG-Änderungsgesetz) was specifically designed for this purpose		Germany	
Smart Grid Experimental Room			Netherlands	
Smart Grids Gotland			Sweden	
ReFlex	The ReFlex project (Replication of Flexible Smart Grid Solutions) provides Community of Practice for practitioners from 8 demo sites in AT, CH, GE, SE in order to learn and exchange on framework conditions for the replication of smart solutions. Practitioners request for zones with regulatory and institutional room for experimenting in order to make the next step to market adoption.		ERANET SG+	ReFlex: 2 Million Euro
NEMoGrid	The NEMoGrid Project is mainly focused on the definition of innovative business models that could ease the penetration of renewables into the distribution grid, with a particular emphasis on the definition of a peer-to-peer strategy based on the block chain technology.		ERANET SG+	NEMoGrid: 1.3 Mil. €
Innovation Deal	This is a new instrument of the EC with the main aim to overcome regulatory bottlenecks hindering innovation The objective of an Innovation Deal is an in-depth understanding and clarification of how an EU rule or regulation applies. If a rule or regulation is confirmed as an obstacle to innovations that could bring wider societal benefits, the Deal will make it visible and feed into possible further action. Innovation Deals (IDs) allow innovators to swiftly address legislative obstacles, shortening the time between moment of inspiration and market uptake. Innovation Deals take the form of voluntary cooperation between the EU, innovators, and national, regional and local authorities. Currently this is applied in the field of Circular economy: <a href="https://ec.europa.eu/research/innovation-deals/index.cfm?pg=about">https://ec.europa.eu/research/innovation-deals/index.cfm?pg=about</a>		EU	



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#### A4-IA0-5 Process chain for interoperability of ICT systems

Implementation Plan – Activity Fiche
<b>Innovation Target:</b> Crosscutting Activity
<b>Innovation Activity Number:</b> A4-IA0-5
<b>Title:</b> Process chain for interoperability of ICT systems
<p><b>Targets:</b></p> <p>The main target is to implement a methodology in conformance with SGAM/M490 and ISO/TR 28380 to achieve interoperability of electronic data exchanges in heterogeneous energy-related ICT systems. Contributions of national stakeholders are required for the coordination of cross-border implementation activities.</p> <ul style="list-style-type: none"> <li>• Implement and establish a transnational vendor-neutral, cooperative and participatory process to achieve interoperability of ICT-systems in European smart energy systems.</li> <li>• Adapt an existing open source interoperability test platform to the needs of the energy sector.</li> <li>• As joint activity together with partners from different EU countries, organise and establish European interoperability test events ("Connectathon Energy") to test interoperability of ICT-components for conformance with existing standards as well as for interoperability among systems by different manufacturers.</li> <li>• Add value to the 'European Interoperability Framework for European public services' (EIF) by setting an example for semantic and technical interoperability in the energy sector.</li> <li>• Increase stakeholders' awareness for competitive advantages of interoperable solutions, thereby achieving a broad applicability and acceptance of test systems to ensure interoperability in future energy systems.</li> </ul>
<p><b>Description of RD&amp;I or Programming Activities:</b></p> <p>Activities should focus on activities to support a European interoperability initiative, i.e. by implementing and establishing an existing methodology to achieve interoperability of electronic data exchange in the European energy sector.</p> <p>A European interoperability initiative provides the opportunity to establish developed processes on a European level, thereby linking national and European activities and ensuring an interoperable transition of the energy system in Europe. Interoperability of ICT-systems helps support the creation of a cross-sector and cross-border digital single Market, as pursued by the European Commission.</p> <p>In particular, activities should address some or all of the following aspects:</p> <ul style="list-style-type: none"> <li>• Coordinate national stakeholders' participation in transnational technical and planning committees to ensure the implementation of the developed methodology.</li> <li>• Support the development of interoperability profiles based on real world use cases and existing standards as reusable digital interoperability building blocks. Use the results of the European projects HITCH and ANTILOPE, where a method for specifying, testing and certification of interoperability of software in healthcare IT was developed. Consider guidance from the ISO TC215 technical report ISO/TR 28380.</li> <li>• Provide information to relevant stakeholders on how to develop technical frameworks. Technical frameworks shall contain information on the addressed business use cases as well as precise technical specifications of integration profiles, transactions and actors.</li> <li>• Adapt the existing test platform to ensure the interoperability of ICT components in the energy sector. Integrate learnings from the operating test bed for interoperability of eHealth information systems 'Gazelle' as well as other existing test tools from the energy and IT domain.</li> <li>• Support the establishment and carry out the yearly organisation of an open and cooperative European test event for interoperability of ICT-systems in the energy sector.</li> <li>• Work to increase stakeholders' awareness of competitive advantages of interoperable solutions in smart grid development by applying cross-application, cross-vendor, cross-sector and cross-border dissemination strategies.</li> </ul>



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- Offer training sessions and seminars to interesting parties to ensure the functioning of the process as well as a transfer of know-how among relevant stakeholders and between the European and the national level. Make the methodology available for further use in all EU-supported smart grid projects.

**Joint Activities:**

JI-1: Setup a joint transnational structure for a European organisation 'IES Europe'

JI-2: Align national, transnational and international activities and funding schemes on interoperability

Further Collaboration ideas:

Share results on a knowledge sharing platform i.e. Expera and in the framework of national stakeholder meetings, e.g. at ETIP SNET National Stakeholder Coordination Group meetings

**Impact of the RD&I Activities:**

JI-1: Setup a joint transnational structure for a European organisation 'IES Europe'

- Setup an annually recurring "IES-process" that brings together users, manufacturers and developers of smart energy system technologies
- Build a lasting transnational organisational structure to coordinate the work of planning and technical committees throughout the IES-process.
- Organisation of demonstrations of IES-compliant systems working in real-world energy-related use cases at energy conferences and other venues.
- Organisation of regular European interoperability test events ('Connectathon Energy') specifically for developers and manufacturers of energy-related ICT-systems.

JI-2: Align national, transnational and international activities and funding schemes on interoperability

- Streamline national, transnational and international activities to ensure a long-term approach to interoperability of ICT-systems in the energy sector.
- Pool personal resources to coordinate national activities within IES Europe.

**TRL:**

**Expected deliverables**

**Timeline**

2018-2022

**Ongoing R&I Activities (Flagship activities or not): relevant to this new activity proposal**

Name	Description	Timeline	Location/Party	Budget
Austrian research project 'IES – Integrating the Energy System' ( <a href="http://www.iesaustria.at">www.iesaustria.at</a> ).	The IES project runs until February 2019 and has two objectives: first, the development of a methodology to ensure interoperability of ICT-systems in the energy sector. Second, the adaption of an existing interoperability test platform to the requirements of the energy sector. The methodology is based on a process, which was established in the health sector by the global non-profit organisation 'Integrating the Healthcare Enterprise (IHE)'. In the IHE-process vendors, manufacturers and users of interoperable ICT-products cooperatively develop technical 'interoperability profiles' to address well defined real-world use cases. These interoperability profiles assemble relevant and specific 'base standards' which together provide complete technical specifications that cover all interoperability issues (e.g. data formats, transport protocols, vocabularies, and security methods).			



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## 7.1.2 Flagship Initiative 1 - "An Optimised European power grid"

### A4-T1.1-1: Develop and implement solutions to increase observability and controllability in the energy system

A4-IA1.1-1 Increased observability and controllability of MV and LV networks with high penetration of distributed energy resources

Implementation Plan – Activity Fiche
<p><b>Innovation Target:</b> Develop and implement solutions to increase observability and controllability in the energy system</p>
<p><b>Innovation Activity Number:</b> A4-IA1.1-1</p>
<p><b>Title:</b> Increased observability and controllability of MV and LV networks with high penetration of distributed energy resources</p>
<p>References to ETIP SNET Implementation plan 2017-2020: TOPIC 16 / 17 - Functional objects addressed: D3, D4, D5, D8, D9</p>
<p><b>Targets:</b></p> <p>The operation of medium and low voltage distribution networks is modified because of the increasing integration of new generation technologies based on renewables, storage systems, EVs and smart loads. New challenges related to power quality, bidirectional power flows, energy balancing at local level, congestion issues, etc., may arise. This situation requires the setting up of network management methods to utilise all available controllable resources in an optimal way, taking into account their different characteristics. Since the MV and LV networks are coupled, control decisions should therefore be made taking the needs of both MV and LV networks into account. Should be developed, paying special attention to the limitation of total costs. The methods should be scalable to enable, on the one hand, the utilisation of the increasing amount of measurement data and controllable resources and, on the other hand, be easily pluggable as a part of the current DSO systems to facilitate real network deployment.</p>
<p><b>Description of RD&amp;I or Programming Activities:</b></p> <p>RD&amp;I Activities in this field should consider the following aspects:</p> <ul style="list-style-type: none"> <li>• Technical challenges regarding reverse power flows, network congestion and losses, power quality, etc. through modelling and demonstration in real conditions to propose innovative solutions based on technologies (storage, EVs, power electronics with new functionalities, etc.) and/or new operational modes (control and scheduling algorithms and new topologies, increased network automation and observability, accurate forecasting, etc.).</li> <li>• Integration of next generation of DER currently under development, of prosumers equipped with small DER, storage as an integrated asset in micro-grids and virtual power plants (VPPs) to provide services at the MV/LV network level. All types of active resources should be taken into account, including e.g. distributed generation, controllable loads, electric vehicles and storage systems (including also hybrid storage systems).</li> <li>• Functionalities and capabilities brought by storage, such as frequency response, voltage stabilisation, real-time intermittency smoothing, islanding, back up, etc.</li> <li>• ICT infrastructures for information exchange between all the actors involved (DSOs, TSOs, aggregators or ESCOs, etc.) to contribute to the increase of observability and decision-making almost in real time as part of the solutions and/or new operation strategies.</li> <li>• Management tools and/or methodologies and schemes to control and operate micro-grids and virtual power plants (VPPs) in the MV/LV networks considering also new business cases for DSOs and new stakeholders' participation (prosumers, aggregators, ESCOs, TSOs, etc.) in energy and flexibility markets.</li> </ul>



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<p><b>Joint Activities:</b></p> <p>JI-1: Align national, transnational and international RD&amp;I programmes</p> <ul style="list-style-type: none"> <li>Align national R&amp;I programs to include the above activities</li> <li>Align the programs of participating national research institutes to include the above RD&amp;I activities, in coordination with the ETIP SNET and its WGs and the joint research programming of the EERA</li> <li>Promote the inclusion of the above RD&amp;I activities into the joint programming of the EERA</li> <li>Coordination of research plans with international organisations and initiatives such as the IEA (and its TCPs), IRENA, Mission Innovation, WEF etc.</li> </ul> <p>JI-2: Share results and best practices</p> <ul style="list-style-type: none"> <li>Share results on a Knowledge sharing platform (e.g. expera, operated by ERA-Net Smart Grids Plus)</li> <li>Leveraging the experience of BRIDGE, organise workshops to share best practices and lessons learned from the practical experiences, including success and failure cases, also in a perspective of scalability and replicability, addressing the issues of technical and non-technical barriers to facilitate the adoption of best practices at European level</li> <li>Organise exchanges with international organisations and initiatives such as the IEA (and its TCPs), IRENA, Mission Innovation, WEF etc. to share results and best practices</li> </ul> <p>JI-3: Further collaboration ideas</p> <ul style="list-style-type: none"> <li>Initiate a CSA, or ERA-Net joint call concentrating on the above RD&amp;I activities</li> <li>Interact with EUREKA clusters (e.g. Eurogia) to have the above RD&amp;I activities incl. in the research plans.</li> </ul>	
<p><b>Impact of the RD&amp;I activities:</b></p> <p>Projects in this topic will:</p> <ul style="list-style-type: none"> <li>Contribute to integrate more renewables at the distribution level for security of supply in a regulatory framework with well-defined roles for DSOs and new and existing (i.e. TSOs) stakeholders.</li> <li>Increase control and observability of the MV and LV networks that will result in higher network efficiency and lower costs, while maintaining the security of the system.</li> <li>Improve the resilience of the electricity networks by offering more degrees of freedom to DSOs when operating the distribution grid close to its physical limits thanks to the integrated MV-LV management and the contribution of DER to system services.</li> <li>Assessment and implementation of recommendations on market rules and mechanisms for provision of ancillary services provided through the MV and LV networks</li> <li>Quantifications of the added value of the new management tools and recommendations for new market schemes including new stakeholders, based on appropriate economic evaluation of solutions/options available.</li> </ul>	
<p><b>TRL:</b> 4-7</p>	
<p><b>Expected deliverables</b></p>	<p><b>Timeline</b> Not indicated in the ETIP SNET Roadmap JI could be developed in a timeframe 2018-2024</p>
<p><b>Ongoing R&amp;I Activities (Flagship activities or not): relevant to this new activity proposal</b></p>	
<p>LIVING grid</p>	<p>Development of new models for improving the system's observability and optimum management. Implementation of tools for optimum management of the electrical system under emergency conditions of the National Transmission Network (RTN), disconnection and reconnection of network portions and related energy resources distributed, contributing to overcoming the traditional concept of "load shedding" and lightening of distributed generation. Location: Savona, Liguria, Italy. Partners: ENEA, Terna, e-distribuzione, RSE, CNR, EnSIEL. Project Awarded (National funds), awaiting startup, implementation 2018-2020. Budget: 1 M€</p>
<p>REDACTIVA</p>	<p>The main goal of the REDACTIVA Project is the development of new solutions and innovative equipment that enable a higher degree of automation in the medium and low voltage distribution networks in order to improve grid operation. At the same time their efficacy and effectiveness will be improved, as well as the quality of the service that currently not being offered to the final user. National funds, 2015-2018. Coordinated by Union Fenosa Distribucion; Spain; 3,8 Mio.</p>



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A4-IA1.1-2 Smart and flexible grid design, planning and operation based on an enhanced transmission grid observability

Implementation Plan – Activity Fiche
<p><b>Innovation Target:</b> Develop and implement solutions to increase observability and controllability in the energy system</p>
<p><b>Innovation Activity Number:</b> A4-IA1.1-2</p>
<p><b>Title:</b> Smart and flexible grid design, planning and operation based on an enhanced transmission grid observability</p>
<p>References to ETIP SNET Implementation plan 2017-2020: TOPIC 22, 25 - Functional objects addressed: T1, T6</p>
<p><b>Targets:</b></p> <p>Increasing renewable generation and cross-border interconnection significantly influences the dynamics of the grid and poses serious challenges to the stability of power transmission networks: risks of cascading events, network separation, voltage and/or frequency collapse require new planning (based on probabilistic approach), operational analysis, protection criteria and containment measures, especially because these risks are no longer local phenomena, rather they must be handled across countries and jurisdictions.</p> <p>The final target of the RD&amp;I activities are to upgrade and smarten power system planning and operation for flexible transmission systems in order to maintain the same quality of supply in a more uncertain and more interconnected system, considering variable RES and DER, demand response, storage and the interface with other energy and transport/mobility networks, new technologies and the evolution of European energy market and new business models.</p>
<p><b>Description of RD&amp;I or Programming Activities:</b></p> <p>RD&amp;I activities in this field should consider the following aspects:</p> <ul style="list-style-type: none"> <li>• Grid planning tools and metrics within an uncertainty framework, i.e. using probabilistic approach, no regret options and risk analysis/risk management perspective.</li> <li>• Power system planning methods and criteria that optimise transmission grid flexibility combining electricity market analysis, production capacities, demand response capacities and infrastructure, storage and environmental constraints, both at the transmission and distribution levels.</li> <li>• Identification of system-wide stress situations through multi-risk analysis; to include an adequacy assessment including the decommissioning of thermal plants, the coupling with other energy networks, specially gas and mobility but also heat and cold.</li> <li>• Cost-effective solutions avoiding over-investments, over-reserve capacity and sub-optimal solutions.</li> <li>• Methodologies for the evaluation of the operational limits of the integrated power system.</li> <li>• Methodologies that exploit the real-time grid monitoring information for system planning, operation and decision support.</li> <li>• Methods and models that enable an increased level of accuracy of the forecast of renewables generation thus decreasing the existing uncertainty as key action to optimise the energy network and maximising the renewable energy utilisation</li> <li>• Assessment at demo level of the capacity of devices and technologies like DLR, FACTS, WAMS, and PMU to enable the operation of the transmission system closer to its physical limits with high reliability, thus deferring new infrastructure while absorbing more RES power.</li> <li>• ICT for grid observability and controllability.</li> <li>• Demonstration of smart control systems for real-time grid monitoring, also making optimal use of smart asset management technologies, involving grid operators, including TSOs and DSOs.</li> </ul>
<p><b>Joint Activities:</b></p> <p>J1-1: Align national, transnational and international RD&amp;I programmes</p> <ul style="list-style-type: none"> <li>• In coordination with national TSOs, ETIP SNET and its working groups and ENTSOe, align national research</li> </ul>



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- programs to include the above RD&I activities in the activities planning of national research centres, also promoting the inclusion of the above RD&I activities into the joint programming of the EERA
- Coordination of research plans with international organisations and initiatives such as the IEA (and its TCPs), GO15, Mission Innovation, etc.
- JI-2: Share results and best practices
- Leveraging the experience of BRIDGE and of ENTSOe, organise workshops to share best practices and lessons learned from the practical experiences, including success and failure cases, also in a perspective of scalability and replicability, addressing the issues of technical and non-technical barriers to facilitate the adoption of best practices at European level
  - Organise exchanges with international organisations and initiatives such as the IEA (and its TCPs), GO15, Mission Innovation, etc. to share results and best practices
- JI-3: Further collaboration ideas
- Promote public-private cooperation with the technologies and services providers to experiment innovative solutions in real situations (e.g. living labs)
  - Engage with ACER and CEER

**Impact of the RD&I Activities:**

The RD&I activities above will:

- Increase system flexibility, stability and security achieved also through improved system design.
- Enhance transmission backbone for enabling the electricity market and facilitate power transactions, develop business opportunities.
- Smarten adequacy assessments including different energy system's components supportive interactions.
- Reduce costs of new infrastructures and boosted coordination with the DSOs and cross border actors.
- Promote the observability of the network in an ever increasing uncertain boundary.
- Maintain European leadership in state-of-the-art technology like WAMS, PMU.
- Send correct and sufficient investment signals to the stakeholders responsible of building the infrastructures, including political leaders.

**TRL:**

Expected deliverables	Timeline
	Not indicated in the ETIP SNET Roadmap JI could be developed in a timeframe 2018-2024

Parties / Partners (countries / stakeholders / EU)	Implementation financing / funding instruments	Indicative financing contribution

**Ongoing R&I Activities (Flagship activities or not): relevant to this new activity proposal**

Name	Description	Timeline	Location/Party	Budget
ISMI	Defining a unified architecture for efficient and stable control of isolated networks (microgrids), by introducing an innovative control system that allows to optimize and to coordinate the operation of individual generators and energy storage systems, considering also RES forecasting. The controllers are configured as intelligent systems that can decide which is the optimum set-up for network operation based on information received from heterogeneous systems, such as distributed network meters, forecasting and nowcasting systems and weather sensors. Type of Activity: Pilot Project. TRL: 4-5. Pending the award (National funds PON H2020), implementation 2018-2020. Location South region of Italy: partners: e-distribuzione (coordinator), Enel Green Power, Enel Produzione, Etna Hitech, TERNA. Budget 9 M€			



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**A4-T1.1-2: Develop and implement solutions and tools to manage the load profile by demand response and control, in order to optimise use of the grid and defer grid investments.**

A4-IA1.2-1 Customer participation and new markets and business models

Implementation Plan – Activity Fiche
<p><b>Innovation Target:</b> Develop and implement solutions and tools to manage the load profile by demand response and control, in order to optimise use of the grid and defer grid investments</p>
<p><b>Innovation Activity Number:</b> A4-IA1.2-1</p>
<p><b>Title:</b> Customer participation and new markets and business models</p>
<p>References to ETIP SNET Implementation plan 2017-2020: Topic: T6 Functional objectives addressed: T16, T17, T20, D1-D13</p>
<p><b>Targets:</b></p> <p>The targets are to address two major barriers for the wide deployment of demand response, namely:</p> <ul style="list-style-type: none"> <li>• The low level of remuneration of the participants as well as the high transaction and investment costs for market players when a large number of small customers are involved;</li> <li>• The reliability of the ICT infrastructure coupling the end-users, the market players and the DSOs, at an affordable and reasonable cost compared with the benefits;</li> </ul> <p>The major European DSOs and market players have already tested and demonstrated the technical feasibility of AD response in projects targeting samples of end-users (of the order of magnitude ~100 consumers): Further R&amp;I work must be promoted to foster end-consumers' participation in the retail electricity markets, so as to enable the provision of system services for network flexibility.</p> <p>The main targets of the activity are to address the different aspects of the customer participation in the evolution of a demand response flexibility model based on a robust market model, and in particular:</p> <ul style="list-style-type: none"> <li>• the definition and boundaries of a customer-centric model, the role of the different parties and the motivation of the consumers;</li> <li>• the definition of main focus/market of the business models;</li> <li>• the analysis of the technologies and solutions that can be applied in this field (e.g. blockchain);</li> <li>• the forecast of demand (and residual loads) accounting for the new loads and the demand-response activities of new market players;</li> <li>• the necessity of regulation changes to enable these business models within an overall coherent wholesale and retail market design.</li> </ul>
<p><b>Description of RD&amp;I or Programming Activities:</b></p> <p>Activities should focus on developing and demonstrating methodologies/tools to define and enable demand response from the technical, regulatory and market models' points of view.</p> <p>In particular, activities should address some or all of the following aspects</p> <ul style="list-style-type: none"> <li>• Use cases, demonstration projects</li> <li>• Cross-sectorial heat, gas, power modelling for optimal supply and demand balancing.</li> <li>• Customer participation by design. Models for new operational markets</li> <li>• Demand forecast accounting for the new loads and the demand-response activities of new market players and as a function of the climate changes</li> </ul>
<p><b>Joint Activities:</b></p>



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- JI-1: Align national R&I programs to include the above activities
- Align the programs of participating national research institutes to include the above RD&I activities, in coordination with the ETIP SNET and its working groups and the joint research programming of the EERA
  - Promote the inclusion of the above RD&I activities into the joint programming of the EERA
  - Coordination of research plans with international organisations and initiatives such as the IEA (and its TCPs), IRENA, Mission Innovation, WEF etc.
- JI-2: Share results and best practices
- Share results on a knowledge sharing platform (e.g. expera, operated by ERA-Net Smart Grids Plus)
  - Leveraging the experience of BRIDGE, organise workshops to share best practices and lessons learned from the practical experiences, including success and failure cases, also in a perspective of scalability and replicability, addressing the issues of technical and non-technical barriers to facilitate the adoption of best practices at European level
- JI-3: National, transnational and European calls for RD&I projects on the above given topics

- Impact of the RD&I Activities:**
- Digitalisation of the energy network.
  - Digital flexible generation (incl. VPPs)
  - Articulation and involvement of the customer and end user in digitalisation of energy supply.
  - Integration of the heat and electricity grid at local level.
  - customer participation by design in energy networks.
  - Supporting the energy transition while maintaining the quality of service in the energy provision.
  - A large scale demonstrator for the lighthouse use cases should demonstrate the feasibility of disruptive real time services.

**TRL:** 4-7

Expected deliverables	Timeline
Effective use of DR flexibility, distributed control, improved use of infrastructure	Not indicated in the ETIP SNET Roadmap JI could be developed in a timeframe 2018-2024

Parties / Partners (countries / stakeholders / EU)	Implementation financing / funding instruments	Indicative financing contribution
•		

**Ongoing R&I Activities (Flagship activities or not): relevant to this new activity proposal**

Name	Description	Timeline	Location	Budget
uGRIP	The five SINTEG projects “C/sells”, “Designetz”, “enera”, “New4.0” and “WindNODE” aim to develop and demonstrate in large model regions exemplary solutions for a climate-friendly, secure and efficient energy supply with high proportions of intermittent power generation on the basis of wind and solar energy. The projects focus on smart grids which should help to ensure stability and improve the interplay of power generation, consumption, storage and grids by means of modern information and communication technologies. The projects thus address key challenges of the energy transition including the integration of renewables into the system, flexibility, security of supply, system stability, energy industry efficiency and the establishment of smart energy systems and market structures.	04/2016- 03/2019	Croatia, Denmark, Germany	



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#### A4-IA1.2-2 EV/PHEV charging infrastructure and integration in smart energy systems

Implementation Plan – Activity Fiche
<p><b>Innovation Target:</b> Develop and implement solutions and tools to manage the load profile by demand response and control, in order to optimise use of the grid and defer grid investments</p>
<p><b>Innovation Activity Number:</b> A4-IA1.2-2</p>
<p><b>Title:</b> EV/PHEV charging infrastructure and integration in smart energy systems</p>
<p>References to ETIP SNET Implementation plan 2017-2020: TOPIC 30 - Functional objects addressed: D6, D5</p>
<p><b>Targets:</b></p> <p>Hybrid and battery electric vehicles are, together with biofuels and fuel cell cars, key for the decarbonisation of transport sector in the European Union. However, charging infrastructures are not deployed at the pace required by the EV/PHEV market evolution and cities’ needs. The lack of appropriate infrastructures is certainly slowing down the electrification of transport, other reasons being e.g. inappropriate business models. Solutions to foster the rollout of EVs are needed if Europe wants to move towards a decarbonised transport sector. First, it is necessary to have a number of real fast-charging solutions (less than 10 minutes) spread appropriately in the streets and cities to allow the user to be less dependent of the battery capacities (thus reducing range anxiety). The impact of the charging systems on the grid operation and development needs to be minimised through intelligent solutions. Alternative and innovative activities should be established to make the charging infrastructures develop. Appropriate business models as well as regulatory changes should be proposed to make this infrastructure deployment possible.</p>
<p><b>Description of RD&amp;I or Programming Activities:</b></p> <p>Work should focus on developing and demonstrating methodologies/tools to integrate EVs and the related slow/fast charging infrastructures into the energy system from the technical, regulatory and market models points of view.</p> <p>In particular, activities should address some or all of the following aspects:</p> <ul style="list-style-type: none"> <li>• Development, integration and demonstration of very-fast charging solutions (&lt;10 min) integrated in smart management systems to minimise the impact on the grid operation. This could include bidirectional conductive charging, enabling EVs to provide ancillary services to the grid (thus enhancing the business case of electro mobility).</li> <li>• Development of simulation and planning for cities and their streets in view of the intelligent deployment of infrastructures.</li> <li>• Innovative uses of reduced and economic storage solutions and renewable energy integrated in the critical points to make a faster charging with reduced impact on the grid possible.</li> <li>• Development of power electronic systems integrated in the fast charger able to provide services to the grid (voltage control).</li> <li>• New business models, including vehicle to grid, regulatory recommendations and proposals of incentives to accelerate the deployment of infrastructure.</li> <li>• Mobility patterns and charging needs of citizens to better understand where to effectively deploy the charging stations.</li> </ul>
<p><b>Joint Activities:</b></p> <p>Jl-1 National, Transnational and European Calls for RD&amp;I projects on the above given topics.</p> <ul style="list-style-type: none"> <li>• Bilateral actions with the European green vehicle initiative</li> </ul>
<p><b>Impact of the RD&amp;I Activities:</b></p> <p>Technological and market demonstration of the feasibility of non-synchronous control through storage and power electronics and of new generation of power electronics with embedded advance grid features</p> <ul style="list-style-type: none"> <li>• Faster deployment of zero-emission transports.</li> <li>• Cleaner air in the cities and a healthy place to live in for citizens.</li> </ul>



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<ul style="list-style-type: none"> <li>A new business model that allows accelerating the implementation of EVs in the cities and routes</li> </ul>				
<b>TRL: 4-7</b>				
<b>Expected deliverables</b>			<b>Timeline</b>	
Non-synchronous control through storage and power electronics, New generation of power electronics with embedded advance grid features			2018 to 2021	
<b>Parties / Partners</b> (countries / stakeholders / EU)		<b>Implementation financing / funding instruments</b>	<b>Indicative financing contribution</b>	
•				
•				
<b>Ongoing R&amp;I Activities (Flagship activities or not): relevant to this new activity proposal</b>				
<b>Name</b>	<b>Description</b>	<b>Timeline</b>	<b>Location/Party</b>	<b>Budget</b>
SMARTMOB	The project is technically oriented to experiment with Smart charging logic for EVs as the second phase of a study conducted in our European pilot project (PlangridEV), experimenting an application of the EMM system to handle the connections and therefore the temporary uses of electricity supplies, including some of the adapted mobility post. Type of Activity: Pilot Project; TRL: 5-7. Planned implementation 2018-2020. Location: Lazio, Italy. Partners: CSP (Coordinator), e-DISTRIBUZIONE, EXELENTIA WEBRAND, POMOS, LINK. Budget 3M€			
<b>Gaps:</b>				



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#### A4-IA1.2-3 Demand response engineering

Implementation Plan – Activity Fiche
<p><b>Innovation Target:</b> Develop and implement solutions to increase observability and controllability in the energy system</p>
<p><b>Innovation Activity Number:</b> A4-IA1.2-3</p>
<p><b>Title:</b> Demand response engineering</p>
<p>References to ETIP SNET Implementation plan 2017-2020: TOPIC 25 - Functional objects addressed: T11, 19</p>
<p><b>Targets:</b></p> <p>The potential benefits of load control, such as peak shaving, and energy savings, must involve large-scale participation of industry, the tertiary sector and end consumers in order to assess the impact on TSO planning and operations. Usage of technologies such as smart meters and energy boxes must be included to add value to traditional demand side response (DSR), raise awareness about consumption patterns and foster active participation of manufacturers, services/businesses and the customer in the energy market.</p> <p>The main target is to develop and integrate demand response mechanisms to provide services to the system.</p> <ul style="list-style-type: none"> <li>• Add flexibility to the system (modulate the load curve) in order to increase overall system efficiency.</li> <li>• Foster active customer participation in the system.</li> </ul> <p>Services provided by large size prosumers and by medium-small prosumers connected to the HV, MV and LV grid; advanced management of selected industrial clients based on system benefits analysis.</p>
<p><b>Description of RD&amp;I or Programming Activities:</b></p> <p>Activities should focus on developing and demonstrating methodologies/tools to define and enable demand response from the technical, regulatory and market models' points of view.</p> <p>In particular, activities should address some or all of the following aspects</p> <ul style="list-style-type: none"> <li>• Define demand requirements and data required by TSOs for optimal DSR utilisation.</li> <li>• Demonstrate active customer (industry, tertiary sector and end consumers) involvement using “indirect” (provided post-consumption) and “direct” (real-time) feedback, in order to achieve a reduction in peak demand.</li> <li>• Demonstrate the feasibility of Demand Response (DSR) to provide innovative ancillary services to power systems. The topic aims at analysing different operation schemes, providing scenario analysis on the feasibility and penetration of DSR techniques and defining case studies for real-environment implementation.</li> <li>• Integrate and demonstrate DSR and storage solutions, including the impact of transport system electrification (e.g., transport EVs, etc.) for off-peak hours, and their use in system balancing.</li> <li>• Develop simulation tools to include Vehicles to Grid capacity.</li> <li>• Model customer/load behaviour and segmentation, and quantify the degree of flexibility provided by distribution networks, e.g., through reconfiguration or other methods.</li> <li>• Test DR models that bring demand response from private customers by, e.g., limiting the rated power during a specific period of time.</li> </ul>
<p><b>Joint Activities:</b></p> <p>J1-1: National, Transnational and European Calls for RD&amp;I projects on the above given topics.</p>
<p><b>Impact of RD&amp;I Activities</b></p> <ul style="list-style-type: none"> <li>• Demonstrated effective use of DR flexibility, distributed control, improved use of infrastructure</li> <li>• An increase of the available resources for ancillary services provision, an improvement of the system flexibility and a higher security.</li> </ul>



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<ul style="list-style-type: none"> <li>• The possibility for electrical consumers to exploit economic advantages associated to the service provision.</li> <li>• A higher interaction between TSOs</li> </ul>				
<b>TRL:</b>				
<b>Expected deliverables</b>			<b>Timeline</b>	
			2018-2023	
<b>Parties / Partners</b> (countries / stakeholders / EU)		<b>Implementation financing / funding instruments</b>		<b>Indicative financing contribution</b>
•				
•				
<b>Ongoing R&amp;I Activities (Flagship activities or not): relevant to this new activity proposal</b>				
<b>Name</b>	<b>Description</b>	<b>Timeline</b>	<b>Location/Party</b>	<b>Budget</b>
<b>Gaps:</b>				



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### A4-T1.1-3: Develop and implement solutions to increase flexibility of all types of generation

A4-IA1.3-1 Interactions between flexible generation and the power system: control strategies, ancillary services in scenarios in presence of very large penetration of renewables and low mechanical inertia

Implementation Plan – Activity Fiche
<b>Innovation Target:</b> Develop and implement solutions to increase flexibility of all types of generation
<b>Innovation Activity Number:</b> A4-IA1.3-1
<b>Title:</b> Interactions between flexible generation and the power system: control strategies, ancillary services in scenarios in presence of very large penetration of renewables and low mechanical inertia
References to ETIP SNET Implementation plan 2017-2020: Topics: T35, T36 - Functional objects addressed: T6, T12, T13
<p><b>Targets:</b></p> <p>The share of renewable energy sources (RES) in the European energy system is expected to grow considerably per the objectives set by the EU and the Energy Roadmap 2050 considers that RES share in electricity consumption could reach up to 97% by 2050. Despite its obvious benefits the increasing penetration of RES also brings a higher level of variability and uncertainty. As the power generation landscape changes in the European energy systems, namely with the integration of variable RES, a further flexible operation of power generation is needed. This poses challenges in the interaction between generation and the power system:</p> <ul style="list-style-type: none"> <li>• Ancillary services need to be re shaped to deal with unforeseen events like generation outages, load forecast errors and demand fluctuations. In fact, future networks with very large presence of renewable generators will be driven by Power Electronics converters (responsible to connect to the grid the elements of this future networks: RES, Storage, HVDC, etc.) instead of synchronous generation. RES must evolve to be able to offer the necessary services requested by the grid in this scenery. New services should be involved in a very broad spectrum of applications to ensure the flexibility, integrity, stability and power quality. Renewable generators must be confronted to this new control paradigm and must be designed in consequence to be able to offer all these new services and to be adapted to the new stability criteria and monitoring parameters to ensure a flexible and safe operation with near 100% of RES.</li> <li>• Forecast RES production with a high level of accuracy is key for the system optimisation in terms of its integration. Present forecasting techniques are usually divided into “day ahead (DA) forecasting” and “hour-ahead (intra-day) forecasting”, which differ from the perspective of accuracy, and applicability. In general, with the current penetration of RES, day-ahead schedules are applicable, while intra-day forecasts are currently of smaller economic value. There is still a high potential lying in the inclusion of exogenous data, as well as data from other meteorological databases, which could significantly increase forecasting accuracy, thus contributing to increase RES availability and their contribution to a flexible energy network system. Improvements can be achieved applying generation forecasting models based on neural networks algorithms and utilising hybrid approaches that combine weather forecasts, local ad-hoc models, historical data, and real time measurements.</li> <li>• The share of grid-connected Power Electronic Converters (PEC) generators being continuously increased their active contribution to the grid stability and to the security of power supply becomes necessary. Current strategies for the PEC generation are expected to be reconsidered for the future power supply scenarios to meet stable network operation conditions also in case of fault scenarios. New RES generation must evolve to a novel concept of Renewable Flexible Modules (RFM) that integrates not only the PEC but also other elements such as the energy storage in single controllable units to become fully flexible structures. The increasing penetration of RFM in the RES system Generation also poses a challenge to the grid operators, affecting issues such as power quality, dynamic behaviour of the system or the existing protection systems. Standards and grid codes lack details concerning testing procedures and quality assessment criteria for grid control/support functions from PEC based generators in the context of PEC dominated grids.</li> </ul>



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#### Description of RD&I or Programming Activities:

Work should focus on developing and demonstrating methodologies/tools to increase the interaction between the flexible generation and the power system including control strategies, ancillary services and synthetic inertia.

RD&I activities should consider the following:

- Improve RES forecast accuracy by means of new ensemble models considering individual forecasting models for power generation and meteorological conditions, including linear, nonlinear and probabilistic methods; test of hybrid approaches that combine weather forecasting, local ad-hoc models, historical data, and on-line measurement. Estimate secondary/tertiary power reserves against RES forecast accuracy/error

Identification of the services to be provided by the VRES technologies to assure a stable operation of the grid in scenarios with high penetration of RES.

- Develop and demonstrate methods for dynamic capacity management and reserve allocation that support system operations with large amounts of RES integration.
- Identification and development of design concepts and advanced strategies to offer the new services required by the grid (such as frequency and voltage support, black start, islanding operation capacity and reserve functions, etc.) depending on the penetration level of RES.
- Development of new control strategies and interaction with other support system like energy storage and manageable RES to be able to provide frequency support and reserves if needed.
- Definition and testing of procedures and strategies using a multi-agent framework to ensure the adequate system flexibility and the provision of ancillary services as well as instability mitigation by RES and identification of new indicators for defining the flexibility and stability criteria in those future scenarios with high RES penetration.
- Identification and implementation of strategies for overcoming possible interactions between the different controls.
- Identification and development of the concept of Renewable Flexible Modules (RFM), including their components, architecture, topology, and interoperability requirements.
- Description of future system's needs in terms of control methods enabling the interconnected grid to be operated in a stable manner by inverter-based /RFM generation and identification of the qualification and interaction criteria of smart inverters to assure the compliance with the required network necessities.
- Assessment of additional functions of the future RFMs leveraging system observability (e.g. embedding PMUs), resulting in an integration of the control and monitoring capabilities, avoiding extra costs of excessive equipment in the grid.
- Development of grid protection functions in power electric converters (PEC) and at RFM level, in order to provide additional information to protection relays, enhancing fault detection.
- Implementation of communication protocols with storage systems in PEC support functions (measurements, protection, voltage and frequency) even if there is no renewable energy resource available.
- Investigation of the role of storage systems and different energy mix configurations concerning grid control and additional generation flexibility
- Development of the appropriate testing environments and implementation of advanced testing procedures of PEC's and RFM's grid support/control functions and support to the development of grid codes and standards

#### Joint Activities:

JI-1: Align national, transnational and international RD&I programmes

- Align national R&I programs to include the above activities
- Align the programs of participating national research institutes to include the above RD&I activities, in coordination with the ETIP SNET and its working groups

JI-2: Share results and best practices

- Share results on a knowledge sharing platform (e.g. expera, operated by ERA-Net Smart Grids Plus, or GridInnovationonline, operated by ETIP SNET)
- Leveraging the experience of BRIDGE, organise workshops to share best practices and lessons learned from the practical experiences, including success and failure cases, also in a perspective of scalability and



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replicability, addressing the issues of technical and non-technical barriers to facilitate the adoption of best practices at European level

- Organise exchanges with international organisations and initiatives such as the IEA (and its TCPs), IRENA, Mission Innovation, WEF etc. to share results and best practices

JI-3: National, Transnational and European calls for RD&I projects on the above given topics.

**Impact of the RD&I Activities:**

- Increase the RES penetration in electricity system without affecting the reliability
- Smarter interfaces between generation and transmission networks, thus coping with grid stability and security of supply
- Support the path towards a 100% RES electrical system with ancillary services provided by RES while ensuring the stability and reliability of the grid. More efficient balancing market decreasing the costs for the whole energy system
- Ensuring that PEC generation and RFM contribute to the reliability, security and stability of power supply in the European interconnected system in times of increasing renewables
- New RES control strategies and interaction with other generation sources
- Identification of RES ancillary services
- New procedures ensuring the provision of ancillary services from RES as well as instability mitigation
- Identification and definition of inverter - based /RFM generation control methods enabling the stable operation of the system
- Definitions and availability of a new generation of Renewable Flexible Modules (components, architecture, topology, and interoperability requirements), including potential storage functions
- Availability of the appropriate testing environments and procedures of PEC's and RFM's grid support/control functions.

**TRL:** 3 to 7: RIA/IA

**Expected deliverables**

**Timeline**

4 YEARS (2018-2022)

**Parties / Partners**

(countries / stakeholders / EU)

**Implementation financing / funding instruments**

**Indicative financing contribution**

- 

**Ongoing R&I Activities (Flagship activities or not): relevant to this new activity proposal**

**Name**

**Description**

**Timeline**

**Location/Party**

**Budget**

**Gaps:**



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#### A4-IA1.3-2 Adaptation and improvement of technologies to novel power-to-gas and power-to-liquid concepts

Implementation Plan – Activity Fiche
<b>Innovation Target:</b> Develop and implement solutions to increase flexibility of all types of generation
<b>Innovation Activity Number:</b> A4-IA1.3-2
<b>Title:</b> Adaptation and improvement of technologies to novel power-to-gas and power-to-liquid concepts
References to ETIP SNET Implementation plan 2017-2020: TOPIC 34 - Functional objectives addressed: T6, T13, T22, D7, D14
<p><b>Targets:</b></p> <p>Power-to-gas and power-to-liquid are promising solutions for the future, using excess energy at the times of low demand and providing a “green” fuel that can be used for improving the system flexibility. More broadly, synthetic liquid or gaseous fuels can be used in this way to support the synergies between transport and power sector by cycling the CO<sub>2</sub> and therefore making CO<sub>2</sub> neutral fuels available. Power-to-Gas offers the best available seasonal storage option in the future energy system via the existing gas grid. Furthermore, hydrogen can be used as feedstock to produce methane combined to CO<sub>2</sub>, increasing the direct impact in the current natural gas system. In thermal power plants, the main challenges are the adaptation of the combustion to the new gases as well as the cost-efficiency of the full process chain. Hydrogen leads to increased reactivity, which is manifested as increased flame speed and reduced ignition delay time. Both mechanisms affect the combustion performance in generation, which results in an increased risk of flashback in lean pre-mixed combustion systems, leading to damaged hardware and increased NO<sub>x</sub> emissions. Synthetic “low carbon fuels” like methanol or ammonia have low heating values and different emission behaviours than standard fuels. Combustion systems must be adapted to these characteristics as well as the environmental system.</p> <p>In other way, in some energy scenarios characterised by an excess of renewable energy generation due to exceptional weather conditions (or to a lack of demand), an opportunity to generate gas in the renewable energy power plants could be a suitable way to reinforce and flexibilise the renewable energy assets by mean of Power to Gas solution, improving their capacities and energy service options. This solution could additionally reinforce the market competitively and quick integration of the renewable energy plants by means of re-electrification (power to power) or by the commercialisation of the generated gas to the industry and/or the transport sector.</p>
<p><b>Description of RD&amp;I or Programming Activities:</b></p> <p>Work should be differentiated in two possible ways: thermal power plants and renewable energy assets.</p> <p>In the thermal area the focus must be on the possibility to combine the advantages of efficient and dispatchable thermal power plant technology and the availability of a large storage solution like the existing gas grid with the ability of generating carbon-neutral “green” gas based on hydrogen. In particular, proposal should address some or all of the following aspects:</p> <ul style="list-style-type: none"> <li>• Development of combustion systems for stable combustion of gas mixtures with hydrogen progressively adapting the technology to 100% hydrogen;</li> <li>• Extension of low emission load range, improving flexible load operation;</li> <li>• Improved design of combustor liners to reduce exposure of surfaces to high-temperature gas and radiation;</li> <li>• Development of a safe hydrogen fuel starting methodology.</li> </ul> <p>In the Renewable area focus must be oriented in increasing the existing capabilities of the renewable energy assets improving they balancing responsibility and capacity, improve their dispatchability and offering new energy services to the system. In particular, activities should address some or all of the following aspects:</p> <ul style="list-style-type: none"> <li>• Design and develop storage options using temporarily energy excess to produce hydrogen and/or synthetic gas.</li> <li>• Analyse the impact on the overall renewable assets to adapt the solution to existing plants becoming flexible and become more dispatchable assets.</li> <li>• Explore mix of sustainable solutions bridging gaps with the transport and gas markets. Additional RD&amp;I</li> </ul>



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<p>activities for optimising the value from the existing gas transport and distribution networks;</p> <ul style="list-style-type: none"> <li>• Adapt and prepare the existing gas network for power to gas solutions (methane, hydrogen, renewable gas);</li> <li>• Economic and capacity feasibility studies to transfer a gas transport and distribution network to a network with a different purpose;</li> <li>• Market aspects for the gas network to become a key player in sector coupling</li> </ul>				
<b>Joint Activities:</b>				
<p>JI-1: Align national, transnational and international RD&amp;I programmes</p> <ul style="list-style-type: none"> <li>• Align national R&amp;I programs to include the above activities.</li> <li>• Align the programs of participating national research institutes to include the above RD&amp;I activities, in coordination with the ETIP SNET and its working groups.</li> </ul> <p>JI-2: Share results and best practices</p> <ul style="list-style-type: none"> <li>• Share results on a knowledge sharing platform (e.g. expera, operated by ERA-Net Smart Grids Plus, or GridInnovationonline, operated by ETIP SNET).</li> <li>• Leveraging the experience of BRIDGE, organise workshops to share best practices and lessons learned from the practical experiences, including success and failure cases, also in a perspective of scalability and replicability, addressing the issues of technical and non-technical barriers to facilitate the adoption of best practices at European level.</li> <li>• Organise exchanges with international organisations and initiatives such as the IEA (and its TCPs), IRENA, Mission Innovation, WEF etc. to share results and best practices.</li> </ul> <p>JI-3: National, Transnational and European calls for RD&amp;I projects on the above given topics.</p>				
<b>Impact of the RD&amp;I Activities:</b>				
<p>Technology developments ensuring that thermal power generation – including existing capacities – is ready to optimally use the gases generated under novel Power-to-Gas concepts. Demonstration of the cost-efficient use of “green” gases and fluids for power and heat generation based on known thermal power generation.</p> <p>In other way, increase the flexibility and dispatchability of the VRES is an important target that could become integrated in the Renewable energy assets from their design and developed and incorporated in the existing RES fleet to become as soon as possible a full decarbonised energy system.</p>				
<b>TRL:</b>				
<b>Expected deliverables</b>			<b>Timeline</b>	
•Improve flexibility on generation, smart responsive interfaces			2018-2023	
<b>Parties / Partners</b> (countries / stakeholders / EU)		<b>Implementation financing / funding instruments</b>		<b>Indicative financing contribution</b>
•				
<b>Ongoing R&amp;I Activities (Flagship activities or not): relevant to this new activity proposal</b>				
<b>Name</b>	<b>Description</b>	<b>Timeline</b>	<b>Location/Party</b>	<b>Budget</b>
<b>Gaps:</b>				



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## A4-T1.1-3.1: Develop and implement solutions to enable Renewable Energy Sources to provide grid services.

### A4-IA1.3-3 Developing the next generation of flexible hydro power plants

Implementation Plan – Activity Fiche
<b>Innovation Target:</b> Develop and implement solutions to enable Renewable Energy Sources to provide grid services.
<b>Innovation Activity Number:</b> A4-IA1.3-3
<b>Title:</b> Developing the next generation of flexible hydro power plants
References to ETIP SNET Implementation plan 2017-2020: TOPIC T37, T38 - Functional objects addressed: T4, T9, T22, D14
<p><b>Targets:</b></p> <p>The increase of variable renewable sources has a direct impact on hydro power plants, which need to adapt their operation to a system with a rapidly changing demand for flexibility, at highest efficiency and lowest emissions. Flexibility is understood as the ability to complement the variable renewable generation quickly and at lowest emission level, ensuring the necessary reliable electricity and heat/cold supply (start-up/shut down rate, ramp-rate and reduced minimum load).</p> <p>For the hydro power plants this includes renovation and adaptation to the markets and new operational regimes. The retrofitting or reconstruction of such systems will raise other challenges than just improving current technology, and sometimes not only refurbishments of large schemes are facing hurdles due to complexity or size and shall be seen as “first-of its kind”. The targets are to analyse and better understand how the new hydropower operation that will lead to changes in the yearly, seasonal, and daily fluctuations in reservoir water levels, that may also affect downstream water bodies and fish population.</p>
<p><b>Description of RD&amp;I or Programming Activities:</b></p> <p>The activity should focus into existing hydropower developing more flexible power plants providing fast regulation and to large-scale pumped storage plants with increased capacity.</p> <p>In particular, activities should address some of the following aspects:</p> <ul style="list-style-type: none"> <li>• The design and development of tools and models to evaluate the benefits of rehabilitation and upgrade existing plants to future demands.</li> <li>• Development of a new generation and robust component designs for hydropower core components.</li> <li>• Development of elements that contribute to improve the ramp response of hydro plants, their efficiency and operational and grid balancing capabilities to provide back-up power for renewable power generation.</li> <li>• Development of new tools (methods and models) for environmental impact assessments, in this new situation/operation modes in order to increase the utilisation of extended flexibility options for existing plants by smarter compatibility with environmental restrictions.</li> </ul>
<p><b>Joint Activities:</b></p> <p>JI-1: Align national, transnational and international RD&amp;I programmes</p> <ul style="list-style-type: none"> <li>• Align national R&amp;I programs to include the above activities</li> <li>• Align the programs of participating national research institutes to include the above RD&amp;I activities, in coordination with the ETIP SNET and its working groups and the joint research programming of the EERA</li> <li>• Promote the inclusion of the above RD&amp;I activities into the joint programming of the EERA</li> <li>• Coordination of research plans with international organisations and initiatives such as the IEA (and its TCPs), IRENA, Mission Innovation, WEF etc.</li> </ul> <p>JI-2: Share results and best practices</p> <ul style="list-style-type: none"> <li>• Share results on a knowledge sharing platform (e.g. expera, operated by ERA-Net Smart Grids Plus)</li> <li>• Leveraging the experience of BRIDGE, organise workshops to share best practices and lessons learned from</li> </ul>



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<p>the practical experiences, including success and failure cases, also in a perspective of scalability and replicability, addressing the issues of technical and non-technical barriers to facilitate the adoption of best practices at European level</p> <ul style="list-style-type: none"> <li>Organise exchanges with international organisations and initiatives such as the IEA (and its TCPs), IRENA, Mission Innovation, WEF etc. to share results and best practices</li> </ul> <p>JI-3: National, Transnational and European calls for RD&amp;I projects on the above given topics.</p>				
<p><b>Impact of the RD&amp;I Activities:</b></p> <p>Achieving a robust, sustainable, flexible and efficient power fleet, able to cope with the systems challenges due an increasing share of variable renewable energy sources – at lowest cost</p>				
<p><b>TRL:</b></p>				
<p><b>Expected deliverables</b></p>			<p><b>Timeline</b></p>	
<ul style="list-style-type: none"> <li>Improve flexibility on generation, smart responsive interfaces</li> </ul>			<p>2018-2023</p>	
<p><b>Parties / Partners</b> (countries / stakeholders / EU)</p>		<p><b>Implementation financing / funding instruments</b></p>	<p><b>Indicative financing contribution</b></p>	
<ul style="list-style-type: none"> <li></li> </ul>				
<ul style="list-style-type: none"> <li></li> </ul>				
<p><b>Ongoing R&amp;I Activities (Flagship activities or not): relevant to this new activity proposal</b></p>				
<p><b>Name</b></p>	<p><b>Description</b></p>	<p><b>Timeline</b></p>	<p><b>Location/Party</b></p>	<p><b>Budget</b></p>
<p><b>Gaps:</b></p>				



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## A4-T1.1-3.2: Develop and implement solutions to improve the flexibility capabilities for new as well as retrofitted thermal power plants

### A4-IA1.3-4 Developing the next generation of flexible thermal power plants

Implementation Plan – Activity Fiche
<p><b>Innovation Target:</b> Develop and implement solutions to improve the flexibility capabilities for new as well as retrofitted thermal power plants</p>
<p><b>Innovation Activity Number:</b> A4-IA1.3-4</p>
<p><b>Title:</b> Developing the next generation of flexible thermal power plants</p>
<p>References to ETIP SNET Implementation plan 2017-2020: TOPIC 33 - Functional objects addressed: T22, D14</p>
<p><b>Targets:</b></p> <p>The increase of variable renewable sources has a direct impact on thermal power plants, which need to adapt their operation to a system with a rapidly changing demand for flexibility, at highest efficiency and lowest emissions. Flexibility, is understood as the ability to complement the variable renewable generation quickly and at lowest emission level, ensuring the necessary reliable electricity and heat/cold supply (start-up/shut down rate, ramp-rate and reduced minimum load). This also includes fuel flexibility (capacity to switch between renewable-based fuel as well as conventional, including different rates of mixtures, reacting to availabilities of carbon-neutral synthetic fuels like synthetic methanol or methane, hydrogen, ammonia, biomass derived from waste, etc.). Addressing efficiency at the same time as flexibility, is a no-regret option, also resulting in a reduced fuel consumption.</p>
<p><b>Description of RD&amp;I or Programming Activities:</b></p> <p>This activity should focus on developing and demonstrating methodologies/tools to increase thermal power plant operational flexibility – including fuel flexibility – together with measures increasing efficiency at full and part-load, at lowest greenhouse gas emissions. Solutions shall either contribute to new concepts for thermal power plants or enable existing capacities to improve their performance. In particular, activities should address some or all of the following aspects:</p> <ul style="list-style-type: none"> <li>• Component improvements, which, in turn, contribute to the optimisation of the power plant operation;</li> <li>• Improvements in operational flexibility (start-up/shut down rate, ramp-rate and reduced minimum load);</li> <li>• Improvement of overall performance (efficiency and emissions) at partial loads;</li> <li>• Robustness of thermal power plants (maintenance and repair costs reduction);</li> <li>• Modifications to allow multi-fuel operation (e.g. fuel handling, feeding, combustion and environmental controls);</li> <li>• Novel monitoring and control tools and advanced modelling tools for better operation and decisional support;</li> <li>• Connecting components together for improved and different applications</li> </ul>
<p><b>Joint Activities:</b></p> <p>J1-1: Align national, transnational and international RD&amp;I programmes</p> <ul style="list-style-type: none"> <li>• Align national R&amp;I programs to include the above activities</li> <li>• Align the programs of participating national research institutes to include the above RD&amp;I activities, in coordination with the ETIP SNET and its working groups</li> </ul> <p>J1-2: Share results and best practices</p> <ul style="list-style-type: none"> <li>• Share results on a knowledge sharing platform (e.g. expera, operated by ERA-Net Smart Grids Plus, or GridInnovationonline, operated by ETIP SNET)</li> <li>• Leveraging the experience of BRIDGE, organise workshops to share best practices and lessons learned from the practical experiences, including success and failure cases, also in a perspective of scalability and</li> </ul>



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replicability, addressing the issues of technical and non-technical barriers to facilitate the adoption of best practices at European level <ul style="list-style-type: none"> <li>Organise exchanges with international organisations and initiatives such as the IEA (and its TCPs), IRENA, Mission Innovation, WEF etc. to share results and best practices</li> </ul> JI-3: National, Transnational and European calls for RD&I projects on the above given topics.				
<b>Impact of the RD&amp;I Activities:</b> Achieving a robust, sustainable, flexible and efficient thermal power fleet, able to cope with the systems challenges due an increasing share of variable renewable energy sources – at lowest cost.				
<b>TRL:</b>				
<b>Expected deliverables</b>			<b>Timeline</b>	
•Improve flexibility on generation, smart responsive interfaces				
<b>Parties / Partners</b> (countries / stakeholders / EU)		<b>Implementation financing / funding instruments</b>	<b>Indicative financing contribution</b>	
•				
•				
<b>Ongoing R&amp;I Activities (Flagship activities or not): relevant to this new activity proposal</b>				
<b>Name</b>	<b>Description</b>	<b>Timeline</b>	<b>Location/Party</b>	<b>Budget</b>
<b>Gaps:</b>				



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#### A4-IA1.3-5 Increase the flexible generation by mean of the use of integrated storage in generation assets

Implementation Plan – Activity Fiche
<p><b>Innovation Target:</b> Develop and implement solutions to improve the flexibility capabilities for new as well as retrofitted thermal power plants</p>
<p><b>Innovation Activity Number:</b> A4-IA1.3-5</p>
<p><b>Title:</b> Increase the flexible generation by mean of the use of integrated storage in generation assets</p>
<p>References to ETIP SNET Implementation plan 2017-2020: TOPIC 25 - Functional objects addressed: T10, T22, D5, D14</p>
<p><b>Targets:</b></p> <p>In a future scenario with large penetration of variable renewables, like solar and wind generation, electric grid stability and flexibility become an issue. The thermal generation assets must increase their role, from providing base-load power to providing fluctuating back-up power to meet unpredictable and short-notice demand peaks and fluctuating renewable energy generation. In addition, vRES must progressively become dispatchable, predictable, and more flexible and able to provide any generation and network system requirements. Hybrid systems, where storage units are localised at the generation plant, would make a mixed solution based on the use of high efficiency conversion systems, contributing to satisfy the grid stability and flexibility requirements. These solutions are confronted with a major challenge that is to combine storage with the generation asset (e.g. conventional thermal, wind, solar, marine) with a positive business case, having more responsibility in dispatching energy and participating in ancillary services markets. This type of solutions is technically feasible, but markets need to be found or developed, regulatory issues need to be solved and control of the storage systems needs to be worked out.</p>
<p><b>Description of RD&amp;I or Programming Activities:</b></p> <p>Activities should focus on the design and demonstration of the integration of energy storage systems within the generation assets to increase flexibility and efficiency assuring the system stability. Solutions should be applicable to both existing and new plants. In particular, activities should address some or all of the following aspects:</p> <ul style="list-style-type: none"> <li>• Realisation of integrated thermal energy storage prototype version for operational investigation and implementation in overall plant design/configuration.</li> <li>• Integration of power-to-fuel technologies into power plants, e.g. generation and storage of renewable fuels (e.g. hydrogen, methane and other chemicals) and adaptation of power plant design.</li> <li>• Identification and development of chemical generation and storage concepts which can be integrated into power plant environment (e.g. safety aspects).</li> <li>• Cycle CO<sub>2</sub> for synthetic fuel generation.</li> <li>• Evaluation of hybrid solutions for an optimal combination of RES with energy storage to manage RES uncertainty, from both the technical and economic perspective.</li> <li>• Demonstration on different scales, for example with a single wind turbine and with large wind parks, for short-term (some seconds) and for long-term (days /weeks/months) storage.</li> <li>• Development of methods to optimise the costs through dimensioning and operation strategy of the different plant blocks for a specific location.</li> <li>• Study of the operation data from at least one real-life hybrid plant to validate the proposed strategies.</li> <li>• Set up of case studies (adjacent countries /non-adjacent countries) to assess the penetration level of intermittent renewables based on the criteria of "energy market value".</li> <li>• Assessment of the value of storage from hybrid plants per energy value (contribute to day-ahead energy equilibrium), ancillary services (contribute to intra-day power equilibrium) and dynamic frequency response (contribute to system inertia), providing dispatchability to currently non-dispatchable renewable sources.</li> <li>• Assessment of the complementarity of flexible and non-flexible generation technologies.</li> <li>• Finding and developing markets, business models and profit solutions for the combination of renewables and storage, optimising self-consumption, peak-load reduction resource aggregation, curtailment management, grid-code compliance, real-time intermittency smoothing and load shifting capabilities are available opportunities.</li> </ul> <p>Energy storage integrated in variable renewable plants and in thermal plants, solutions need to demonstrate how</p>



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<p>they will contribute to a better operation of the system (e.g. offering new or enhanced ancillary services) and its positive impact into price formation and operation of both electricity wholesale and retail markets</p>		
<p><b>Joint Activities:</b></p> <p>JA-1: Integration of Storage and vRES</p> <ul style="list-style-type: none"> <li>Demonstration projects of a positive business case for the integration of storage in at least two different variable RES generation sites (e.g. wind, PV, marine)</li> </ul> <p>JA- 2: integration of different Storage technologies</p> <ul style="list-style-type: none"> <li>Demonstration projects of a positive business case for the integration of at least two different storage technologies (e.g. batteries, power to X technologies, etc.) in a conventional thermal generation site</li> </ul>		
<p><b>Impact of the RD&amp;I Activities:</b></p> <p>Innovative integrated energy storage has a game changing role to play in transforming network management and flexibility to meet the new demands. Expected impact will be, but not only:</p> <ul style="list-style-type: none"> <li>The optimisation of the operation of power generation assets through storage for instance by bridging between stop and restart of a generator or by providing the needed time to achieve optimal ramp-up/-down, will allow fast load changes to be met. This option can also contribute to increasing efficiency of thermal power plants – including fuel efficiency, which will be translated into a reduction of CO<sub>2</sub> emissions of the overall energy system. Integration of storage will enable the de-coupling of generation of power and heat in CHP plants.</li> <li>Development of prototypes for complete process chain using compressed air, batteries, or other kinds of mechanical or electrical energy storage to increase the flexibility of thermal power plants.</li> <li>Maximise profits for the owners of assets (wind power and PV plants) and decrease the frequency deviations in the grid because of overproduction of electricity at certain moments of the day.</li> <li>Stabilise the electricity production from solar and wind assets so that the amount of backup power provided by fossil sources can be reduced; this will lead to a decrease of CO<sub>2</sub> emissions.</li> <li>The delivery of design criteria and operation strategies to optimise the dispatch ability of hybrid solar power plants (STE/PV) with thermal storage so they can be considered as baseload generators in the grid.</li> <li>The R&amp;I activities to be carried out should help lower the cost of storage integration through the promotion of standards and the economies of scale.</li> </ul>		
<p><b>TRL: 5-8</b></p>		
<p><b>Expected deliverables</b></p> <ul style="list-style-type: none"> <li>Guidelines for optimal and profitable operation strategies for power plants (RES and conventional) in the future power grid</li> <li>New control algorithms</li> <li>New integrated solutions, including innovative components (storage, power electronics)</li> <li>New or enhanced ancillary services provided to the grid particularly relev. for RES+ storage</li> </ul>		<p><b>Timeline</b></p> <p>2018-2020 - duration of about 4 years.</p>
<p><b>Parties / Partners</b> (countries / stakeholders / EU)</p>	<p><b>Implementation financing / funding instruments</b></p>	<p><b>Indicative financing contribution</b></p>
<p><b>Ongoing R&amp;I Activities (Flagship activities or not): relevant to this new activity proposal</b></p>		
<p>Flexibility impact assessment on thermal power plants (POWER-FLEX)</p>	<p>Evaluate capabilities of battery storage integration in coal fired power plants to enhance flexibility and increase generation efficiency. Demonstration of MW scale batteries capabilities to support plant ramp rate capabilities and provide frequency regulation services to the TSO. Design of the battery to be integrated in Italian TVN coal fired power plant, Permitting, Type of Activity: DEMO Project. Start date: early 2018. Internal funding ENEL</p>	
<p>Thermal Energy Storage (THEsIS)</p>	<p>Identification and assessment of innovative technologies in thermal storage field to increase efficiency and flexibility of power plants. Evaluation of potential use cases suitable for thermal storage systems. Feasibility study of thermal storage system capabilities to increase efficiency and flexibility of generation assets. Pilot phase to assess technical capabilities and integration strategies. Scouting and assessment of innovative technologies in thermal storage fields (i.e. thermal storage using concrete, molten salts, etc) Type of Activity: Pilot Projects. Start date early 2018. Location: Italy-Spain. Enel Funding</p>	



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## A4-T1.4-1: Reduce the cost of all energy storage solutions contributing to the minimisation of the overall system costs

### A4-IA1.4-1 Multiservice storage applications to enable innovative synergies between system operators and market players

Implementation Plan – Activity Fiche
<p><b>Innovation Target:</b> Reduce the cost of all energy storage solutions contributing to the minimisation of the overall system costs</p>
<p><b>Innovation Activity Number:</b> A4-IA1.4-1</p>
<p><b>Title:</b> Multiservice storage applications to enable innovative synergies between system operators and market players</p>
<p>References to ETIP SNET Implementation plan 2017-2020: TOPICS 15, 20, 25 - Functional objects addressed: T6, T10, T22 D5</p>
<p><b>Targets:</b></p> <p>Storage facilities in transmission systems or on generation sites are a promising solution for advanced grid services implementation as well as an effective way to increase system flexibility and decrease the requirements of back-up conventional energy while ensuring the supply. They are also crucial to integrate renewable electricity. Storage is also a key factor for new market players to manage balance responsibility and to access the ancillary service market with innovative resources. Therefore, the investigation of models for a multiservice usage of single or aggregated energy storage system can increase the value for both the whole system and market players. Note that this target focus on the potential of on-site storage to optimise generation operations, partially decoupling heat and electricity generation in the case of combined heat and power, or turning fluctuating renewable resources into dispatchable, predictable, flexible generation assets, able to provide any generation and network system requirements.</p>
<p><b>Description of RD&amp;I or Programming Activities:</b></p> <p>Activities should focus on storage integration in the electric system that aim to valorise the multi services offered by storage facilities, including network requirements, energy market parameters and generator technical and market issues. There are technical issues to overcome and many economic, regulatory, market and environmental aspects must be addressed.</p> <p>The goal is:</p> <ul style="list-style-type: none"> <li>to provide a significant flexibility to the overall system and market incl. especially to TSOs and DSOs, that will have the possibility to exploit innovative ancillary services and higher availability of resources</li> <li>the development of new business models related to dispatching services provision for electrical market operators.</li> </ul>
<p><b>Joint Activities:</b></p> <p>JI-1: Align national, transnational and international RD&amp;I programmes</p> <ul style="list-style-type: none"> <li>Align national R&amp;I programs to include the above activities</li> <li>Align the programs of participating national research institutes to include the above RD&amp;I activities, in coordination with the ETIP SNET and its working groups and the joint research programming of the EERA</li> <li>Promote the inclusion of the above RD&amp;I activities into the joint programming of the EERA</li> <li>Coordination of research plans with international organisations and initiatives such as the IEA (and its TCPs), IRENA, Mission Innovation, WEF etc.</li> </ul> <p>JI-2: Share results and best practices</p> <ul style="list-style-type: none"> <li>Share results on a knowledge sharing platform (e.g. expera, operated by ERA-Net Smart Grids Plus)</li> <li>Leveraging the experience of BRIDGE, organise workshops to share best practices and lessons learned from the practical experiences, including success and failure cases, also in a perspective of scalability and replicability, addressing the issues of technical and non-technical barriers to facilitate the adoption of best practices at European level</li> <li>Organise exchanges with international organisations and initiatives such as the IEA (and its TCPs), IRENA,</li> </ul>



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<p>Mission Innovation, WEF etc. to share results and best practices          JI-3: National, Transnational and European calls for RD&amp;I projects on the above given topics.</p>		
<p><b>Impact of the RD&amp;I Activities:</b></p> <ul style="list-style-type: none"> <li>• Scenarios identification related to storage penetration;</li> <li>• An exhaustive analysis of possible services obtainable with storage technologies, inclusive of the most effective and profitable combinations among services;</li> <li>• Provision of ancillary services to the grid;</li> <li>• Demonstration of commercial viability of new combinations of storage technologies and business models;</li> <li>• Identification of some key-factors that would determine a broader penetration of storage in electrical systems;</li> <li>• Better understanding of potential of various storage technologies based on long-term viability;</li> <li>• Aging models definitions for several technologies according to the operating conditions and required regulation services.</li> <li>• Definition of communication tools, platforms and devices for increased observability/controllability of the resources and measurement acquisition.</li> <li>• Virtual storage implementation: technological and regulatory conditions.</li> <li>• Impact of the cloud-storage model on power system management.</li> <li>• Reduced demand for network enforcement</li> <li>• New opportunities for extended installation of RES on subordinate network levels</li> <li>• Definitions of specific regulatory frameworks that would enhance storage distribution.</li> <li>• Priority rules for the defined possible services which can be offered by storage technologies</li> <li>• Clear pricing signals on which storage owners can react during operation</li> </ul>		
<p><b>TRL:</b> 4-8</p>		
<p><b>Expected deliverables</b></p>		<p><b>Timeline</b></p>
<p>See Impacts above, of which concrete deliverables include:</p> <ul style="list-style-type: none"> <li>• Scenarios identification related to storage penetration.</li> <li>• An exhaustive analysis of possible services obtainable with storage technologies, inclusive of the most effective and profitable combinations among services.</li> <li>• Aging models definitions for several technologies according to the operating conditions and required regulation services.</li> <li>• Identification of some key-factors that would determine a broader penetration of storage in electrical systems.</li> <li>• Definition of communication tools, platforms and devices for increased observability/controllability of the resources and measurement acquisition.</li> <li>• Definitions of specific regulatory frameworks that would enhance storage distribution.</li> <li>• Demonstrations in an operational environment.</li> </ul>		<p>2017-2023</p>
<p><b>Parties / Partners</b> (countries / stakeholders / EU)</p>	<p><b>Implementation financing / funding instruments</b></p>	<p><b>Indicative financing contribution</b></p>
<p><b>Ongoing R&amp;I Activities (Flagship activities or not): relevant to this new activity proposal</b></p>		
<p>Enel TGx-Enel BD Project. Location: Italy/Spain - ENEL Produzione. Start date: early 2018</p>	<p>Identification and assessment of innovative technologies in thermal storage field to increase efficiency and flexibility of power plants. Evaluation of potential use cases suitable for thermal storage systems. Feasibility study of thermal storage system capabilities to increase efficiency and flexibility of generation assets. Pilot phase to assess technical capabilities and integration strategies. Scouting and assessment of innovative technologies in thermal storage fields (i.e. thermal storage using concrete, molten salts, etc). Type of Activity: Pilot Projects (Projects focusing on a specific technology and involving a feasibility study and a phase of implementation and testing. Present funding source: internal to ENEL.</p>	

A4-IA1.4-2 Advanced energy storage technologies for energy and power applications

**Implementation Plan – Activity Fiche**



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<p><b>Innovation Target:</b> Reduce the cost of all energy storage solutions contributing to the minimisation of the overall system costs</p>
<p><b>Innovation Activity Number:</b> A4-IA1.4-2</p>
<p><b>Title:</b> Advanced energy storage technologies for energy and power applications</p>
<p>References to ETIP SNET Implementation plan 2017-2020: TOPIC 31 - Functional objects addressed:D5, T10</p>
<p><b>Targets:</b></p> <p>The energy transition will have a tremendous impact on balancing electricity supply and demand in the future, rising also concerns on the stability and reliability of the system. The increase on the supply side of intermittent renewable energy sources, like wind and solar will result in larger needs of intraday, intraweek and seasonal modulations. Network operators will need different grid balancing services to guarantee real-time balancing of generation and demand and different technologies of storage will be crucial to support system stability. Energy storage technologies for energy and power applications, such as balancing, seem to be still far from meeting technical and economic targets. For example, while current available storage technology are proving their effectiveness in fast balancing services, there is still a strong need to optimise and demonstrate storage technologies able to cover the intraweek and seasonal modulation needs. Moreover the total cost of storage systems, including all the subsystem components, installation, and integration costs need to be competitive with other non-storage options available to electric utilities. The principal challenges to focus on are:</p> <ul style="list-style-type: none"> <li>• Identify use cases of storage in the various services it may provide to the grid, individually and in multiple or “stacked” services, where a single storage system has the potential to capture several revenue streams to achieve economic viability.</li> <li>• Cost competitive energy storage technology: Achievement of this goal requires attention to factors such as life-cycle cost and performance (round-trip efficiency, energy density, life cycle, degradation, etc.) for energy storage technology as deployed. Long-term success requires both cost reduction and the capacity to realise revenue for all grid services that storage provides.</li> <li>• Validated reliability and safety: Validation of the safety, reliability, and performance of energy storage is essential for user confidence.</li> <li>• Equitable regulatory environment: Value propositions for long-term grid storage depend on reducing institutional and regulatory hurdles to levels comparable with those of other grid resources.</li> </ul>
<p><b>Description of RD&amp;I or Programming Activities:</b></p> <p>The following R&amp;I activities should be addressed:</p> <ul style="list-style-type: none"> <li>• Materials and systems engineering research to resolve key technology cost and performance challenges of known and emerging storage technologies (including manufacturing). In particular, proposals should aim at new storage technologies with a significant improvement in the reduction of capital cost, increasing system efficiency and extension of cycle life over the state-of-art performance;</li> <li>• Validation of the safety, reliability, and performance through programs focused on degradation and failure mechanisms and their mitigation, and accelerated life testing;</li> <li>• Collaborative field trials and demonstrations enabling accumulation of experience and evaluation of performance – especially for enhanced grid resilience. Proposers could address this topic following a 3-step approach             <ul style="list-style-type: none"> <li>▪ grid operators propose a real-life scenario for an energy storage solution.</li> <li>▪ R&amp;D institutes and industry develop the energy storage solution.</li> <li>▪ The whole "consortium" tests and evaluates the technological viability and reliability from a technical and economical point of view.</li> </ul> </li> </ul>
<p><b>Joint Activities:</b></p> <p>J1-1: Align national, transnational and international RD&amp;I programmes</p> <ul style="list-style-type: none"> <li>• Align national R&amp;I programs to include the above activities.</li> <li>• Align the programs of participating national research institutes to include the above RD&amp;I activities, in</li> </ul>



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<p>coordination with the ETIP SNET and its working groups and the joint research programming of the EERA.</p> <ul style="list-style-type: none"> <li>Promote the inclusion of the above RD&amp;I activities into the joint programming of the EERA.</li> <li>Coordination of research plans with international organisations and initiatives such as the IEA (and its TCPs), IRENA, Mission Innovation, WEF etc...</li> </ul>				
<p>JI-2: Share results and best practices</p> <ul style="list-style-type: none"> <li>Share results on a knowledge sharing platform (e.g. expera, operated by ERA-Net Smart Grids Plus).</li> <li>Leveraging the experience of BRIDGE, organise workshops to share best practices and lessons learned from the practical experiences, including success and failure cases, also in a perspective of scalability and replicability, addressing the issues of technical and non-technical barriers to facilitate the adoption of best practices at European level.</li> <li>Organise exchanges with international organisations and initiatives such as the IEA (and its TCPs), IRENA, Mission Innovation, WEF etc. to share results and best practices.</li> </ul>				
<p>JI-3: National, Transnational and European calls for RD&amp;I projects on the above given topics.</p>				
<p><b>Impact of the RD&amp;I Activities:</b></p> <ul style="list-style-type: none"> <li>Energy storage should be a broadly deployable asset for decarbonising the European economy and the energy transition.</li> <li>Long-term energy storage should be available to industry and regulators as an effective option to resolve issues of grid resilience and reliability.</li> <li>Demonstrations in an operational environment.</li> </ul>				
<p><b>TRL:</b></p>				
<p><b>Expected deliverables</b></p>			<p><b>Timeline</b></p>	
<p><b>Parties / Partners</b> (countries / stakeholders / EU)</p>			<p><b>Implementation financing / funding instruments</b></p>	<p><b>Indicative financing contribution</b></p>
<ul style="list-style-type: none"> <li></li> <li></li> </ul>				
<p><b>Ongoing R&amp;I Activities (Flagship activities or not): relevant to this new activity proposal</b></p>				
<p><b>Name</b></p>	<p><b>Description</b></p>	<p><b>Timeline</b></p>	<p><b>Location/Party</b></p>	<p><b>Budget</b></p>
<p>SELF</p>	<p>Main targets: Evaluate second life batteries competitive landscape, Identify and assess applications suitable for a storage system based on second life batteries, Demonstration of second life batteries capabilities to support both Italian Island and Canary Islands thermal generation assets, providing flexibility to the grid and avoiding load shedding events. Expected deliverables: Assessment of second life batteries characteristics, market opportunities and trends, Identification of optimal application and related business model for second life batteries integrated in thermal power plants. Type of Activity: Pilot Project. TRL: from 6 to 8. Expected starting date: early 2018; location Italy and Spain. Budget: self financed project</p>			
<p><b>Gaps:</b></p>				



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### 7.1.3 Flagship Initiative 2 - "Integrated local and regional energy systems"

#### A4-T2.1-1: Low temperatures for the efficient integration of different sources

##### A4-IA2.1-1 Reduction of return temperatures in current DH networks

Implementation Plan – Activity Fiche
<p><b>Innovation Target:</b> Low temperatures for the efficient integration of different sources</p>
<p><b>Innovation Activity Number:</b> A4-IA2.1-1</p>
<p><b>Title:</b> Reduction of return temperatures in current DH networks</p>
<p><b>Targets:</b></p> <p>DH Networks traditionally operate with high supply temperatures in order to reduce the investment costs by reaching the required transport capacity with small pipe diameters and using cost effective customer installations. The integration of renewables and waste heat sources into existing DHC networks can contribute to the decrease of emissions in the building sector on a major basis. This integration however, requires an adaptation of the temperatures in the DH networks aiming at lowering the return temperature (&gt;5°C). Whereas new networks can be designed for the temperature level of the local available heat source a priori (see Activity number: A4-IA2.1-2), existing networks require major adaptations. To achieve this, networks need to become more efficient on the primary side (&gt;10%). At the same time, many of the needed measures apply to the building (i.e. secondary) side to ensure that the return temperatures on that side are decreased accordingly and that the efficiency of the connecting systems is increased (&gt;10%). Therefore, business models generating appropriate incentives for all involved stakeholders, especially building owners and final consumers are key to the deployment of the developed technologies. The activities to reach these targets should involve RTOs, engineering offices, network operators while considering the role of customers and consumers.</p>
<p><b>Description of RD&amp;I or Programming Activities:</b></p> <ul style="list-style-type: none"> <li>• Develop and implement measures for reducing the return temperatures of existing 1st, 2nd or 3rd generation DH networks by at least 5°C in a cost-effective and sustainable manner.</li> <li>• Increase the efficiency of substations and optimise building side installations for DH networks while also focus on the development of new hardware and software to reduce the return temperatures in the in-house installation especially for houses equipped with classical heat distribution systems (radiators and convector systems).</li> <li>• Develop suitable business models generating win-win situations for all related stakeholders, especially the building owner and the final consumer.</li> <li>• Develop suitable models for the integration of heat pumps on different levels of the DH network enabling to decrease the local or global temperatures on a central or decentral location.</li> <li>• Further development and adaptation of fault detection technologies and solutions in different case studies in a larger scale and context.</li> </ul>
<p><b>Joint Activities:</b></p> <ul style="list-style-type: none"> <li>• Promote the diffusion and acceptance of existing standardisation schemes / quality labels of substations and other building side equipment.</li> <li>• Initiatives to share results and best practices for business models.</li> <li>• ERA-Net joint calls, like under RegSys ERA-Net, for developing fault detection technologies and methodologies             <ul style="list-style-type: none"> <li>• developing suitable models for the integration of heat pumps</li> </ul> </li> </ul>
<p><b>Impact of the RD&amp;I Activities:</b></p>



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<ul style="list-style-type: none"> <li>• Large scale demonstration of the technical feasibility and economic competitiveness of low temperature grids combining the above described aspects.</li> <li>• Large scale demonstration of above described non-technical characteristic (end user participation, integration of heat prosumers, new business models).</li> <li>• Showcases for fault detection, diagnosis and correction method in DH networks and HVAC systems.</li> <li>• Demonstrated new hardware and software reducing the return temperature of the in-house heating circuits as a basis for the reduction of the return temperature in the DH network.</li> <li>• Demonstration of compact thermal energy storage with energy management for in-house application to increase the flexibility of the DH networks and to reduce peak heat demand resulting in lower return temperatures in DH networks.</li> <li>• Demonstration of flexible and efficient heat pumps aiming to cope with variable (renewable and waste) heat sources.</li> <li>• Demonstration of small scale flexible heat pumps for low temperature DH networks equipped with smart inverters to deliver services to the DH and the electricity grid.</li> </ul>				
<b>TRL:</b>				
<b>Expected deliverables</b>			<b>Timeline</b>	
			2020-2025	
<b>Parties / Partners</b> (countries / stakeholders / EU)		<b>Implementation financing / funding instruments</b>		<b>Indicative financing contribution</b>
•				
•				
<b>Ongoing R&amp;I Activities (Flagship activities or not): relevant to this new activity proposal</b>				
<b>Name</b>	<b>Description</b>	<b>Timeline</b>	<b>Location/Party</b>	<b>Budget</b>
<b>Gaps:</b>				



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#### A4-IA2.1-2 Optimised low temperature and highly flexible (micro) DHC networks

Implementation Plan – Activity Fiche
<p><b>Innovation Target:</b> Low temperatures for the efficient integration of different sources</p>
<p><b>Innovation Activity Number:</b> A4-IA2.1-2</p>
<p><b>Title:</b> Optimised low temperature and highly flexible (micro) DHC networks</p>
<p><b>Targets:</b></p> <p>Many areas have ambitious goals for the reduction of CO<sub>2</sub> emissions and the use of local resources. Depending on the location of the area (country/city, underground condition, nearby industries or sewage water ducts, available areas for solar energy, local renewable biomass, etc.) different sources for heating and cooling are locally available and can be utilised. The efficient exploitation of locally available resources requires the design of efficient DHC networks (&gt;10% reduction of heat losses compared to standard grids). A high level of utilisation of these sources (&gt;80%) contributes to the areas climate goals on a major basis. At the same time, unconventional resources such as surplus heat from industry or natural cooling but also the inclusion of RES often requires more flexible concepts, lower temperatures and/or large storage capacities. Besides the network related actions that are needed, the use of more standardised efficient and cost-effective construction materials and components plays an important role (specific numerical target to be added if possible). Measures to achieve these targets need to consider the economic viability and supply security as key aspects.</p>
<p><b>Description of RD&amp;I or Programming Activities:</b></p> <ul style="list-style-type: none"> <li>• Develop, test, implement and standardise innovative and flexible concepts for small and micro heating and cooling networks that can be tailored to the local situation and exploit locally available and renewable or residual heat and cold sources best. Such networks typically have low (e.g. 35-50°C) or very low (e.g. 10-30°C) supply temperatures, are integrated within the overall energy system and offer high short and long-term flexibility.</li> <li>• Develop design solutions considering central or decentralised heat pumps and the integration of cooling options and storages to improve the utilisation of local solutions for heating and cooling services on various temperature levels, e.g. heating, DHW, cooling.</li> <li>• Optimise the interaction with existing DHC networks (if existing) for bi-directional transport of energy. Therefore, develop and demonstrate integrated energy concepts, with special attention for the use of local electricity generation and/or power-to-heat solutions.</li> <li>• Develop sophisticated planning and design tools as well as costs effective and flexible components, effective control mechanisms and controls/ energy management strategies. Due to the individual nature of such systems, they normally have a high specific planning efforts and investment costs (also due to the missing scale of economics). Therefor these tools, solutions and components are required.</li> <li>• Develop, test and define standards for small heating/cooling networks, able to metabolise the main equipment with a minimum impact in the urban context. They should have the ability for interconnection between them to be able to follow demand reducing distribution losses.</li> </ul>
<p><b>Joint Activities:</b></p> <ul style="list-style-type: none"> <li>• Best practice sharing on international cases for similar networks, analyses barriers and opportunities.</li> <li>• ERA-Net joint calls for further developing planning and design tools, components and control mechanisms / energy management strategies.</li> </ul>
<p><b>Impact of the RD&amp;I Activities:</b></p> <ul style="list-style-type: none"> <li>• 5 large scale demonstration projects realised demonstrating 30 % efficiency improvement compared to state-of-the-art thermal grids and &gt;80 % RES or industrial surplus heat.</li> <li>• Development and demonstration of new hardware and software to reduce the return temperature of the in-house heating circuits as a basis for the reduction of the return temperature in the DHN.</li> </ul>



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<ul style="list-style-type: none"> <li>• Development and demonstration of compact thermal energy storage with energy management for in-house application to increase the flexibility of the DHN and to reduce peak heat demand resulting in lower return temperatures in DHN.</li> <li>• Development and demonstration of flexible and efficient heat pumps aiming to copy with variable (renewable and waste) heat sources.</li> <li>• Development and demonstration of small scale flexible heat pumps for low temperature DHN equipped with smart inverters to deliver services to the DHN and the electricity grid.</li> </ul>				
TRL: 4-6 (2020)   7-9 (2025)				
Expected deliverables			Timeline	
			2020 - 2025	
<b>Parties / Partners</b> (countries / stakeholders / EU)		<b>Implementation financing / funding instruments</b>		<b>Indicative financing contribution</b>
•				
•				
<b>Ongoing R&amp;I Activities (Flagship activities or not): relevant to this new activity proposal</b>				
<b>Name</b>	<b>Description</b>	<b>Timeline</b>	<b>Location/Party</b>	<b>Budget</b>
<b>Gaps:</b>				



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## A4-T2.1-2: Flexibility

### A4-IA2.1-3 Increasing the short-term flexibility of DH and DC networks and enabling its efficient utilisation

Implementation Plan – Activity Fiche
<p><b>Innovation Target:</b> Flexibility</p>
<p><b>Innovation Activity Number:</b> A4-IA2.1-3</p>
<p><b>Title:</b> Increasing the short-term flexibility of DH and DC networks and enabling its efficient utilisation</p>
<p><b>Targets:</b></p> <p>One characteristic of modern energy systems is a short-term mismatch (e.g. hours to days) between a variety of both, stable (e.g. geothermal, industrial waste heat, natural cooling) and intermittent (e.g. solar, wind) low carbon energy sources, as well as the availability of unused electricity or heat in the relevant networks, and the typical demand curves for heating and cooling. To increase the utilisation of these resources, the integration of different network based energy services (heating, cooling, and electricity) and therefore the flexibility of individual DHC networks the knowledge about complex supply-and-demand structures needs to be improved. At the same time, existing technologies that are already available as state-of-the-art solution (e.g. centralised and customer side storages, utilisation of the network as storage, customer side load shifting), need to be spread out more by show casing their impact on a network basis. Given that the last step towards fully sustainable DHC is often hampered by the need for fossil-based peak load technologies for heating and cooling, an increase in flexibility also aims at the reduction of expensive and fossil fuel peak technologies (reduction to 0% use of oil and gas heat only boilers). At the other end, it also needs to be ensured that the use of the output from coupled production processes (CHP, HP) can be decoupled by using storage technologies. Overall, the storage and flexibility functions need to be made available to the higher level system operators in an effective and reliable way, without endangering the security of supply and customer comfort outside the usual parameter. All the measures should also aim at improved system integration and cost-effectiveness.</p>
<p><b>Description of RD&amp;I or Programming Activities:</b></p> <ul style="list-style-type: none"> <li>• Development of new supply-and-demand forecast models supporting measures in order to increase the short-term flexibility (e.g. hours to days) of DHC networks including in their initial design or during densification and retrofitting.</li> <li>• Develop tools to control and exploit short-term flexibilities to allow for peak-shaving and the phase-out of fossil peak technologies.</li> <li>• Developing new technologies, services and business models and measures enabling the execution the flexibility of DHC networks in order to include it in the overall system management.</li> <li>• Develop new approaches for the use of cooling technologies and storage systems for improved short time flexibility.</li> <li>• Develop new solutions to decouple demand and production in multi-output systems such as CHP and HP.</li> <li>• Adapt supply profiles of e.g. solar thermal energy and power-to-heat optimised by the electricity market.</li> </ul>
<p><b>Joint Activities:</b></p> <ul style="list-style-type: none"> <li>• ERA-Net joint calls, like under RegSys ERA-Net, for further development and demonstration of advanced measures for increasing the short-term flexibility</li> </ul>
<p><b>Impact of the RD&amp;I Activities:</b></p> <ul style="list-style-type: none"> <li>• Development of methods to identify, evaluate and remunerate the flexibility in DHC systems.</li> <li>• Development of cost-effective and compact storage solutions for DHC networks.</li> <li>• Demonstration and implementation of control algorithms for the use of flexibility in DHC networks.</li> </ul>
<p><b>TRL:</b> 4-6 (2025)   7-9 (2030)</p>



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<b>Expected deliverables</b>		<b>Timeline</b>		
		2025-2030		
<b>Parties / Partners</b> (countries / stakeholders / EU)		<b>Implementation financing / funding instruments</b>		<b>Indicative financing contribution</b>
•				
•				
<b>Ongoing R&amp;I Activities (Flagship activities or not): relevant to this new activity proposal</b>				
<b>Name</b>	<b>Description</b>	<b>Timeline</b>	<b>Location/Party</b>	<b>Budget</b>
<b>Gaps:</b>				



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#### A4-IA2.1-4 Increasing the long-term flexibility of heating and cooling Systems

Implementation Plan – Activity Fiche	
<b>Innovation Target:</b> Flexibility	
<b>Innovation Activity Number:</b> A4-IA2.1-4	
<b>Title:</b> Increasing the long-term flexibility of Heating and Cooling Systems	
<p><b>Targets:</b></p> <p>Beside the short-term mismatch, a major barrier for integrating renewable and residual heat and cold sources in DHC networks is their seasonal mismatch to the demand profiles. The integration of seasonal (&gt;4 weeks), i.e. large-scale, storage systems in DHC systems is key to the increased counter-seasonal integration (&gt;20% of seasonal demand covered) of seasonal surplus heat resources such as solar thermal, geothermal, heat from thermal treatment of waste or industrial surplus heat and seasonal surplus cold sources such natural cooling, industrial surplus cold or cold from LNG terminals. Various available seasonal storage systems (e.g. aquifer, borehole, pit, tank storages, ice, slurry or water based systems) have mainly been implemented in smaller networks and building clusters so far due to various barriers. To increase the use of seasonal storage systems in DHC networks these barriers, i.e. required temperature levels, space requirements and high investment costs need to be overcome.</p>	
<p><b>Description of RD&amp;I or Programming Activities:</b></p> <ul style="list-style-type: none"> <li>• Develop and implement measures for increasing the long-term flexibility (e.g. weeks to month, also seasonal storages) of larger, urban DH network.</li> <li>• Further development, optimisation and demonstration of existing and new storage technologies and materials, including energy management, state of charge determination and heat pump integration. Design methods to optimise the dimensions of seasonal storage system taking into account the interaction with central and distributed short-term storage and any available market price signals.</li> <li>• Specifically, development, optimisation and demonstration of high-density large-scale cold storage systems and solutions for their efficient integration in DC grids.</li> <li>• Optimised planning, design and operation of the storage including the consideration of the different energy vectors, market price signals and multiple purposes for the storage and energy sources feeding onto the storage.</li> <li>• Assessment and management of the risks connected with the investment into the storage including long-term forecasting.</li> <li>• Develop suitable investment solutions for the realisation of seasonal storage projects.</li> </ul>	
<p><b>Joint Activities:</b></p> <ul style="list-style-type: none"> <li>• Initiatives to share results and best practices for long-term storages in urban DHC networks.</li> <li>• ERA-Net joint calls, like RegSys, for further technology development, optimised integration and risk management.</li> </ul>	
<p><b>Impact of the RD&amp;I Activities:</b></p> <ul style="list-style-type: none"> <li>• Maximise the economic utilisation of energy from different sources via the application of storages.</li> <li>• Large scale demonstration of the technical feasibility and economic competitiveness.</li> <li>• Development of methods to identify, evaluate and remunerate the flexibility in DHC systems.</li> <li>• Development of cost-effective and compact storage solutions for DHC networks.</li> <li>• Demonstration and implementation of control algorithms for the use of flexibility in DHC networks.</li> </ul>	
<b>TRL:</b> 4-6 (2025   7-9 (2030)	
<b>Expected deliverables</b>	<b>Timeline 2020-2030</b>



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## A4-T2.2-1: RES integration at regional and local levels, including different energy vectors

A4-IA2.2-1 Transnational joint programming platform on smart, integrated, regional energy systems

Implementation Plan – Activity Fiche
<p><b>Innovation Target:</b> RES integration at regional and local levels, including different energy vectors</p>
<p><b>Innovation Activity Number:</b> A4-IA2.2-1</p>
<p><b>Title:</b> Transnational joint programming platform on smart, integrated, regional energy systems</p>
<p><b>Targets:</b></p> <ul style="list-style-type: none"> <li>• Develop and demonstrate technologies, systems and solutions that make it possible to efficiently provide, host and utilise high shares of renewables, up to and beyond 100% in the local or regional supply by 2030. At the same time they shall link to a secure and resilient European energy system, enabling the participation in inter-regional exchange of energy as well as in sharing responsibility to maintain the overall system, considering a sustainable use of local and global resources.</li> <li>• Solutions should follow a holistic view on the energy system, linking different energy domains (electricity, heat/cold, gas, mobility) at different scales as well as system, market and organisational aspects, allowing for making optimal use of renewable energy sources and recovered energy</li> <li>• Develop methodologies, tools and technologies that enable local energy communities to operate multidimensional energy systems that are optimally integrating regional infrastructures and facilities (swimming pools, greenhouses, steel factory, etc.). These shall also enable local energy communities to actively contribute to the energy markets and overall system. Solutions have to consider the layers: technology (physical and digital), market and adoption in order to - increase efficiency above the established European target and - keep quality of supply on established levels</li> <li>• Create transregional and transnational synergies, providing the base for a critical mass of marketable solutions, the implementation of common standards and reference architectures as well as a linking to European innovation initiatives of the SET-Plan.</li> </ul>
<p><b>Monitoring</b></p> <ul style="list-style-type: none"> <li>• Formative evaluation with projects;</li> <li>• Progress monitoring and periodic scoping for formulation of calls.</li> </ul>
<p><b>Description of RD&amp;I or Programming Activities:</b></p> <p>Organise a joint programming platform that performs a series of targeted joint calls for transnational projects, including accompanying activities.</p> <p>Call Challenge: Smart, integrated, regional energy systems. Projects shall develop and demonstrate technologies, systems and solutions that make it possible to efficiently provide, host and utilise high shares of renewables, up to and beyond 100% in the local or regional supply by 2030. At the same time they shall link to a secure and resilient European energy system, enabling the participation in inter-regional exchange of energy as well as in sharing responsibility to maintain the overall system, considering a sustainable use of local and global resources.</p> <p>Projects shall:</p> <ul style="list-style-type: none"> <li>• Identify the critical needs and involve the most significant need-owners in local and regional energy systems.</li> <li>• involve technology and service providers, innovators and researchers to develop and define tailor-made solutions for local and regional energy systems that meet the demand of the need owners.</li> <li>• Engage private and public stakeholders in co-creation eco-systems that accelerate the innovation and implementation of new solutions, while stimulating European business</li> </ul>



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- development with the support of the transnational ERA-Net SG+ knowledge community.
- Funded projects could well deal with energy systems for regions below the size of a NUTS 2 region (which is 800.000 inhabitants and more). It could be the case that a smaller political and planning entity (starting from 150.000 inhabitants. i.e. NUTS 1) will better fit the needs when developing a regional energy system. Especially in rural contexts, smaller regions often allow for better involving the right stakeholders and creating the necessary buy-in.

### Joint Activities:

#### Jl 1: Sustainable and efficient collaboration platform for joint programming

- Setup a joint programming initiative of ambitious national and regional RDD funding programmes from European and associated countries in order to develop, demonstrate and validate integrated local and regional energy systems with a cross sectoral holistic approach. Expand the existing ERA-Net Smart Grids Plus with new partners and by piloting new ambitious formats and stimulate their uptake in the whole consortium of 21 European countries and regions.

#### Jl 2: Joint calls

- Organise a first joint call for proposals in 2018, coordinating national and regional RDD budgets of 26 Mio EUR to finance transnational projects. Organise at least one additional joint call until 2023.

#### Jl 3: Associated Partner Network

- Initiate co-creation processes on a programme level together with associated partners from the regional and local innovation and business communities in order to align the R&I knowledge relating to technology and system aspects with new innovation approaches from start-ups and local and regional stakeholders in societal and business domains. Link investors, funders and start-up networks and cooperate with data-, software- and service- platform solution providers (incl. block chain)

#### Jl 4: knowledge community

- Organise a knowledge community together with experts from the resulting transnational projects and the regions in order to share best practise, develop planning tools and governance guidance increasing confidence to demonstrate and exploit new solutions and business opportunities. Build on existing structures like the ERA-Net Smart Grids plus knowledge community and the digital expera platform.

#### Further collaboration ideas

- Accompanying action on mapping local challenges and needs
- Accompanying action: Studies and discussion channels for common denominators among countries

### Impact of the RD&I Activities:

- 10-15 transnational RDD projects of differing scale resulting from the EC co-funded joint call involving national, regional and local actors from various domains (e.g. power, heat, agriculture, mobility) and spanning the development, piloting and demonstration phases as well as the actual implementation of innovative solutions. Additional projects will result from an additional joint call.
- Practice oriented solutions within all projects shall address the three layer research model (technology, market and adoption) as well as the 3 Dimensions of Integration (cross sectoral, regional development, smart energy system) and involvement of a significant number of SMEs, crafts and start-ups with a minimum of one in each project.
- Institutionalised cooperation between 100 actors on different governance levels in pioneer regions across Europe, which have delivered successful and highly ambitious pilots resulting in minimum of 10 well described and demonstrated innovative business processes providing services for utilities, enterprises, prosumers and end users.

### TRL:

TRL 3-6: in explicitly identified areas in order to develop concepts and technologies for solutions with a potential to become best practice by 2030.

TRL 6-7: prepare or implement demonstration projects (TRL 6-7); projects shall expand on results from and connect to ongoing or recently finished demonstration projects (utilise test infrastructure, utilise knowledge, cooperation of key demos, transfer of results, opening-up, etc.) New greenfield demos however are also intended, but must be complementary (no duplication). Projects should develop new solutions with the potential to become best practice by 2025.



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TRL 8-9: RDD projects should show potential for follow-up projects with market uptake measures that could be supported by associated partners, that can provide appropriate financing or funding schemes				
<b>Expected deliverables</b>		<b>Timeline</b>		
		JPI-1: 2018-2023 (and beyond) JPI-2: 2018, 2020 (to be continued) JPI-3: 2018-2023 (and beyond) JPI-4: 2018-2023 (and beyond)		
<b>Parties / Partners</b> (countries / stakeholders / EU)		<b>Implementation financing / funding instruments</b>		<b>Indicative financing contribution</b>
•				
•				
<b>Ongoing R&amp;I Activities (Flagship activities or not): relevant to this new activity proposal</b>				
<b>Name</b>	<b>Description</b>	<b>Timeline</b>	<b>Location/Party</b>	<b>Budget</b>
ERA-Net co-fund action "SG+ RegSys - A European joint programming initiative to develop integrated, regional, smart energy systems enabling regions and local communities to realise their high sustainable energy ambitions"				
<b>Gaps:</b>				



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#### A4-IA2.2-2 Creating and linking living labs for integrated regional and local energy systems

Implementation Plan – Activity Fiche
<p><b>Innovation Target:</b> RES integration at regional and local levels, including different energy vectors</p>
<p><b>Innovation Activity Number:</b> A4-IA2.2-2</p>
<p><b>Title:</b> Creating and linking living labs for integrated regional and local energy systems</p>
<p><b>Targets:</b></p> <ul style="list-style-type: none"> <li>• Sustainable local energy systems with high share of renewable energies, high efficiency, sector coupling, use of storage, demand-side-management, and smart energy management systems are complex systems. They require solutions adapted to the specific requirements of the local actors (consumer, prosumer, distributors, planners, other stakeholders). Due to the high complexity, an optimal design could probably not be developed theoretically by models and planning tools: achieving a good local solution with high acceptance by all stakeholders requires a strong interaction between technology providers, planners, investors and users. Living labs provide the framework to develop together and with the input of all stakeholders an optimised solution for local energy systems. In this action, the concept of living labs for the development of decentralised local and regional sustainable energy systems will be developed. 10 European living labs sound be implemented and evaluated. Regular interactions and discussions between these living labs will be forecast.</li> <li>• The implementation of sustainable energy system on district, local, and regional level requires the leadership of the government and administration of these entities, as well as an active contribution of all stakeholders (local utilities, building owners, industry, consumer, planners, craftsmen,...) to successfully implement these systems (e.g. by investments in building refurbishment, DH networks, energy efficient equipment, use of EVs,...). Regulators will be regularly consulted during these living labs.</li> <li>• Smart City projects address a wide range of aspects related activities in cities like ICT, energy, mobility, services, etc. Living labs could focus on a limited scope requiring important investments and/or scaling to bring innovative solutions from TRL4 (proof of concept) to TRL7 (Open Water Validation). In this way Laboratory and Test Facility validation is skipped; but most demonstrations related to innovative energy solutions show that the end user behaviour and interaction is at least of the same importance than the technical aspects. Laboratories suitable for testing with hundreds of nodes are very rare. A living lab could be a variation of a Test Facility but then not with all external parameters under control, but completely exposed to external factors that could impact real life performance.</li> <li>• Thus, a living lab should represent real life operating conditions, failures, behaviour and misuse of the solution in order to detect next to the intended impact also the weaknesses, learnings and opportunities for improvement.</li> </ul> <p>Following should be part of living lab research:</p> <ul style="list-style-type: none"> <li>• Investigating competing use cases that are interesting for different stakeholders (government, end user, grid operator, commercial companies) and decide on a test plan that includes a consensus or includes some competing use cases.</li> <li>• Consulting Covenant of Mayors and sharing ideas, programs and progresses.</li> <li>• Defining possible value chains and the required interactions, technology, technology integration, incentives/tariff structures and corresponding regulation.</li> <li>• Allow competing companies to integrate their solutions in parallel in order to represent a free market operation as close as possible.</li> <li>• Implement experiment legislation in order to support the required behavioural changes and allow the innovative value chains.</li> </ul>
<p><b>Description of RD&amp;I or Programming Activities:</b></p> <ul style="list-style-type: none"> <li>• Create and link living labs.</li> <li>• Accompanying measures to stimulate innovation procurement.</li> </ul>



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<ul style="list-style-type: none"> <li>• Develop a concept, how living labs for the optimisation of local/regional sustainable energy systems should be designed and implemented.</li> <li>• Support the implementation of X living labs in Europe implementing and testing the developed concept.</li> <li>• Build up a network of living labs for local/regional energy systems to exchange concepts and experiences, develop KPIs and evaluate results.</li> <li>• Development of methods to organise, manage and support living labs for local/regional energy system development.</li> <li>• Offer funding solutions for living labs (high investment + high risk, high complexity, work load).</li> </ul>				
<b>Joint Activities:</b>				
<ul style="list-style-type: none"> <li>• JIP1: Develop methods to design and operate living labs (What is necessary to design a living lab, integrating social science, economy also. and to integrate this to the existing research environment).</li> <li>• JIP2: Concrete living labs to be supported by a Joint Call (enable to compare projects and different environments).</li> </ul>				
<b>Impact of the RD&amp;I Activities:</b>				
<ul style="list-style-type: none"> <li>• Speed up product development (commercial companies), end user awareness (media), experiment legislation (government, regulator) in order to lower time to market</li> <li>• Methods and tools to design, plan and implement sustainable local/regional energy systems with active participation of all relevant stakeholders</li> </ul>				
TRL: 7 or 8				
<b>Expected deliverables</b>			<b>Timeline</b>	
			2018-2023	
<b>Parties / Partners</b> (countries / stakeholders / EU)		<b>Implementation financing / funding instruments</b>		<b>Indicative financing contribution</b>
•				
•				
<b>Ongoing R&amp;I Activities (Flagship activities or not): relevant to this new activity proposal</b>				
<b>Name</b>	<b>Description</b>	<b>Timeline</b>	<b>Location/Party</b>	<b>Budget</b>
			Germany	
City LAB Graz			Austria	
Living Lab Schwechat			Austria	
Energy Ville			Belgium	
<b>Gaps:</b>				



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### A4-IA2.2-3 Cross-linking of large-scale demonstration projects and respective programs

Implementation Plan – Activity Fiche
<p><b>Innovation Target:</b> RES integration at regional and local levels, including different energy vectors</p>
<p><b>Innovation Activity Number:</b> A4-IA2.2-3</p>
<p><b>Title:</b> Cross-linking of large-scale demonstration projects and respective programs</p>
<p><b>Targets:</b></p> <ul style="list-style-type: none"> <li>• Innovative technologies, market mechanisms and efficient work processes for integrated regional energy systems based on previous experience.</li> <li>• Efficient and coordinated funding programs and demonstration projects with respect to management and results.</li> <li>• Recommendations for harmonised legislative and regulatory frameworks.</li> </ul>
<p><b>Description of RD&amp;I or Programming Activities:</b></p> <p>Throughout Europe, there exist several national large-scale research and innovation projects with the goal to develop and demonstrate model solutions for a safe, efficient and environmentally compatible energy supply with high shares of renewable energy sources. Though the focus of the projects differs, they all design and test innovative technologies, new market mechanisms and work processes fit for those future markets, with a heavy emphasis on the demonstration of the individual and combined use of those solutions in the framework of integrated regional energy systems.</p> <ul style="list-style-type: none"> <li>• Exchange on "lessons learned" concerning the management and implementation of research and demonstration projects with a high number of partners.</li> <li>• Information exchange between several demonstration projects on the experiences with different technologies, market designs and work processes.</li> <li>• Information exchange about national legislation and regulatory frameworks and joint development of "best practice" cases.</li> <li>• Joint international RD&amp;I projects building on the results of the existing large-scale demonstration projects.</li> </ul>
<p><b>Joint Activities:</b></p> <p>JI-1: Facilitation of Joint Networking Meetings and Topical Workshops (focusing on RD&amp;I activities 1, 2 &amp; 3) Joint meetings and workshops between several demonstration projects shall be facilitated by a stronger coordination of financial and personnel resources among the different demonstration projects and/or the accompanying national actions. This will be achieved through a strong transnational collaboration between the different involved ministries and/or the involved national funding agencies, leveraging on existing structures and resources (e.g. program managements).</p> <p>JI-2: Initiation of Joint International RD&amp;I Projects (focusing on RD&amp;I activity 4) Extensive information on funding possibilities for transnational RD&amp;I projects shall be provided to each involved demonstration project. This includes, but is not limited to, the existing ERA-Net programs SG+ and REGSYS. If necessary, a match-making process between partners of the different demonstration projects and possibly external stakeholder shall be provided.</p>
<p><b>Impact of the RD&amp;I Activities:</b></p> <ul style="list-style-type: none"> <li>• Joint Activities of program managements and demo projects</li> <li>• Technological and regulatory recommendations toward the national governments</li> <li>• European business partnerships and new transnational research projects</li> </ul>
<p><b>TRL:</b> 2018-2022</p>



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<b>Total budget required:</b>				
Costs for the organisation of at least one meeting or workshop per participating countries				
<b>Expected deliverables</b>			<b>Timeline</b>	
			JI-1: 2018-2022	
			JI-2: 2018-2022	
<b>Parties / Partners</b> (countries / stakeholders / EU)		<b>Implementation financing / funding instruments</b>		<b>Indicative financing contribution</b>
•				
•				
<b>Ongoing R&amp;I Activities (Flagship activities or not): relevant to this new activity proposal</b>				
<b>Name</b>	<b>Description</b>	<b>Timeline</b>	<b>Location/Party</b>	<b>Budget</b>
<b>SINTEG - Smart Energy Showcases - Digital Agenda for the Energy Transition</b>	The five SINTEG projects "C/sells", "Designetz", "enera", "New4.0" and "WindNODE" aim to develop and demonstrate in large model regions exemplary solutions for a climate-friendly, secure and efficient energy supply with high proportions of intermittent power generation on the basis of wind and solar energy. The projects focus on smart grids which should help to ensure stability and improve the interplay of power generation, consumption, storage and grids by means of modern information and communication technologies. The projects thus address key challenges of the energy transition including the integration of renewables into the system, flexibility, security of supply, system stability, energy industry efficiency and the establishment of smart energy and systems and market structures.		<b>Germany</b>	<b>More than 200 Mio. €</b>
<b>Vorzeigeregion Energie</b>	Vorzeigeregion Energie develops and demonstrates sample solutions using innovative energy technologies to provide smart, secure and affordable energy and mobility systems for the future. The program is focussing on an efficient interaction of generation, consumption, system management and storage in a system temporarily running on 100% renewables that is optimized for all market participants.		<b>Austria</b>	<b>20-40 Mio€</b>
			<b>Sweden</b>	
			<b>Denmark</b>	
<b>Gaps:</b>				



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#### A4-IA2.2-4 Optimised planning, managing and monitoring of integrated regional energy systems

Implementation Plan – Activity Fiche
<p><b>Innovation Target:</b> RES integration at regional and local levels, including different energy vectors</p>
<p><b>Innovation Activity Number:</b> A4-IA2.2.-4</p>
<p><b>Title:</b> Optimised planning, managing and monitoring of integrated regional energy systems</p>
<p><b>Targets:</b></p> <ul style="list-style-type: none"> <li>• Development of guidelines, methods and tools on collection, processing and storage of energy data in districts, cities and regions to enable optimised planning, implementation, and monitoring of sustainable regional energy systems.</li> <li>• Development of modelling tools to calculate regional energy systems with optimised renewable energy mix taking into account sector coupling and the high dynamic of future energy systems.</li> <li>• Development of innovative algorithms and tools for optimised management of regional energy systems with mixed solutions taking into account sector coupling, weather and demand forecasting, market frameworks, prosumer interest and new business models (e.g. blockchain based energy trading) with the goal to maximise consumption of local generated renewable energy, minimise the energy cost for consumer and provide flexibility services to the energy network outside the region.</li> <li>• Development of methods and tools to monitor regional energy systems and their transformation regularly using automatically provided energy data, which will become available in the framework of the increasing digitalisation.</li> </ul>
<p><b>Description of RD&amp;I or Programming Activities:</b></p> <p>This activity aims at applying and combining the advances of recent years in data sciences, modelling and simulation, and puts a thematic focus on supporting data- and model-driven optimisation of planning, operation and monitoring of regional energy systems. In this context, the close functional link of data collection, data processing, model-based data analysis, innovative modelling solutions and monitoring based on automatically collected energy data is a key element to handle the complexity of future integrated energy systems. In addition, new energy system management algorithms will be developed to handle the growing complexity of renewable energy driven energy systems with increased storage capacity, sector coupling (electricity, heating, cooling, and mobility), growing number of prosumers, and new business models optimised by using agent-based models and new trading solutions.</p> <p>A good example is the forecasting of the flexibility that a pool of heat pumps can provide to an electrical system. This requires the analysis of thermal data that can be used to calibrate demand models, which in turn may be used for a flexibility assessment for the electrical domain (maybe including further data and models related to pricing).</p> <p>To this end, the following challenges have to be addressed:</p> <ul style="list-style-type: none"> <li>• Make use of increasing availability of data: To enable a holistic planning, management and monitoring of complex regional energy systems, a broad range of different data has to be gathered, stored and processed. Due to increasing digitalisation and implementation of IoT (Internet of Things), the availability of energy data is rapidly increasing. The challenge is to develop and adopt methods to select the relevant data (e.g. in relation to spatial/temporal resolution and domains) and to transfer, process and analyse the data (e.g. by using big data methods). Furthermore, best practices regarding data accessibility have to be adopted, in order to guarantee (open) data access to a broad community of stakeholders, while addressing at the same time legal issues (e.g. data ownership, security, privacy, and level of aggregation).</li> <li>• Make use of innovative modelling approaches: The holistic optimisation of the design and the operation of regional energy systems, which are characterised by growing fluctuations of energy generation, increasing sector coupling and integration of storage and decentral generation (prosumer), requires improved modelling tools with high temporal resolution, taking into account the coupling of all sectors and components. In addition, new business models and changing market frameworks require flexible and high performing models and algorithms to manage regional energy systems optimally. Strong progress in ICT</li> </ul>



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technology allows developing such modelling and energy management tools.				
<b>Joint Activities:</b>				
JI-1: Practical Implementation (Research and local operators of heating and electrical systems) - Evaluation of energy management systems				
JI-2: Evaluate opportunities to integrate ICT systems and digitalisation for the improvement of local systems (Mainly driven by research sector and public bodies and associations of heating systems)...including cybersecurity and data privacy.				
<b>Impact of the RD&amp;I Activities:</b>				
<ul style="list-style-type: none"> <li>• Concepts and tools for automatic collection, processing and analysing of data relevant for optimised operation and monitoring of regional energy systems.</li> <li>• Modelling tools to design optimised regional energy systems with mix solutions.</li> <li>• Monitoring guideline and tools to monitor the progress in the transformation of regional energy systems towards sustainability.</li> <li>•</li> </ul>				
The optimised planning and management of integrated regional energy systems will increase the reliability of energy supply though using a high share of solar and wind energy, allow the optimal integration of decentral renewable energy generation (prosumer), maximise the local consumption of locally generated renewable energy, and minimise energy cost for the consumer by using the increasing availability of energy data due to IoT and digitalisation.				
TRL: 4-8				
<b>Expected deliverables</b>			<b>Timeline</b>	
			JPI-1: 2018-2022 JPI-2: 2018-2022	
<b>Parties / Partners</b> (countries / stakeholders / EU)		<b>Implementation financing / funding instruments</b>		<b>Indicative financing contribution</b>
•				
•				
<b>Ongoing R&amp;I Activities (Flagship activities or not): relevant to this new activity proposal</b>				
<b>Name</b>	<b>Description</b>	<b>Timeline</b>	<b>Location/Party</b>	<b>Budget</b>
<b>Gaps:</b>				



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## A4-T2.2-2: Multi-dimensional local energy systems

A4-IA2.2-5 Families of living labs to develop technology - service systems for direct use of PV energy on an aggregated level of multi-family buildings, districts or communities

### Implementation Plan – Activity Fiche

**Innovation Target:**

Multi-dimensional local energy systems

**Innovation Activity Number:** A4-IA2.2-5

**Title:** Families of living labs to develop technology - service systems for direct use of PV energy on an aggregated level of multi-family buildings, districts or communities

**Targets:**

Optimising direct consumption of PV energy on an aggregated level of multifamily buildings, districts or communities can be seen not only as a starting point for business model development, but also for mobilising flexibility potentials for power grids, integrating the end user. It is expected, that synergies can be leveraged by aggregation of users and assets. At the same time, the development of comprehensive technology-service systems for potential procurers (communities, property developers, building managers,) is complex. Economic potentials and opportunities for the energy systems often are not exploited.

Solutions will have to provide a sufficient service-depth in order to meet the actual demand of potential procurers and users, leveraging on the opportunities provided by digitalisation. They will have to be able to integrate regional optimisation goals (of users and operators of the technology-service systems) as well as overarching system-optimisation goals (contribution to system control, flexibility potentials, etc.). In order to reach critical scale, they shall be ready to be effectively implemented under actual framework conditions (technologies, business processes, legal and contractual issues, licence, etc.)

The overall goals of this activity are:

- Facilitate the development of such comprehensive technology-service systems that enable optimised direct consumption of PV energy on an aggregated level of multi-family buildings, districts or communities.
- Provide innovation ecosystems, in which potential procurers and providers work together in co-creation processes in order to develop and test prototypes under real-life or close to real-life-conditions.
- Leverage on the opportunities provided by digitalisation and enable sustainable business models by promoting trans-regional platform solutions.

**Description of RD&I or Programming Activities:**

- Coordinate and link living labs on national or regional level that facilitate an innovation ecosystem for the development and testing of prototypes
- Share real-live (or close-to-real-live) development and test environments, in which technology-service systems and their components (energy management systems, business processes and platforms, etc.) can be developed and tested.
- Connect those to networks of procurers, that gather potential buyers and users of the solutions at an early stage, in order to help to understand the needs and requirements
- Develop and implement methodologies and tools to enable effective co-creation of "need owners" (potential users and procurers) and solution providers (involvement, building competences, working methods, etc.)
- Develop and implement dynamic decision support models that enable optimisation among different ways of utilisation of produced PV energy (direct use, storage, provide grid and system services, trade, etc.) under actual and upcoming legal and regulatory framework conditions (EU Winter package).
- Link those living labs to the European knowledge base in this field of smart energy systems (e.g.: ERA-Net SG+ knowledge community)



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<b>Joint Activities:</b>				
<p>JI-1: Create a transnational platform for living labs</p> <ul style="list-style-type: none"> <li>• facilitate the sharing of test environments</li> <li>• facilitate the sharing of co-creation methods and tools</li> <li>• facilitate the knowledge exchange across different legal, cultural and technical environments</li> </ul> <p>JI-2: Start a transnational initiative with the living labs to co-create with need owners and solution providers</p> <ul style="list-style-type: none"> <li>• Provide information about technical and legal possibilities as well as already existing practical examples for potential procurers and customers (communities, building operators, etc.)</li> <li>• Develop standardised need profiles ("what do people dream of")</li> </ul>				
<b>Impact of the RD&amp;I Activities:</b>				
<p>JI-1:</p> <ul style="list-style-type: none"> <li>• Transnational Platform of living labs</li> </ul> <p>JI-2:</p> <ul style="list-style-type: none"> <li>• Workshops and information material for potential procurers and customers (communities, building operators, etc.)</li> <li>• Standardised "need profiles" ("what do we dream of") of interested potential procurers of technology-service-systems, available to potential developers</li> <li>• Joint co-creation events for potential providers, users and facilitators (Start-ups, SMEs, technology providers, utilities, grid operators)</li> </ul>				
<b>TRL:</b>				
<b>Expected deliverables</b>			<b>Timeline</b>	
			2018-2022	
<b>Parties / Partners</b> (countries / stakeholders / EU)		<b>Implementation financing / funding instruments</b>		<b>Indicative financing contribution</b>
•				
•				
<b>Ongoing R&amp;I Activities (Flagship activities or not): relevant to this new activity proposal</b>				
<b>Name</b>	<b>Description</b>	<b>Timeline</b>	<b>Location/Party</b>	<b>Budget</b>
			Germany (Gerhard S.)	
City LAB Graz			Austria	
Living Lab Schwechat			Austria	
Energy Ville			Belgium	
<b>Gaps:</b>				



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A4-T2.3-1: Provide co-creation frameworks to develop attractive services, creating value for the participants in the energy system and allowing for participation in the development of local and regional value chains (from investments to customer services)

A4-IA2.3-1 Create an innovation environment for smart services in cooperation with ICT platform solution providers

### Implementation Plan – Activity Fiche

**Innovation Target:** Provide co-creation frameworks to develop attractive services, creating value for the participants in the energy system and allowing for participation in the development of local and regional value chains (from investments to customer services)

**Innovation Activity Number:** A4-IA2.3-1

**Title:** Create an innovation environment for smart services in cooperation with ICT platform solution providers

#### Targets:

Developers of Smart Services face the problem that ICT solutions for the complex world of energies cannot be developed from scratch. Public funding programs aiming to support projects for smart service development in the energy sector, risk financing pilots that build on generic technology that never will be able to reach critical size to be compatible on the market. At the same time, multiple platform solutions are available in the ICT sector to enable the development of technical or business services. These platforms are usually not easily available for project consortia and service developers. The general assumption is here that such platforms and development eco-systems have a layered structure with clear interfaces between the layers.

The overall goals of this activity are:

- Enable SME's and start-ups in the smart energy services world to develop scalable, customisable and replicable solutions applicable from a very local to an interregional and global level, leveraging synergies by building on digital platforms.
- Ensure that service solutions account for security and privacy requirements.
- Foster development of applications that address customers from small communities up to 100.000 and more inhabitants (households, commercial, etc.) with easy to use and consumer centric services.
- Above all, enable cooperation and co-creation networks of solution providers.

#### Description of RD&I or Programming Activities:

- Together with ICT platform providers create transnational innovation environments that support start-ups and SMEs in designing, implementing and testing technical and business services for the future energy systems, building on available ICT platforms and tools (e.g. leveraging on FIWARE, the key output of the EC FI PPP program, e.g. energy blockchain).
- Develop data-hubs with clearly defined accessibility, connectivity and security for key stakeholders, including sample data for prototyping processes.
- Develop and unambiguously communicate standards for the development and deployment of smart energy service solutions.
- Introduce state of the art innovation methodology (such as Co-Creation, Design Thinking) to the community of solution designers to ensure high quality solutions developed towards high acceptance and the real needs of citizens, communities, energy regions, peer groups, etc. .
- In cooperation with ICT infrastructure and platform providers prepare proposals for innovative regulatory environments for the use of ICT in the future operation of technical energy systems and new energy market designs (Further development and implementation in accordance with TWG A3.1).

#### Joint Activities:

Jl-1: Setup a joint development ecosystem for transnational projects



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<ul style="list-style-type: none"> <li>• Provide a dictionary referring to third party software modules that can be used in research or prototyping Setup framework contracts with platform and cloud solution providers to allow for start-ups and academic institutions to develop their prototypes at reasonable costs</li> <li>• Call for projects helping to improve the ecosystem by concentrating on RD&amp;I and programming activities 1. 2., 3.</li> </ul>				
<p>JI-2: Align national, transnational and international RD&amp;I programmes</p> <ul style="list-style-type: none"> <li>• In program development, bring on board the national ICT programs with their eco-system and projects in accordance with DG Connect</li> </ul>				
<p>Further collaboration ideas</p> <ul style="list-style-type: none"> <li>• Share results on a knowledge sharing platform (e.g. expera, operated by ERA-Net Smart Grids Plus)</li> <li>• Foster transnational public private partnerships</li> <li>• Join international programmes (e.g. Mission Innovation)</li> <li>• Initiate a CSA or ERA-Net in H2020 concentrating on RD&amp;I activities 3. 4., 5.</li> </ul>				
<b>Impact of the RD&amp;I Activities:</b>				
<b>TRL:</b>				
<b>Expected deliverables</b>			<b>Timeline</b>	
			2018-2022	
<b>Parties / Partners</b> (countries / stakeholders / EU)		<b>Implementation financing / funding instruments</b>		<b>Indicative financing contribution</b>
•				
•				
<b>Ongoing R&amp;I Activities (Flagship activities or not): relevant to this new activity proposal</b>				
<b>Name</b>	<b>Description</b>	<b>Timeline</b>	<b>Location/Party</b>	<b>Budget</b>
<b>Gaps:</b>				



## 7.2 Stakeholder declaration (Draft – 19.10.2016)

### SET Plan – Declaration on Strategic Targets in the context of an Initiative on Energy Systems

#### Purpose of this document

This document<sup>10</sup> is intended to record the agreement reached between representatives of the European Commission services, representatives of the EU Member States, Iceland, Norway, Turkey and Switzerland, and representatives from the SET-Plan stakeholders most directly involved in energy systems activities, on the implementation of the actions contained in the SET-Plan Communication<sup>11</sup>, and specifically the strategic targets for the priority "Number 4 – Increase the resilience, security, smartness of the energy system".

This agreement follows input from EERA Joint Programme Smart Grids, the European Association for the promotion of Cogeneration (COGEN), European Power Plant Suppliers Association (EPPSA), European Association of Gas & Steam Turbines Manufacturers (EU Turbines), European Turbine Network (ETN), European Engine Power Plants Association (EUGINE), EDSO for SMART GRIDS, ENTSO-E, European Association for Storage of Energy (EASE), European Platform of the Universities in Energy Research and Education (EUA-EPUE), European Geothermal Energy Council (EGEC), Energy Materials Industrial Initiative (EMIRI). Note that a number of these stakeholders are also part of the European Technology and Innovation Platform (ETIP) on Smart Networks for the Energy Transition (SNET) who hold its first General Assembly in June 2016. This agreement also integrates input from a public consultation via the SETIS website<sup>12</sup> on an issues paper prepared by the Commission services<sup>13</sup>. It takes into consideration the responding input papers and public comments available on SETIS and discussions in the SET-Plan Steering Group on 20 January 2016 with the participation of the SET-Plan stakeholders most directly involved in the topic.

The stakeholders agree to the proposed approach and targets in an endeavour to progress towards an energy system which is capable of hosting large shares of variable renewables, to put forward their best efforts in a coordinated way between public and private sectors, and to jointly address all relevant issues in order to attain these targets.

Brussels, 19th October 2016

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<sup>10</sup> This document has no legally binding character, and does not prejudice the process or final form of any future decisions by the European Commission.

<sup>11</sup> Towards an Integrated Strategic Energy Technology (SET) Plan: Accelerating the European Energy System Transformation" (C(2015)6317).

<sup>12</sup> Strategic Energy Technology Information System website <https://setis.ec.europa.eu/>

<sup>13</sup> [https://setis.ec.europa.eu/system/files/issues\\_paper-action4\\_energysystem.pdf](https://setis.ec.europa.eu/system/files/issues_paper-action4_energysystem.pdf)



## 4.1) An optimised European power grid

### Introduction

In the 2020 and 2030 climate-energy packages, the EU committed itself to lower greenhouse gas emissions by 20% by 2020 and 40% by 2030, with respect to 1990, and to reach a share of renewables of 20% by 2020 and at least 27% by 2030.

In this framework, the **European power grid** has a central role to play and is seen as the starting point to progress towards an energy system approach. Indeed, today, it integrates already a high share of renewables (26% of renewables in 2013, 10% being variable renewables) with high growth perspectives and offers a number of possibilities to connect to heat and transport networks (e.g. through energy storage or with electric vehicles). The energy transition will be based mainly on dispersed sustainable electricity generation and distributed load controls.

A system approach is therefore needed to guide research and innovation activities in view of designing and developing a portfolio of appropriate solutions. The optimised power system must enable a greater flexibility and effective capacity of the electricity system which, in turn, allows connecting effectively and efficiently an ever-increasing share of variable renewables (wind and solar) and coping with new consumption profiles coming, for instance, from electric vehicles. Conversely, system flexibility can be reached in several ways: upgrading of the entire electricity value chain (generation, transmission, distribution and customers, and energy storage), reinforcing / creating new links with other energy networks, via for example power to heat/cold, power to gas / liquid and connections with the electrical components of the transport network and increasing the capabilities of RES through the improvement of their predictability and mechanism development for the future systems network services.

In order to meet the identified challenges in the power system, technologies, systems and services for more flexibility should therefore be developed in the following areas:

- Energy grids and systems (including interconnections),
- Storage, connections with other energy networks
- Demand response, integration of prosumers
- Flexible and sustainable backup and generation
- Optimised integration of renewables

Not only should the flexibility of the system be enhanced but also its economic efficiency.

#### 1) Flexibility

The power system must be **more flexible** by enhancing the grid hosting capacity for RES and by responding to variability and uncertainty of operational conditions from short time scale resulting from new variable loads and variable renewable generation to long time scales resulting from a wide range of possible energy scenarios. Enabling the needed flexibility calls for the following:

1.1) **Grid** smartening in the sense of grid **observability and controllability**, which brings to the system improved forecasting and operation. Benefits will be the potential for less curtailment of distributed generation resources such as photovoltaic or small wind installations, for improved management of distribution losses and voltages, and for reducing negative effects or durations of interruptions due to equipment failure. This requires substations at high, medium and low voltage levels (HV, MV and LV) equipped with remotely accessible monitoring and control devices.



1.2) **Tools for managing the variability and uncertainty of operational conditions** at several timescales. Since distributed generation replaces central generation, self-consumption becomes increasingly important affecting the load profile supplied from the integrated grid. With distributed generation and storage growing in the energy mix and at prosumers' sites, more and more customers can support the paradigm change where loads follow variable generation through demand response, instead of having generation following load as practiced today. Examples of the R&I that can contribute to management of variability and uncertainty include work on transmission and distribution planning under uncertainty, on forecasting methods especially applied on local conditions, on synthetic inertia, or on market design for demand response and for the interaction between different partial markets and different grids.

1.3) Increased **grid hosting capacity** for renewable generation. This acknowledges that the electricity system including especially the grids is, together with Information and Communication Technology, the platform where the innovations described in this paper come together and create value for customers. The challenge lies to a large extent in the distribution systems where a combination of network reinforcements, congestion management, energy storage, demand response, market and system operational improvements are needed. Finding the right balance for each region between reinforcements and improved market, storage, demand response and operations tools will have significant economic effects. Examples of R&I activities that can contribute to increased use of the grid infrastructure are development of methodologies, software, models for planning, market and network assessment, monitoring schemes to extend the life time of the networks, use of new power technologies, integration of energy storage, and the ICT platforms to support all these developments.

1.4) A further **flexibilisation of centralised and decentralised thermal power generation** technologies, including for the combined production of heat and power. Flexibilisation in this sense includes not only the speed to adapt to changes in demand and volatile RES generation, but also the ability to integrate the storage and use of excess energy via power-to-heat and power-to-gas, the further development of hybrid solutions combining vRES with the reliability of dispatchable energy sources, an increased fuel flexibility supporting a switch from fossil to renewable sources, a better integration of industrial combined production of heat and power into the overall system and an increased used of sustainable combined production of power and heat/cold (e.g. from biomass, solar, waste, geothermal, heat pumps). A key challenge in this is the efficient use of data from the system to run the plants and have them react efficiently and minimising the environmental and climate impact.

1.5) Increase the capability of RES to provide services to the energy system. This include improvements in the accuracy of the forecast of production, the development of technologies, tools and services like combining locally RES production with storage or/and power to gas facilities so as to reduce the variability of the production and enable RES to be a market player and to provide services to the grid.

## 2) Economic efficiency

Economic efficiency is tied strongly on one hand to technological and cost reduction progress – in particular for technologies such as energy storage and flexible thermal generation which support flexibility – and on the other hand to market design and dynamic pricing. R&I is needed to accompany progress in these fields.

At the same time, network operators must face a technology transition in the years to come. Keeping the system reliable, at the likely different levels requested by the different economic agents, means a power system that is observable and controllable while welcoming a growing number of such agents, using dynamic prices and customer-centric market design. The existing power system has been designed by implementing a “cyber ICT layer” on the top of a “hardware (equipment) layer”. The future power system’s cyber layer will cover the whole continent, and, at the same time, will reach, whenever possible, each agent in order to observe and help them optimising their behaviours. This new cyber layer may also contribute to mitigate/delay infrastructure investments, thanks to integrated intelligent infrastructure monitoring strategies enabling life extension and exploitation.



## Overarching goals

The SET-Plan R&I activities aim at developing, maturing and demonstrating technologies, systems and services up to a Technology Readiness Level 7-9, i.e. up to demonstration-pre-commercial. These will enable developing and operating the power system with the appropriate level of reliability and economic efficiency, while integrating variable renewables, such as wind and solar generation (see in annex the gross electricity generation from wind and solar in 2013 – EU 28). The required flexibility will be provided thanks to innovative technologies enhancing customer participation, integrating better storage, making the best use of connections with other networks (e.g. heat and cold, transport) and optimising the use of flexible sustainable combined power and heat generation.

## Strategic Targets

### Flexibility of the system, by 2030

Technologies for grid observability and controllability: **the percentage of substations at high, medium and low voltage levels equipped with remotely accessible monitoring and control devices should be 80% or higher for HV and MV substations and around 25% for LV substations.** Values will vary depending on Member States.

Tools for managing the variability and uncertainty of operational conditions should enable the **peak load to be reduced by 25% due to demand response by 2030**<sup>14</sup>.

Technologies for flexibilisation of centralised and decentralised thermal power generation **enabling 50% of all thermal power plants (new as well as retrofitted) should meet the flexibility requirements demanded by vRES.** This requires:

- Doubling of average ramping-rates (the speed at which output can be increased or decreased)
- Halving efficiency losses for part-load operations
- Reducing minimum load by 30% compared to the average of today (avoiding plant switch-off)

Increasing the capability of RES to provide services to the energy system by:

- **Improving accuracy of forecasting models** for aggregated RES plant power production by 10 %
- Developing technologies, tools, services and interfaces **enabling a full and effective integration of RES in the grid** (balancing services, dispatch, contribution to the stability, 'smart' connection with the grid)

### Economic efficiency

The main indicator for the technological development that will be used focuses on the **cost reduction by 2030** of energy storage ranging from **50% to 70%** depending on the specific technologies **for the same storage function**<sup>15</sup>. Here storage is meant broadly, including batteries, pumped hydro, and the interaction of heat and electricity networks, power-to-heat and power-to-gas/fuel concepts, interaction of gas, heat and electricity networks.

The targets mentioned above should be understood as aspirational targets for which the SET-Plan promotes R&I activities that will, if successful, enable these targets to be reached. The fact that these targets will actually be reached or not will depend on the evolution of the energy system, on the market conditions and the large scale deployment of the matured technologies, parameters on which the SET-Plan has little influence.

<sup>14</sup>

<sup>15</sup> Cost and performance of EV Batteries, Final Report for The Committee on Climate Change, 2012, see Fig 6-1, Measurement details to be developed for other technologies.



As soon as the Temporary SET-Plan working group on the Energy System is operational, it will re-evaluate the above-mentioned input-oriented targets with a view on complementing or replacing them by clear output-oriented targets.

## Monitoring of the targets

For the **overarching goal, an overall indicator** will be defined to capture progress in developing, maturing and demonstrating technologies, systems and services to be able to operate the power system with the appropriate level of reliability and economic efficiency, while integrating variable renewables. For example, the percentage of methodologies and tools developed in R&I projects whose results can be implemented within eight years of projects completion in at least two European countries' electricity or related markets could be tracked. A target value should be set based on recent projects results' implementation. This is to indirectly capture efficiency improvements in grids as these are a function of effective dissemination and implementation of RDI results.

**The flexibility of the electricity system** and especially the magnitude of its connections with other energy networks can be assessed thanks to an **EU-28 modelling system, relying on several scenarios**. Common scenarios with gas and strongly improved system adequacy forecasting methodology will be useful to monitor the progress towards targets. This will also allow to model and track the system's capacity to operate with much higher share of production from variable renewables with the modelling of all flexibility mechanisms such as demand-response, storage with re-electrification, power to-x (energy transferred to other networks), and flexible generation and improved capacities of variable renewables to service the grid. The modelling system should also be able to assess the impact of interconnections between EU Member States networks and of greenhouse gas savings and the impact of local grid (microgrids) and power to heat solutions as regional and local forecasting renewables modelling together with innovative mix solutions. In this respect, tools and methodologies used to produce the Ten Years Network Development Plans (TYNDP) for electricity and gas will be particularly useful. A better and more complete modelling of the new capacities from renewables to fully understand the energy system evolution and new necessities is needed.

To monitor the progress on technologies for **grid observability and controllability**, the percentage of HV, MV and LV separable networks that use smart meter data for observability and/or control system will be tracked. In order to capture reliability benefits of observability and controllability, a target should be quantified on reductions in average duration of service interruptions; basis will be CEER annual statistics.

As already stated above, the targets and their monitoring will be re-evaluated by the Temporary SET-Plan working group on the Energy System, as soon as it is operational.

Regarding capacity available from **demand response**, studies on current and future years' data will be made together with yet-to-be developed estimates of customers' price elasticity, in combination with the TYNDP's.

The capabilities **to assess safety, stability and security** will rely on ENTSO-E's new adequacy methodology<sup>16</sup> and partly on the network codes. This should enable us to define additional indicators with grid operators who bear the responsibility for these matters. Reference values should then be established based on historical data and the evolution of the situation predicted. These are nonetheless non-trivial issues, requiring studies as well as the inclusion of data security aspects (cybersecurity).

## Next steps

The stakeholders agree to develop and clarify within 12 months any missing details of target values and indicators, as well as a detailed implementation plan for the delivery of these targets, determine joint and/or coordinated actions, to identify:

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<sup>16</sup> Midterm Adequacy Forecast (ENTSO-E) 2016



- the ways in which the EU and national research and innovation programs could most usefully contribute,
- the contributions of the private sector, research organisations, and universities
- all issues of a technological, socio-economic, regulatory or other nature that may be of relevance in achieving the targets.

They will report regularly on the progress with the purpose to monitor the realisation of the targets and take rectifying action where and whenever necessary.

The stakeholders intend to use the European Technology and Innovation Platform on “Smart Networks for Energy Transition” that was set up on 27 June 2016, which builds on the Set-Plan EEGI, Smart Grid Technology Platform, EERA and includes additional stakeholders (e.g. EASE), as the main vehicle for discussing and agreeing on the implementation plan.

Annex: Gross electricity generation from wind and solar per EU Member State in 2014

	Gross electricity generation	Wind	Solar	Total wind + solar	% wind-solar/gross electricity
	2014 (TWh)				
<b>EU-28</b>	<b>3190.7</b>	<b>253.2</b>	<b>97.8</b>	<b>350.9</b>	<b>11.0</b>
<b>BE</b>	72.7	4.6	2.9	7.5	10.3
<b>BG</b>	47.5	1.3	1.3	2.6	5.4
<b>CZ</b>	86.0	0.5	2.1	2.6	3.0
<b>DK</b>	32.2	13.1	0.6	13.7	42.5
<b>DE</b>	627.8	57.4	36.1	93.4	14.9
<b>EE</b>	12.4	0.6	0.0	0.6	4.9
<b>IE</b>	26.3	5.1	0.0	5.1	19.5
<b>EL</b>	50.5	3.7	3.8	7.5	14.8
<b>ES</b>	278.7	52.0	13.7	65.7	23.6
<b>FR</b>	562.8	17.2	5.9	23.2	4.1
<b>HR</b>	13.6	0.7	0.0	0.8	5.6
<b>IT</b>	279.8	15.2	22.3	37.5	13.4
<b>CY</b>	4.4	0.2	0.1	0.3	6.1
<b>LV</b>	5.1	0.1	0.0	0.1	2.7
<b>LT</b>	4.4	0.6	0.1	0.7	16.2
<b>LU</b>	3.0	0.1	0.1	0.2	5.9
<b>HU</b>	29.4	0.7	0.1	0.7	2.4
<b>MT</b>	2.2	0.0	0.1	0.1	3.0
<b>NL</b>	103.4	5.8	0.8	6.6	6.4
<b>AT</b>	65.4	3.8	0.8	4.6	7.1
<b>PL</b>	159.1	7.7	0.0	7.7	4.8
<b>PT</b>	52.8	12.1	0.6	12.7	24.1
<b>RO</b>	65.7	6.2	1.6	7.8	11.9
<b>SI</b>	17.4	0.0	0.3	0.3	1.5
<b>SK</b>	27.4	0.0	0.6	0.6	2.2
<b>FI</b>	68.1	1.1	0.0	1.1	1.6
<b>SE</b>	153.7	11.2	0.0	11.3	7.3
<b>UK</b>	338.9	32.0	4.1	36.1	10.6

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## 4.2) Integrated local and regional energy systems

### Introduction

**Regional and local energy systems and networks are** composed of locally and regionally available energy sources, built infrastructures, specific production and consumption characteristics and user and consumer structures. They have an important role to play in reaching the 2020 and 2030 targets and to reduce our energy dependency. They also have to provide appropriate services to citizens, to the overall European energy system, ensure the security of supply and maximise the primary energy efficiency and the share of renewables. According to actual drivers like technologies for decentralised energy systems, digitalisation and associated business models and current societal trends, local and regional energy systems will face of transformation in the coming years. In that respect, also the entire regional and local technology and innovation ecosystems will be an important factor.

Therefore, smart and integrated local and regional energy systems need to be developed and implemented urgently. They will allow integrating efficient energy supplies from various sustainable and variable sources and securing optimal utilisation of the limited local and regional infrastructures and resources. These local systems will also connect to the overall energy and associated digital system, contributing to its stability, resilience and flexibility.

In this new systemic approach, electricity, gas, heating and cooling grids, end-use technologies in buildings and other infrastructures (e.g. water supply and sewage systems, transport system etc.), different kinds of end-users and management of energy conversion are combined and integrated. By using energy management, monitoring systems and smart technologies, synergies between different energy vectors and infrastructures will be leveraged in order to achieve optimal solutions for the regional or local energy systems as well as for the overall European energy system.

This new approach will lead to new jobs in Europe and place the European energy industry and research institutions in a globally competitive position with new export opportunities. Furthermore, it is a European ambition to strengthen the knowledge base of the universities with a resulting increase in highly qualified candidates, who will ensure the growth of European industry.

The transport sector is also challenged to integrate more renewables. Electric vehicles are an opportunity for using renewable electricity and the related infrastructure can be part of the local or regional system. Production of renewable fuels (e.g. bio-fuels, power to gas/fuels) is another opportunity for integration between different energy systems.

It is important to focus on integrated solutions, where several grids interact, e.g. by combining heating and cooling systems, energy storage assets, management of buildings and infrastructure, etc. Integrating all parts of the energy system also allows for the balancing of fluctuating electricity production in an efficient and cost-effective manner.

R&I focus should aim at maximising the share of local renewable and recovered resources, minimising the conversion losses and identify synergies to recover unused energy. Furthermore the implementation of smart and integrated energy systems is not only a technological practice, but also a social, cultural, commercial and political practice where cooperation and coordination are pivotal ingredients. It entails a change in the relationship between production, distribution, consumption and storage, going beyond capacity optimisation.

Implementing smart and integrated energy systems requires organisational innovation, new business models, new or reconfigured value chains, new actors in the research and business landscape of energy services and technologies as well as a better integration of different types of end-users into the energy system. A variety of entrepreneurial initiatives and partnerships among multiple actors are needed to speed up the implementation of smart and integrated energy in society. Integrated initiatives are needed to support social, institutional, organisational and



market innovation in the energy sector including the intersections between energy supply, energy efficiency, and new user practices.

Supporting new cooperative approaches and common standards will not only strengthen local and regional transition dynamics and entrepreneurship, but also enable steps towards EU level solutions in the integration of energy systems. This will help sustain European industrial leadership in sustainable energy solutions worldwide while paving the way to a low-carbon economy.

## Overarching goals

(One of the first missions of the Temporary working group dealing with this part will be to refine and quantify the targets and propose an approach to monitoring, before developing the implementation plan).

- Integrated local and regional energy systems shall be developed in order to contribute to increase integration and accessibility for various infrastructures as well as for technologies and players in end-use, smart services, system operation, generation and conversion, storage, system operation, smart services,
- Advanced design tools and optimised management of energy networks, in particular for heating, supplied by renewable energy and waste heat recovery,
- Design, plan, construct and operate highly efficient system of systems to minimise the consumption of non-renewable resources, maximise conversion efficiencies and optimise the utilisation of energy and ICT-infrastructures (existing and new)
- Increasing flexibility of the energy system, in particular the short and long-terms, in order to fulfil the requirements for system operation as well as from different user-groups (end-users, retail, generation, retail, end-users/storage) with particular focus on the optimised integration of energy from local renewable sources,
- Maintaining or even increasing the resiliency of the energy system and considering safety, security & privacy aspects as integral design parameters,
- Enable the development of new and smart energy services for the dynamic management of the energy systems and empower and integrate end-users by increasing connectivity and data accessibility,
- Enable cities and regions to be actors in their sustainable energy supply, participate in inter-regional exchange of energy, including solutions that allow for high shares of renewables, up and beyond 100%.

## Strategic Targets

- **Heating and cooling systems: local integration from different sources of different temperature levels, including unused recoverable energy.**

Develop and implement local heating and cooling systems, including district heating, that are integrating heat pumps and heat storage technologies, rely on local energy sources (e.g. bio energy, solar thermal and geothermal energy, natural cooling sources, flexible CHP production) and recover heat from other processes (e.g. industry, data centres, cogeneration with cooling and waste water facilities, excess of energy from wind and solar electricity production).

These systems shall be able to cope with high levels of decentralised energy supply and to interact with future low-energy buildings, leveraging synergies and economic energy-efficient solutions. Furthermore they shall deliver differentiated thermal services (heat, steam, cold, etc.) with optimised primary energy efficiency and significantly contribute to the decarbonisation of the heating and cooling sector which represents more than 50% of the EU final energy consumption.



- **Develop innovative mix solutions (e.g. wind, solar, renewable heat production combined with energy storage) that will reduce variability.**

In this respect, tools and methodologies used to produce the Ten Years Network Development Plans (TYNDP) for electricity and gas will be particularly useful; enhanced and more complete modelling of the new renewables capacities to fully understand the energy system evolution and its new necessities are needed. This includes the development of regional and local forecasting models for renewables.

- **Smart Services: establish innovation environments for the development of smart services**

The integration of users and participants in the energy systems is - according to the exponential growth in number - a key competence to design the future energy systems. In order to cope with international developments, European innovation ecosystems should be created around the regional and local energy systems that will enable the potential buyers, developers and providers to work together in co-creation processes, to develop attractive services serving the requirements of the different participants and of the overall system. This includes

- Data accessibility for pilot initiatives in cooperation with ICT infrastructure providers,
- Initiation of developer platforms for digital business processes,
- Development of cooperation formats that facilitate the participation of Start-Ups and SMEs.
- Development of participation models for citizens, communities, energy regions, peer groups, etc.



## 7.3 Countries and Stakeholders

### 7.3.1 National Representatives (Countries)

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## 8. Directories

### 8.1 Literature

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### 8.2 Abbreviations

CCS	Carbon Capture and Storage
CHP	Combined Heat and Power
COST	Coordination of Service Team
CSA	Coordination and Support Actions
DA	Day Ahead
DC	District cooling
DER	Distributed Energy Resources
DG	Director General
DH	District Heating
DHC	District Heating and Cooling
DHN	District Heating Networks
DHW	Domestic Hot Water
DLR	Dynamic Line Rating
DSO	Distribution System Operator
DSR	Demand Side Response
EC	European Commission
EERA	European Energy Research Alliance
EIF	European Interoperability Framework for European public services
EIP-SCC	European Innovation Partnership on Smart Cities and Communities marketplace
ENTSOe	European Network of Transmission System Operators for Electricity
ESCO	Energy Service Company
ETIP DG	European Technology and Innovation Platform - Deep Geothermal
ETIPs	European Technology and Innovation Platforms
EV	Electric Vehicle
FACTS	Flexible AC Transmission System
GDP	Gross Domestic Product
GIS	Geographical Information System



HP	Heating Plant
HPCC	High Performance Computer Centre
HVDC	High Voltage Direct Current
ICT	Information and Communication Technology
IEA	International Energy Agency
IES	Integrating the Energy System
IoT	Internet of Things
ISGAN	IEA Implementing Agreement for a Co-operative Programme on Smart Grids
ISO	International Standardisation Organisation
KPI	Key Performance Indicator
LEC	Local Energy Community
LV, MV, HV	Low, Mid, High voltage
MoU	Memorandum of Understanding
NIS	Network and Information Security
NUTS	Classification of Territorial Units for Statistics
NUTS	Nomenclature des unités territoriales statistiques
PEC	Power Electronic Converters
PHEV	Plug in Hybrid Electric Vehicle
PMU	Phasor Measurement Unit
PoC	Points of Contact
PPP	Private Public Partnership
PV	Photovoltaic
R&I	Research and Innovation
RD&I	Research, Development and Innovation
RDD	Research and Development Division
RES	Renewable Energy Sources
RFM	Renewable Flexible Modules
RHC	Renewable heating and cooling
RIS	Regulatory Innovation Zones
ROI	Return on Investment
RSE	Ricerca sul sistema Energetico
SET	Strategic Energy Technology
SETIS	SET Plan Information System
SME	Small Medium Enterprise
SNET	Smart Networks for Energy Transition
STE	Solar Thermal Energy
STRIA	Strategic transport Research and Innovation Agenda
TRL	Technology Readiness Level
TSO	Transmission System Operator
TYNDP	Ten Year Network Development Plan
VPP	Virtual Power Plant
VRES	Variable Renewable Energy Sources
WAMS	Wide Area Measurement Unit
WEF	World Economic Forum



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