ETIP SNET

EUROPEAN TECHNOLOGY AND INNOVATION PLATFORM

SMART NETWORKS FOR ENERGY TRANSITION

SYNERGIES AND COMPLEMENTARITIES OF EUROPEAN AND INTERNATIONAL INITIATIVES TOWARDS ENERGY TRANSITION

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PLAN. INNOVATE. ENGAGE.

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GLOSSARY

21CPP - 21st Century Power
CCUS – Carbon Capture Utilisation and Storage
CEM – Clean Energy Ministerial
EERA - European Energy Research Alliance
ESI – Energy System Integration
ETIP - European Technology and Innovation Platforms
EC – European Commission
EU – European Union
EVI - Electric Vehicles Initiative
FCH – Fuel Cells and Hydrogen
IC – Innovation Challenge
IEA – International Energy Agency
IPEEC - International Partnership for Energy Efficiency Cooperation
IRENA - International Renewable Energy Agency
ISGAN - International Smart Grid Action Network
IWG – Implementation Working Group
JP – Joint Programme
JTI - Joint Technology Initiatives
OA – Operating Agent
PPP – Public Private Partnership
P-t-X – Power to X
R&I – Research and Innovation
SDS – Sustainable Development Scenario
SET - Strategic Energy Technologies
SP – Sub-Programme
TCP - Technology Collaboration Programme
TR – Technology Roadmap
TRL – Technology Readiness Level
UN – United Nations
WG – Working Group

1 INTRODUCTION

In June 2018, the European Technology and Innovation Platform “Smart Networks for Energy Transition”, ETIP SNET, released its Vision 2050 for the Energy system, a vision of “systems of systems”, in which the conversion from power to gas, from heat to liquid and back to power will be seamless. In such a vision, the maximisation of the use of all type of renewables will be possible, allowing to meet environmental challenges, bringing affordable energy to societies while ensuring security of supply.

Such a vision cannot come alone, one of the key recommendations of the vision is to: “achieve fully-coordinated participation of all ETIP SNET stakeholders in all energy systems areas, avoiding silo visions, missions, roadmaps and implementation plans.”

The current report aims for this exact objective, breaking down barriers and silos, getting to know who does what in Europe and at a Global level in the energy system areas which will contribute to the Vision 2050 devised by ETIP SNET to happen.

This document proposes an analysis of the key organisations that act on a daily basis to research priorities that allow a deep transformation of our energy system, informing public authorities who can make the transformation happen on where to prioritise funding and putting such recommendations into practice with research and development programmes.

This document, prepared with the support of the EC funded INTENSYS4EU project, will help you find your way into the labyrinth of EU and Global organisations and also proposes some recommendations with regards to where gaps exist today, and which areas are not covered enough with the spectrum of organisations which can help implement such vision. The INTENSYS4EU team would like to thank the authors of this guide and hope that you will find it useful in your own daily contribution to the energy transition.

2 JOINING EFFORT FOR TACKLING THE CHALLENGES OF CLIMATE CHANGE

There is nowadays a general and widespread consensus about the importance and urgency of the process of decarbonizing the global economy, and in particular the energy system, responsible for a significant share of climate-changing gas emissions. The COP21 international agreements of December 2015, ratified in almost all cases by the governments of the various signatory countries, commit to more or less significant reductions in emissions, with the aim of maintaining the increase of the average temperature of the earth compared to that of the pre-industrial period, within 2°C in the XXI century, preparing measures for a containment within a 1.5°C trend. The needed acceleration towards the implementation of low emission technologies and solutions requires substantial public and private investments and regulatory and development schemes to accompany self-sustained market uptake without the need of special measures or incentives. Noting that no industrial operator, region, country or continent can alone solve the immense challenge of making clean technologies competitive and seamlessly integrated into the energy system, it is necessary to involve the entire international community to work in parallel, to distribute efforts, to build on the results of each actor so as to shorten the time taken to reduce emissions and to allow all countries to act in sync along the sustainable development path.

According to analysis carried out by IEA [1], public investments in innovation in the field of low-emission energy technologies over the last five years have increased by about 2.5%, with a peak (+12%) in 2017. This trend positively offsets the period of decline that characterized the previous two years. The turnaround in public funding has been generalized, but particularly significant in the United States (+13%) and in Asia (+18%), with a focus on CCUS and energy efficiency (US), and on renewables (China). Public funds are used by national governments to invest in research, demonstration and deployment of clean technologies mitigating the potential market failures of products and services that have not yet passed the "death valley" of innovation. Data from the private sector, even if partial and more difficult to collect, show an average increase over the 5 years of 5.75% which, excluding the car sector, is reduced to 4.6%. The 2016 figure is particularly significant, with an increase of over 8% compared to the previous year, particularly focused on electrical technologies and renewables. The general trend is illustrated in Figure 1.

The present situation is, however, far from being ideal: in fact, as shown in Figure 2, the vast majority of technologies considered essential for the energy transition, has accumulated significant delay in terms of installed capacity, technological and industrial development and investment level for innovation compared to what is necessary to achieve the objectives of the IEA SDS scenario (Sustainable development Scenario - which assumes the achievement of climate change mitigation objectives, favoring access to energy and improving air quality) [2]. In particular, all the sectors related to the integration of the energy system are characterized by more or less important delays: from storage to smart grids, including the digitalization of the electricity system and the intelligent management of demand.

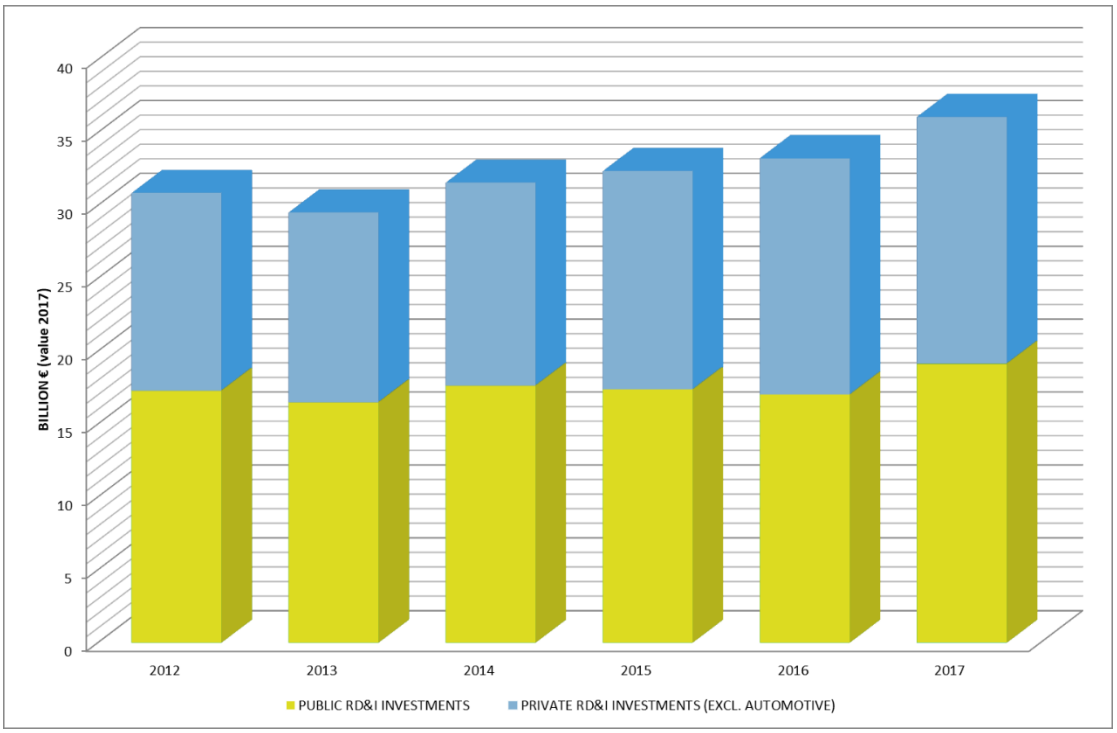


Figure 1: Innovation investments in clean technologies (excluding automotive) – [RSE elaboration on IEA data]

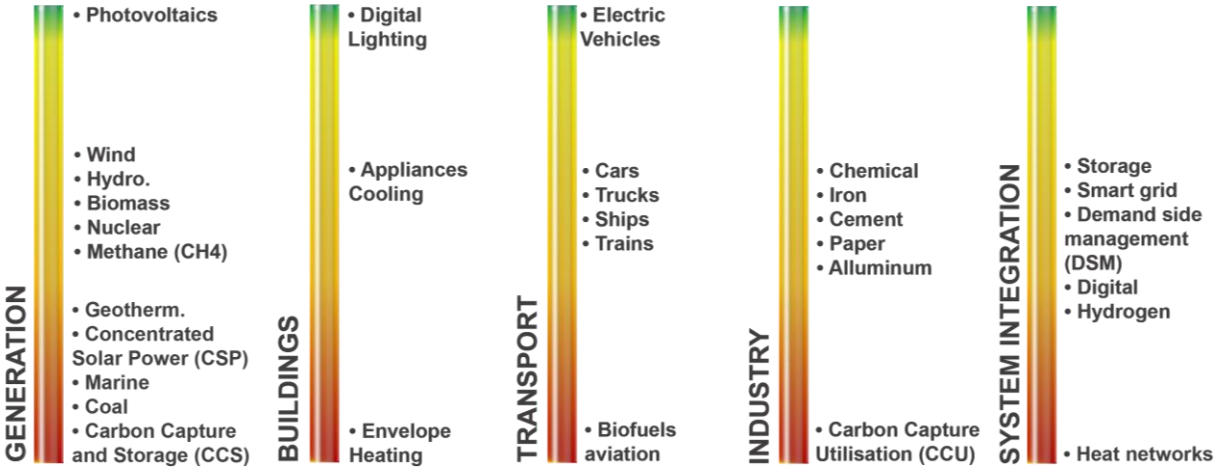


Figure 2: Performances of the different clean energy technology sectors with respect to the objectives of the IEA sustainable development scenario [RSE elaboration from IEA data]

The achievement of the decarbonisation objectives therefore requires a dramatic acceleration of the development, demonstration and deployment of innovative technologies in all the sectors considered, with the aim of catching up from the accumulated delay. But how can we reconcile the urgency of climate change mitigation with the development time needed to guarantee the adequate level of reliability of the solutions and to keep under control the deployment costs? This is the so-called "trilemma of energy innovation", which very often leads decision-makers to yield on urgency on the altar of costs and reliability. The sector of technologies and energy systems is very widespread and addresses extremely diversified scientific and industrial disciplines and experiences. Energy decarbonisation is an extremely ambitious and complex project that some have compared to the first mission of man on the moon. With due caution related to the technological, scientific, cultural and political developments that have occurred since the glorious mission of 1969, it seems a risky comparison: unlike the Apollo project that was

successfully conducted by a single nation, the transition to a clean energy system, sustainable, circular and low-emission is global by definition. Only an international collaborative effort, characterized by a great diversity of cultures, financial resources, technology promotion, market approaches, research support, involvement of complementary actors and policies, can lead to solving the innovation trilemma. The question is therefore not whether to cooperate internationally, but rather **how much, with whom, on what, and how**.

2.1 EUROPEAN INITIATIVES

The European Union has since long supported the objective of dramatically reducing greenhouse gases emissions to ensure that the global temperature increase of the planet stays below 2°C. To achieve this goal, the EU has engaged in a process leading to emissions reductions by 80-95% in 2050 with intermediate steps, targeting by 2030 reductions by at least 40% (with respect to 1990), increasing the share of renewable energy to at least 27%, and achieving an energy efficiency improvement of at least 27%. EU leadership demonstrates to other parts of the world that this transition is both possible and beneficial beyond the fight against climate change. According to the EC[1], the road to a net-zero greenhouse gas economy could be based on joint action along different strategic building blocks: i.e. **energy efficiency** in the building environment, **deployment of renewables**, **use of electricity** to fully decarbonise the energy supply (by 2050, electrify more that 53% of the final energy demand, generating more than 80% of electricity from renewable energy sources), the adoption of **clean, safe and connected mobility**, the evolution toward a **circular economy** with particular reference to industry (recovery and recycling of raw materials), the development of an adequate **smart network infrastructure and inter-connections** (smart electricity networks, data/information grids, hydrogen pipelines, sector integration, etc.), **bio-economy** and carbon sinks (sustainable biomass for heat, production biofuels and biogas, precision farming and agriculture, advanced agroforestry techniques, afforestation and restoration of degraded forests), **CCUS.**

The Energy Union was launched in 2015, 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. It sets broader goals covering five mutually reinforcing dimensions: **energy security**, internal **energy market**, **energy efficiency**, **decarbonisation** (including renewable energy development), **research, development and competitiveness**. For the research pillar, the Strategic Energy Technologies (SET) Plan has been a key deliverable and crucial component linking EU, Member State and industry action. 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 multiple roles of the European SET-Plan are illustrated in FIGURE 3:

[1] COM(2018) 773 final Communication from the Commission to the European Parliament, the European Council, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank : “A Clean Planet for all - A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy”

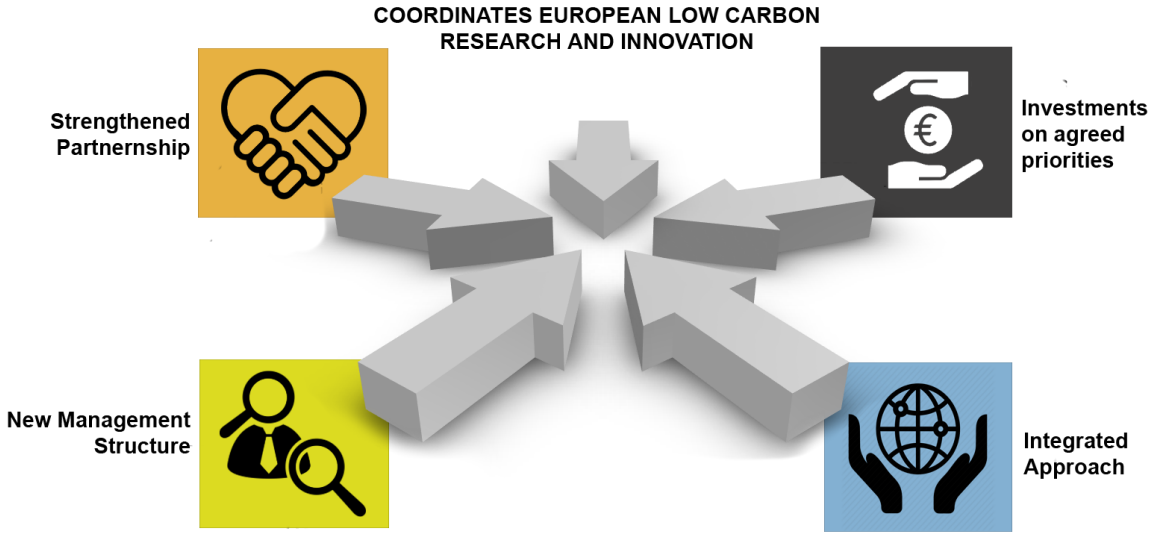


Figure 3: The outstanding role of the European SET-plan in the coordination and acceleration of innovation

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:

- A more targeted focus: ten actions structured around the research and innovation priorities of the Energy Union have been developed;
- An integrated approach 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 and stakeholders, including research organisations and industry.

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 10 actions of the SET-Plan are the following:

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

The main operational instruments of the SET-Plan are the following:

2.1.1 EUROPEAN TECHNOLOGY AND INNOVATION PLATFORMS (ETIPs)

They are recognised as key industry-led communities to develop and implement the SET-Plan R&I priorities, with the aim to foster innovation in low-carbon energy technologies and bring such new technologies to the market. They provide consensus-based strategic advice on the SET-Plan covering technical and non-technological aspects (e.g. industrial strategy, market opportunities, exploitation of research results, innovation barriers, need for specific research activities, strategy for international cooperation, education, environmental and social impacts) and addressing linkages with other sectors

in view of increased system integration. They support the SET-Plan in the development and monitoring mechanisms of the SET-Plan R&I priorities. The diversified roles of the ETIPs are illustrated in the Figure 4.

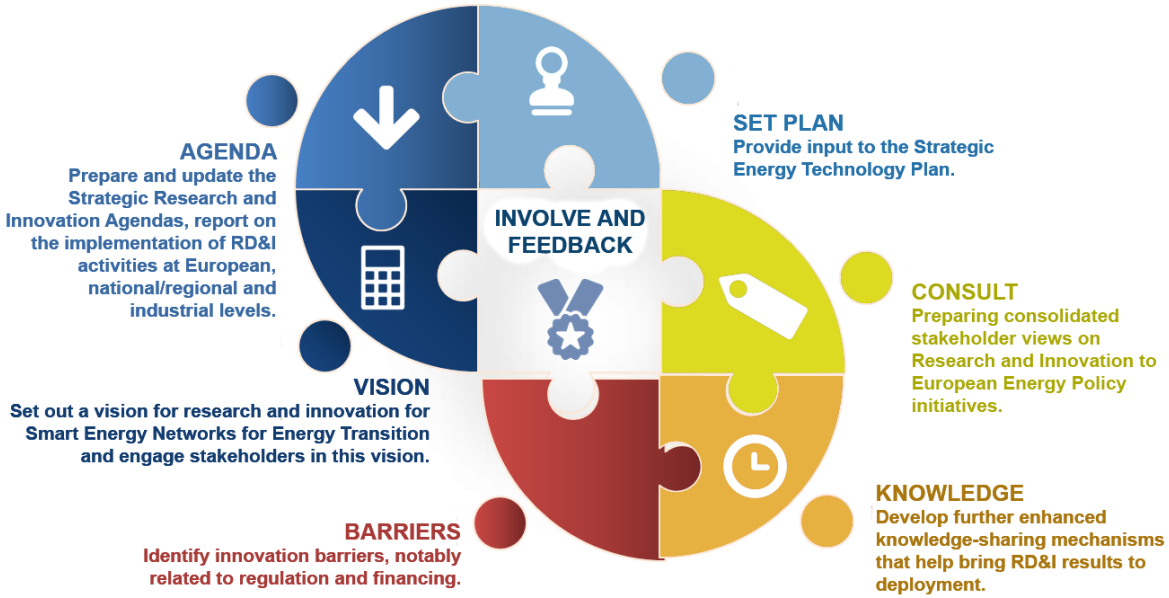


Figure 4: The main roles of the ETIPs

In order to adequately cover all the technologies required for the energy transition, 8 industrial collaboration frameworks were envisaged, namely:

- ETIP PV;
- ETIP WIND;
- OCEAN ENERGY EUROPE;
- ETIP DEEP GEOTHERMAL (EGEC);
- SUSTAINBLE NUCLEAR ENERGY TECHNOLOGY PLATFORM (SNETP);
- ETIP RENEWABLES HEATING AND COOLING (RHC);
- EUROPEAN BIOFUELS TECHNOLOGY PLATFORM;
- ZERO EMISSIONS PLATFORM (ZEP);
- ETIP SMART NETWORKS FOR ENERGY TRANSITION (SNET).

The following initiatives are of particular interest for the present report and are analysed in greater detail in the following sections:

Initiatives Analysed	
Smart Networks for Energy Transition	*Fiche ETIP SNET*
Renewable Heating and Cooling	*Fiche ETIP RHC*
District Heating and Cooling +	*Fiche TP-DHC+*

Amongst the different ETIPs, the ETIP SNET is the European technology platform on energy networks [3]: it gathers stakeholders in the energy networks sector under the coordination of industrial operators (network operators and technology providers), for the indication to the European Commission research and innovation priorities. This initiative also monitors the achievement of technological, regulatory and regulatory goals that enable the dissemination of intelligent network solutions. It recently published VISION2050 [4] and the Research Roadmap [5].

2.1.2 EUROPEAN INNOVATION PARTNERSHIPS (EIPs)

These initiatives were launched in the context of the innovation union flagship initiative in October 2010. EIPs were set up with the aim to promote the implementation of a new innovation ecosystem in Europe and were meant to act across policies, sectors and borders to tackle societal challenges and enhance Europe's competitiveness.

Presented as a new approach to address the fragmentation of efforts in research and innovation across the whole innovation ecosystem EIPs were intended to go beyond existing private-public partnerships (PPPs), streamlining and coordinating existing instruments in the European research landscape. In their present form, EIPs are coordination instruments for research and innovation activities at EU level in their respective fields.

The following initiative is considered for analysis in the present report:

Initiatives Analysed	
SMART CITIES AND COMMUNITIES	*Fiche EIP SCC*

2.1.3 EUROPEAN ENERGY RESEARCH ALLIANCE (EERA)

This is the alliance of European public research centres and universities active in the field of clean energy. This community has a central role in the implementation of the 10 actions of the SET-Plan and acts towards the society as an independent and trusted advisor and as an ambassador to the SET-Plan priorities.

The framework has great potential impact because it coordinates a significant portion of the European public scientific community in the energy sector to produce excellent research, being a “reservoir” of research results/solutions/knowledge/IP ready to be transferred to the industry. As can be seen in Figure 5, the alliance aims at coordinating national research programmes to speed up the achievement of key exploitable results and the market uptake of clean energy technologies. The active collaboration across the research community spreads from the setting up of common research agendas, to the sharing of resources (personnel, infrastructures), to the conduction of common research programmes, delivering results to all stakeholders and transferring the related knowledge.

EERA brings together around 250 research centres and universities across 30 countries. Actively working together in 17 joint research programmes (the EERA Joint Programmes - JPs), EERA builds on national research initiatives and works on shared priorities and research projects. The EERA JPs are aligned with the priorities for low carbon technologies defined in the EU SET-Plan. EERA works together with industry stakeholders to coordinate research and innovation priorities. This collaboration aims to foster world-class technology and innovation in Europe’s energy sector and to reduce the time-to-market for technologies. The EERA JPs are important points of contact for collaboration outside Europe.

EERA members regularly represent the European scientific community globally, collaborating with international partners worldwide. The conceptual map of EERA JPs is shown in Figure 6, subdividing the different programmes into 3 main work streams: namely: material, technologies and systems.

Within the large plethora of initiatives active in the EERA framework, for the scope of this report, we will retain and analyse the following:

Initiatives Analysed	
Smart Grids	*Fiche EERA SG*
Economic, Environmental and Social impacts	*Fiche EERA E3S*

Energy Storage	*Fiche EERA Storage*
Energy System Integration	*Fiche EERA ESI*
Smart Cities	*Fiche EERA SC*

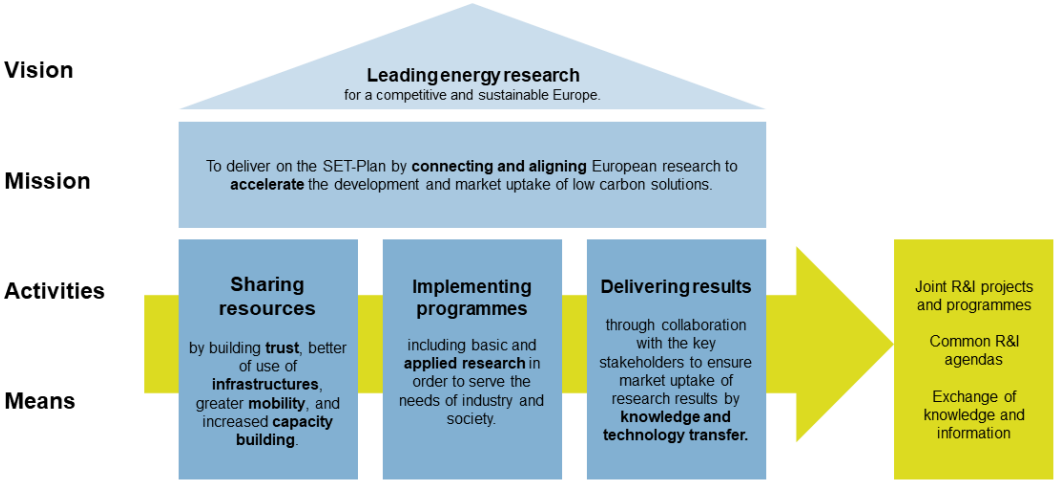


Figure 5: The main pillars of the action of EERA Joint programmes

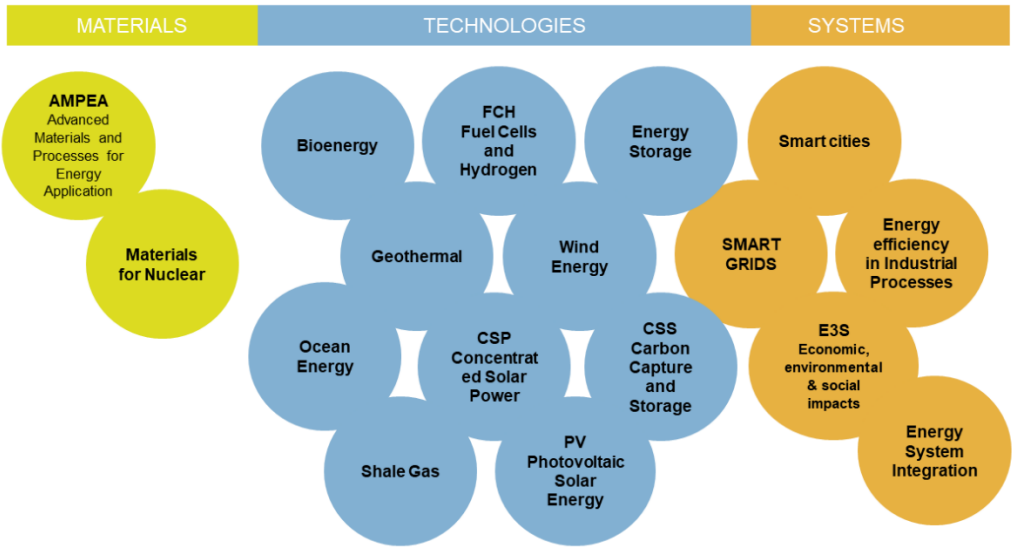


Figure 6: Conceptual map of EERA Joint programmes (JPs)

Amongst the different EERA JPs, JP Smart grids is focused on electric networks with the aim of aligning national research programmes with common objectives, in order to limit duplication and promote synergies. This initiative involves 42 partners from 17 countries and develops research activities on control architectures (and in particular the concept of "Web-of-cells"), integration of storage, renewable energy, user involvement and modernization of transmission networks.

2.1.4 SET-PLAN IMPLEMENTATION WORKING GROUPS (IWGs)

The IWGs were established to tackle the SET-Plan's research and innovation actions, optimizing national R&I funding programmes to jointly implement activities of common interest. In the IWGs,

representatives of the SET-Plan countries are present with the aim of working together to optimize their use of national R&I funding programmes to implement activities appointed by the IWGs.

Amongst the numerous IWGs addressing all 10 actions of the SET-Plan, the following will be further analysed in this report:

Initiatives Analysed	
SMART ENERGY SYSTEMS	*Fiche IWG Smart Energy System*
BATTERIES	*Fiche IWG Batteries*
SMART CITIES	*Fiche IWG Smart Cities*

In particular, the IWG 4 – Smart Energy Systems complements ETIPs giving the perspective of the governments of the 15 participating countries, which, inspired by the indications of the experts of the industry, identify and agree concrete objectives for the implementation of energy grid intelligence solutions. Joint public research projects are planned, promoting the establishment of regulatory and regulatory frameworks that facilitate innovation and adoption by users; co-ordinated jointly by Italy and Austria, recently presented its Implementation Plan [6].

2.1.5 EUROPEAN RESEARCH AREA-NET (ERA-NETs)

This instrument, created under the framework of Horizon 2020, is designed to support public-public partnerships in their preparation, establishment of networking structures, design, implementation and coordination of joint activities as well as topping up of single joint calls and of actions of a transnational nature.

The focus of ERA-Nets is shifting from the funding of networks to the top-up funding of single joint calls for transnational research and innovation in selected areas with high European added value and relevance for Horizon 2020. This aims at increasing substantially the share of funding that Member States dedicate jointly to challenge driven research and innovation agendas. Financial contributions of Member States can be in cash or in kind in order to broaden the scope of ERA-Nets towards the coordination institutional funding of governmental research organisations. In addition to the joint calls they implement, ERA-Nets have developed over the past years a vast range of networking and other joint activities that contribute significantly to the impact of the ERA-Net scheme and that should be sustained.

Amongst all active ERA-Nets, the following will be further considered in the present report:

Initiatives Analysed	
Smart Energy System	*Fiche EN SES*
Sustainable Urbanisation Global Initiative	*Fiche ENSUGI*
Smart Cities and Communities	*Fiche ENSCC*
Smart Urban Future	*Fiche ENSUF*

ERA-Net REGSYS: the ERA-Net funding scheme encourages the creation of multinational projects (financed by the agencies of the various participating countries) with the additional contribution of the Commission to reward transnational collaboration. Specifically, RegSys promotes projects on a local scale dedicated to the demonstration of integrated solutions amongst energy carriers, including not only technological aspects, but also market and user involvement.

2.1.6 PUBLIC PRIVATE PARTNERSHIPS (PPPs)

PPPs were created to enable a long-term, strategic approach to research and innovation, reducing uncertainties by allowing for long-term commitments, pooling resources into a critical mass. These initiatives enable innovative technologies to get faster to the markets, enabling the scale of research

and innovation effort needed to address critical societal challenges and major EU policy objectives. In the intention of European policy makers, PPPs intend to:

- Provide a legal structure to pool resources and to gather critical mass;
- Make research and innovation funding across the EU more efficient by sharing financial, human and infrastructure resources;
- Facilitate the creation of an internal market for innovative products and services;
- Enable innovative technologies to get faster to the market;
- Can provide the right framework for international companies to anchor their research and innovation investments in Europe;
- Enable the scale of research and innovation effort needed to address critical societal challenges and major EU policy objectives.

The most important PPPs for the present report are the following:

Initiatives Analysed	
5G Infrastructure	*Fiche 5G PPP*
Big Data Value	*Fiche PPP BIG DATA*
Cybersecurity	*Fiche PPP Cybersecurity*
European Green Vehicles Initiative	*Fiche PPP EGVI*

2.1.7 JOINT UNDERTAKINGS (JUs)

JUs are established for the efficient execution of EU research, technological development and demonstration programmes. In particular, this type of public-private partnership bodies have often been created in order to integrate industrial research in specific areas.

The members of these JUs are typically the European Union (represented by the European Commission) and, industry-led association(s), as well as other partners. JUs adopt their own research agenda and award funding mainly on the basis of open calls for proposals. Joint Technology Initiatives Joint Undertakings (JTI JUs) are a type of JU set up to implement part of a strategic research agenda of a broader industrial initiative (the JTI) arising primarily from the work of European technology platforms.

Of particular interest for the present work the following JU will be further analysed:

Initiatives Analysed	
Fuel Cells and Hydrogen	*Fiche JU FHC*

2.2 GLOBAL INITIATIVES

The multilateral initiatives landscape focussing on clean energy is very vast and continues to grow every year. There are many initiatives starting in the political frameworks (e.g. Group of Seven (G7), Group of Twenty (G20)), in the United Nations bodies (e.g. United Nations Industrial Development Organization (UNIDO), Sustainable Energy for All (SE4ALL), Climate Technology Centre and Network (CTCN)), and other international partnerships and initiatives (e.g. World Economic Forum (WEF), Carbon Sequestration Leadership Forum (CSLF), Renewable Energy and Energy Efficiency Partnership (REEP), Renewable Energy Policy Network for the 21st century (REN21) and Biofuture Platform (BfP)).

The International Energy Agency is a key global player in the study, survey and scenario setting of clean technologies.

2.2.1 INTERNATIONAL ENERGY AGENCY - TECHNOLOGY COLLABORATION PROGRAMMES (IEA-TCPs)

Founded in 1974, the IEA was initially designed to help countries co-ordinate a collective response to major disruptions in the supply of oil, such as the crisis of 1973/4. While this remains a key aspect of its work, the IEA has evolved and expanded significantly. The IEA examines the full spectrum of energy issues including oil, gas and coal supply and demand, renewable energy technologies, electricity markets, energy efficiency, access to energy, demand side management and much more. Through its work, the IEA advocates policies that will enhance the reliability, affordability and sustainability of energy in its 30-member countries and beyond.

Today, the IEA is at the heart of global dialogue on energy, providing authoritative analysis through a wide range of publications, including the flagship World Energy Outlook and the IEA Market Reports; data and statistics (such as Key World Energy Statistics and the Monthly Oil Data Service) and a series of training and capacity building workshops, presentations, and resources.

The four main areas of IEA focus are:

- **Energy Security:** Promoting diversity, efficiency, flexibility and reliability for all fuels and energy sources
- **Economic Development:** Supporting free markets to foster economic growth and eliminate energy poverty;
- **Environmental Awareness**: Analysing policy options to offset the impact of energy production and use on the environment, especially for tackling climate change and air pollution; and
- **Engagement Worldwide**: Working closely with partner countries, especially major emerging economies, to find solutions to shared energy and environmental concerns.

The IEA's Technology Collaboration Programmes (TCPs) is a complex network with 38 collaborative partnerships exchanging knowledge and conducting various levels of research and technology analysis. The TCPs involve over 6 000 experts worldwide who represent nearly 300 public and private organisations located in 55 countries, including a large participation by IEA Association countries, such as China, India and Brazil.

TCPs have examined around 2 000 energy-related topics and carried out projects on socio-economic aspects of technology deployment, research to reduce greenhouse gas emissions, advancing demonstration of innovative energy technologies, contributing to benchmarks and international standards and sharing information through hundreds of expert stakeholder events. Comprised of senior experts from IEA member governments, the Committee on Energy Research and Technology (CERT) considers effective energy technology and policies to improve energy security, encourage environmental protection and maintain economic growth.

Under the guidance of the IEA Governing Board, the CERT oversees the technology forecasting, analyses and the research, development, demonstration and deployment (RDD&D) strategies of the

IEA Secretariat, notably through its flagship technology tracking project, Tracking Clean Energy Progress (TCEP), and the series of Technology Roadmaps. The CERT also provides strategic guidance to its Working Parties, Experts' Groups and the Technology Collaboration Programmes. The map of CERT, Working Parties and TCPs is reported in Figure 7.

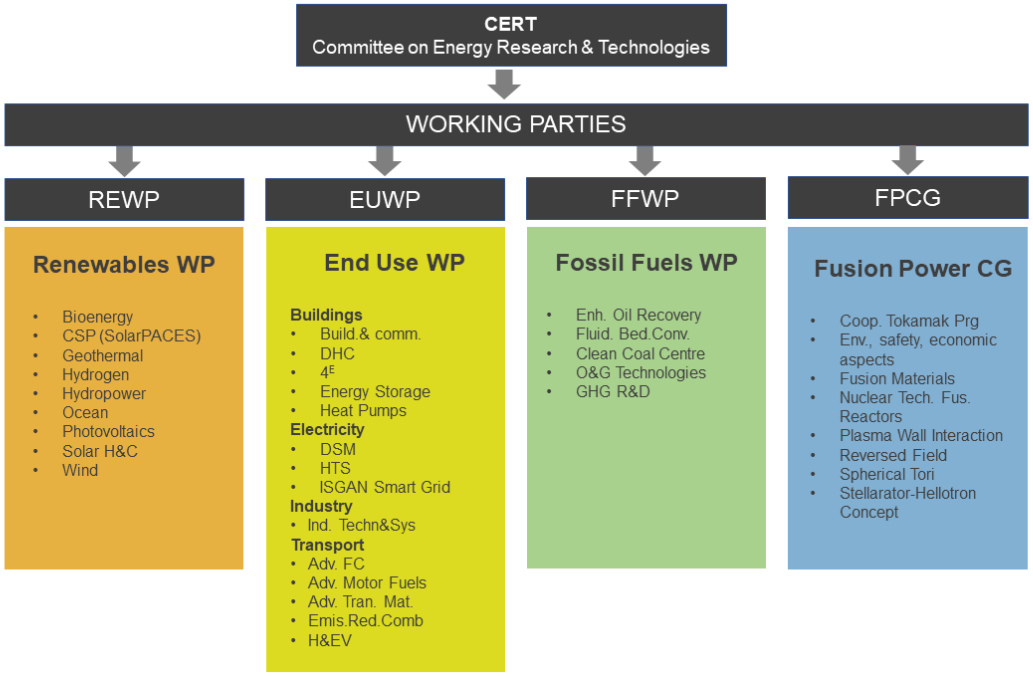


Figure 7: Structure of influence of the CERT and its working parties and TCPs

Amongst the 38 TCPs, the most important for the purpose of the present publication are the following:

Initiatives Analysed	
Energy Conservation through Energy Storage	*Fiche TCP ECES*
Energy Efficient End-Use Equipment	*Fiche TCP 4E*
Hybrid & Electric Vehicle	*Fiche TCP HEV*
Demand Side Management	*Fiche TCP DSM*
International Smart Grids Action Network	*Fiche TCP - ISGAN*
Energy Buildings & Communities	*Fiche TCP EBC*
District Heating and Cooling CHP	*Fiche TCP DHC-THC*

2.2.2 MISSION INNOVATION (MI)

MI is a global initiative of 23 countries and the European Union (representing more than 80% of global GHG emissions and of global clean energy R&D budgets) announced on November 30th, 2015 when world leaders came together in Paris to undertake ambitious efforts to combat climate change and dramatically accelerate global clean energy innovation.

As part of the initiative, participating countries have committed to seek to double their governments' clean energy research and development (R&D) investments over 5 years (starting from the benchmark of 15 b$/year to reach after 5 years the total investment of 30 b$/year), while encouraging greater levels of private sector investment in transformative clean energy technologies. New investments are focused on transformational clean energy technology innovations that can be scaled to varying economic and energy market conditions that exist in participating countries and in the broader world. High-level

leadership is provided by member governments' Ministers with responsibility for clean energy innovation. The MI Steering Committee, comprised of member government representatives, provides strategic guidance to foster implementation of the Enabling Framework. Core administrative functions are carried out by the MI Secretariat, a small, flexible team supporting the Steering Committee.

Innovation Challenges (ICs) are global calls to action aimed at accelerating research, development and demonstration (RD&D) in technology areas that could provide significant benefits in reducing greenhouse gas emissions, increasing energy security and creating new opportunities for clean economic growth. 8 ICs were identified by MI participants, and namely:

- **IC1: Smart grids:** To enable future grids that are powered by affordable, reliable, decentralised renewable electricity systems
- **IC2: off grid access to electricity:** To develop systems that enable off-grid households and communities to access affordable and reliable renewable electricity.
- **IC3: carbon capture:** To enable near-zero CO_2 emissions from power plants and carbon intensive industries.
- **IC4: sustainable biofuels:** To develop ways to produce, at scale, widely affordable, advanced biofuels for transportation and industrial applications.
- **IC5: converting sunlight:** To discover affordable ways to convert sunlight into storable solar fuels.
- **IC6: clean energy materials:** To accelerate the exploration, discovery and use of new high-performance, low-cost clean energy materials.
- **IC7: Affordable Heating and Cooling of Buildings:** To make low-carbon heating and cooling affordable for everyone.
- **IC8: Renewable and Clean Hydrogen:** To accelerate the development of a global hydrogen market by identifying and overcoming key technology barriers to the production, distribution, storage, and use of hydrogen at gigawatt scale.

Amongst the 8 ICs, the most important for the purpose of the present publication are the following:

Initiatives Analysed	
IC#1 SMART GRIDS	*Fiche MI - IC#1*
IC#7 HEATING AND COOLING	*Fiche MI - IC#7*

2.2.3 CLEAN ENERGY MINISTERIAL (CEM)

The Clean Energy Ministerial (CEM) is a high-level global forum to promote policies and programmes that advance clean energy technology, to share lessons learned and best practices and to encourage the transition to a global clean energy economy. Initiatives are based on areas of common interest amongst participating governments and other stakeholders. Together, the 25 countries and the European Commission that are members of the CEM account for about 90% of global clean energy investments and 75% of global greenhouse gas emissions. They also fund the vast majority of public research and development in clean energy technologies. They are the world's leading installers of wind turbines and solar photovoltaics as well as the primary markets for emerging options such as carbon capture and storage. They are also the world's major producers and purchasers of key energy-consuming products such as automobiles, televisions, and other appliances.

Current CEM members are Australia, Brazil, Canada, Chile, China, Denmark, the European Commission, Finland, France, Germany, India, Indonesia, Italy, Japan, Korea, Mexico, Norway, Russia, Saudi Arabia, South Africa, Spain, Sweden, the Netherlands, the United Arab Emirates, the United Kingdom, and the United States. The CEM is currently the only regular meeting of energy ministers at which they exclusively discuss clean energy. The CEM also engages other ministries that play an important role in clean energy in some governments, such as ministries of science and technology or economics. The CEM also builds on and informs existing multilateral technical and policy work in cooperation with institutions such as the International Energy Agency, International Partnership for

Energy Efficiency Cooperation and International Renewable Energy Agency. The CEM's unique focus on clean energy and the broad set of participating ministers make it an especially promising forum for collaboration.

The work of the CEM takes place through 3 main activities:

- High-level policy dialogue at annual ministerial meetings helps advance international collaboration to accelerate the adoption of clean energy policies and practices;
- Public-private engagement builds the industry, government, and civil society cooperation needed to scale up clean energy around the globe;
- Year-round work through action-driven, transformative **clean energy initiatives and campaigns** expands the deployment of clean energy technologies, policies, and practice.

CEM initiatives focus on empowering energy decision makers around the world with the up-to-date information and tools they need to improve the policy environment for clean energy. This low-cost, high-impact technical work also facilitates international coordination that amplifies each government's clean energy deployment efforts. The following initiatives are presently active within CEM:

- **21st Century Power (21CPP)**: to support new generation, T&D construction and refurbishment, grid intelligence, and end-use efficiency;
- **Appliances (SEAD):** the Global Efficiency Medal competition recognizes products in the following categories: Television, Lighting, Motors, Display, Connected equipment;
- **CCUS Initiative:** to strengthen the framework for public-private collaboration on CCUS, while complementing the efforts and adding coordinated value beyond the activities of existing organizations and initiatives (IEA, MI, CSLF etc.);
- **Clean Energy Solutions Center**: helps governments design and adopt policies and programmes that support the deployment of transformational low-carbon technologies. The Solutions Center offers no-cost clean energy policy assistance for government policy makers, online training and webinars, and peer-to-peer learning to help countries tailor solutions to their needs and foster international collaboration on policy innovations;
- **Electric Vehicles Initiative (EVI):** is a multi-government policy forum dedicated to accelerating the introduction and adoption of electric vehicles worldwide;
- **Global Lighting and Energy Access Partnership (Global LEAP),** is an energy access initiative, working to catalyze the development of commercial markets for energy access solutions;
- **Regional and Global Energy Interconnections Initiative**: facilitates the transition of energy systems to electricity-centered and interconnected modern energy systems, featuring high penetration of clean energy;
- **Energy Management Working Group (EMWG):** leverages government resources and takes collective action to accelerate ISO 50001(i.e. certified energy management systems (EnMS)) adoption around the globe;
- **Investment and Finance initiative (CEM-IF):** aims to support energy ministries of CEM countries in developing policies and enabling frameworks conducive to mobilizing investment and financing, particularly from private sources, for deployment of clean energy at scale;
- **Nuclear Innovation**: seeks to start a dialogue on the role that nuclear energy can play in clean energy systems of the future;
- **ISGAN - International Smart Grid Action Network:** creates a mechanism through which stakeholders from around the world can collaborate to accelerate the development and deployment of smarter electric grids;
- **The Multilateral Solar and Wind Working Group:** aims to promote the accelerated deployment of solar and wind technologies;
- **Sustainable cities and eco-towns:** the initiative facilitates sharing of best practices and learnings between cities and also addresses important energy issues in small and remote communities;

- **Clean Energy Education and Empowerment (C3E):** enables greater gender diversity in clean energy professions, recognizing that the transition to a clean energy future will only success if we harness all possible talent.

Amongst the 14 CEM initiatives, the most important for the purpose of the present publication are the following:

Initiatives Analysed	
21st Century Power Partnership	*Fiche CEM 21 CPP*
Electric Vehicle Initiative	*Fiche CEM EVI*
Regional and Global Energy Interconnection	*Fiche CEM RGEI*
Sustainable Cities and eco-energy Town	*Fiche CEM Sustainable Cities*

3 MUTUAL RELATIONS AMONGST THE MAIN INITIATIVES IDENTIFIED

Each country develops its own energy strategy, which reflects the practical actions to be implemented to ensure at national level the energy security, competitiveness and sustainability objectives, aligned with the engagements taken at European (National Energy and Climate Plans) and international levels (Nationally Determined Contributions (NDCs)). The energy strategy includes an energy research strategy, composed of research programmes. In addition, decisions are taken with regards to the frameworks of international collaboration.

The national strategies of the EU28 countries and the European collaboration framework give rise to the strategy of the European Energy Union, where the research and innovation arm is constituted by the SET-Plan. The operation of the SET-Plan is explicated through the different initiatives: ETIPs (focusing on stakeholders under the main driver of the industrial operators and technology providers), EERA (focusing on public research centres and universities) and IWGs (where the main actors are governments representatives highlighting and aligning the national policy priorities). EERA and IWGs, are mostly financed by national research funds and aim at aligning the national research priorities with the SET-Plan. ETIPs address mainly the European research priorities and give indication and feedback to the SET-Plan and the related funding schemes (for example Horizon 2020). National and European research frameworks are amongst the actors of the Technology Collaboration Platforms (TCPs) of the IEA, the main global research framework. Some of the European governments, at the light of their national energy strategies, participate to the CEM initiatives and campaigns and through their national research strategies and resources to some (or all) the Innovation Challenges of Mission Innovation.
This simplified flow is depicted in Figure 8.

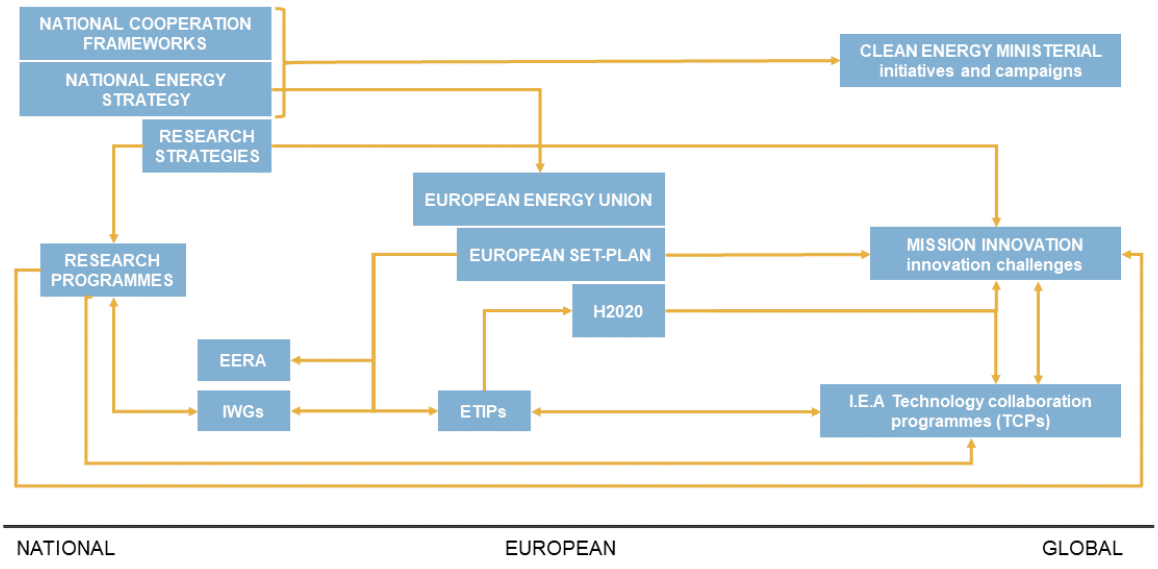


Figure 8: Simplified flow and relations among national, European and global initiatives in the field of clean energy technologies and solutions

4 INSIGHT INTO THE INITIATIVES DEALING WITH THE INTEGRATED ENERGY SYSTEM

The different initiatives were analysed to identify their perimeter, geography, composition, outcomes and potential synergies. The data considered are based on the publicly available information (websites, publications, experts view) and, when possible, were successively validated by outstanding representatives, by means of online questionnaires and requests of feedback on material sent for revision. The list of respondents is reported in the Annexes.

4.1 ANALYSIS BY ENERGY SYSTEM FRACTIONS

The first dimension considered in view of addressing the potential synergies, gaps and complementarities of the initiatives, is aimed at analysing the portion of the energy system addressed in their workstream. Towards this purpose, the energy system was subdivided into its main components, according to the scheme shown in Table 1:

Table 1: Components of the energy system considered in the detailed analysis

Code	Portion of the energy system
1	Fossil fuel generation – flexibility
2	Nuclear generation – flexibility
3	Large RES – integration
4	Distributed RES
5	Bioenergy and circularity
6	Electricity networks
7	Gas networks
8	Heating & cooling networks
9	Energy vector integration
10	Mobility: electric and other forms
11	EV Charging stations integration
12	Vehicle to grid services
13	Small scale electricity storage
14	Large scale electricity storage
15	Gas storage
16	Heat storage
17	Pumped hydro storage
18	Hydrogen
19	Power-to-gas
20	Gas-to-power
21	Power-to-heat
22	Gas-to-heat
23	Heat pumps
24	Demand response
25	Consumer behavior
26	Zero energy buildings
27	Local energy communities – smart cities
28	ICT and related aspects

An overall view of the range of activities of the European initiatives across the components of the integrated energy system selected is reported in Figure 9. The figure reports, on the right-hand side the initiatives, in ascending order of number of relations (proceeding clockwise from 00h00h to 06h00) and on the left part of the quadrant the components of the energy system, in ascending order of interest (proceeding clockwise from 06h00 to 12h00).

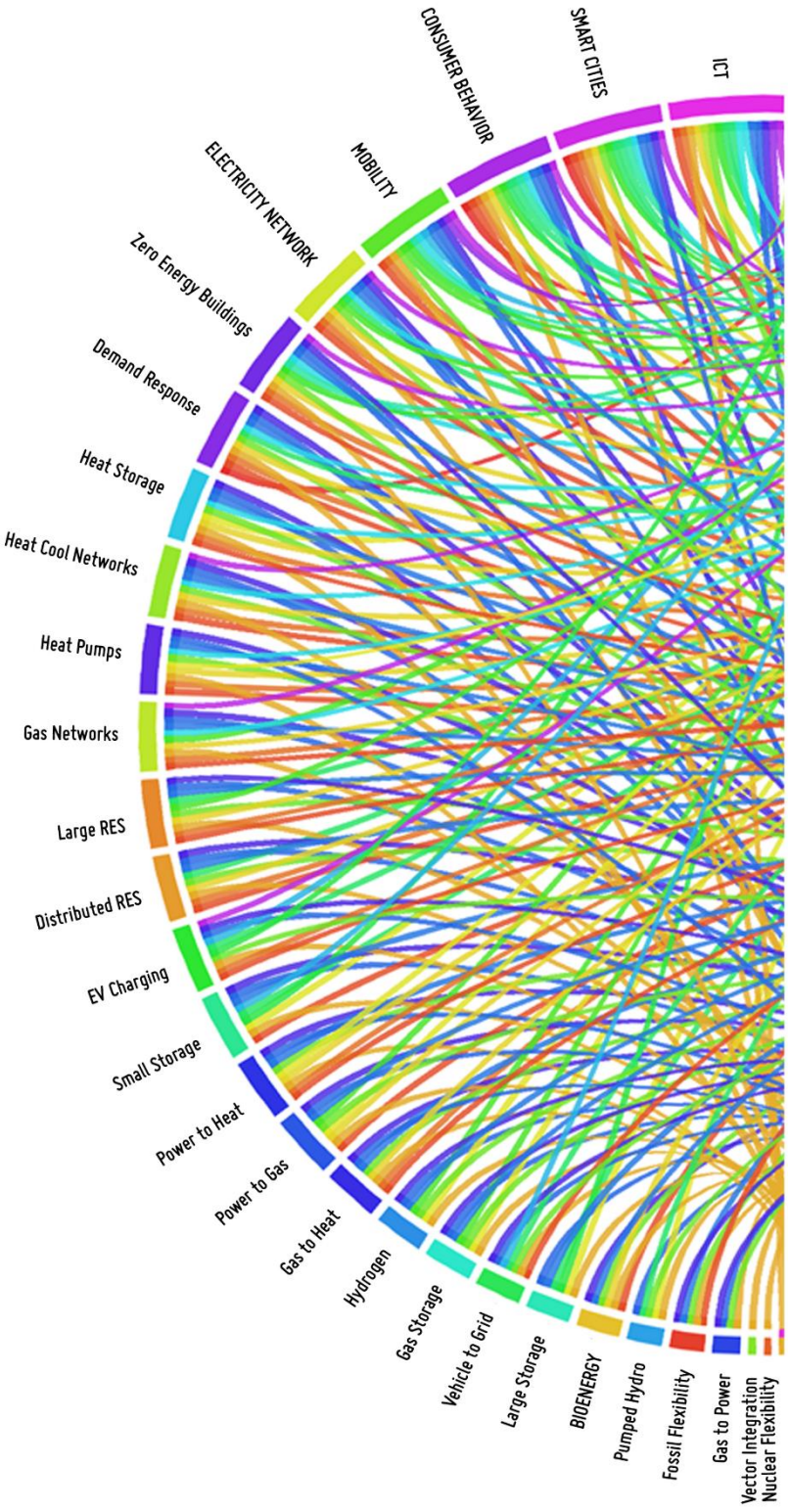
Each line in the graph starts from an initiative and ends on a target portion of the energy system: it represents the presence of the target into the scope of the initiative, whatever the “intensity” of this relation (core activity or marginal for the initiative). The representation has the only purpose to illustrate qualitatively the situation.

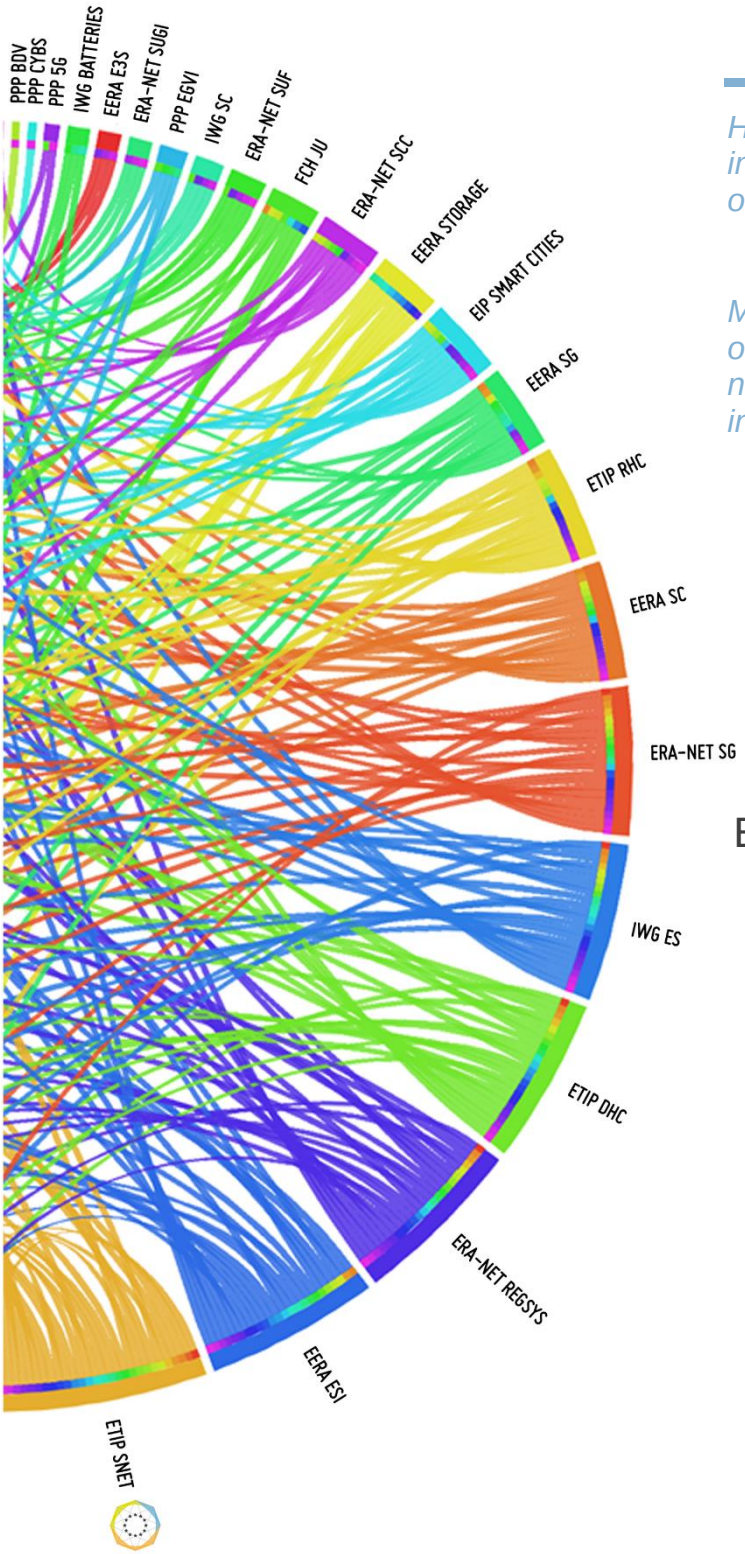
The overall image that emerges shows at first that all portions of the integrated energy system are covered: this is a sign of vitality of the European cooperative research and innovation field. The second message from the figure is the absolute and urgent need of rationalisation and collaboration. In fact, most of the targets are hit by several lines showing that different initiatives address in parallel the same subjects (at least partially) with a potential risk of overlap.

Figure 9: Qualitative relations diagram between European initiatives and the portions of the integrated energy system

It is visible that all components of the energy system are covered. This demonstrates the vitality of the European cooperative research and innovation field.

COMPONENTS OF THE ENERGY SYSTEM





Here it is possible to see how each initiative takes part in the different portions of the energy system.

Many initiatives address common portions of the energy system. This is a sign of the need for rationalisation and collaboration in order to avoid overlaps.

EUROPEAN INITIATIVES

Further analysis is required to evaluate this risk, at the light of a higher level of detail: e.g. looking at scopes, time spans, stakeholders, TRLs, etc of the different contexts (e.g. ETIPs, EERA, ERA-Net, PPPs) to highlight synergies and complementarities of approach. Looking from the perspectives of the ETIP SNET, its scope appears to be the widest and overarching, as it covers the entire span across the integrated energy system. Similar ranges are seen in the scope of EERA ESI (although with a more methodological and long-term perspective), the SET-Plan IWGs and the ERA-Nets REGSyS and Smart Grids Plus (here more focused on the development and fostering of joint calls and local integrated projects). The initiatives dealing with smart cities (e.g. EIP, EERA) and integration of heating and cooling (e.g. DHC+, RHC) hit similar targets and need links and synergies.

The complete set of information and feedback collected from the initiatives in terms of the relevance that each of them gives to each of the components considered in Table 1, is reported as an Annex.

Although part of the analysis was carried out using the 28 components listed above, a higher-level approach was used, aggregating the components according to the criteria shown in TABLE 2:

Table 2: Components of the energy system considered in the aggregated analysis

Code	Aggregated components of the energy system	Ingredients from the detailed list
A	Generation	1, 2, 3, 4
B	Renewables	3, 4, 5
C	Electric Network	6
D	Energy Networks	6, 7, 8
E	Mobility	10, 11, 12
F	Systems Integration	6, 7, 8, 19, 20, 21, 22
G	Storage	13, 14, 15, 16, 17
H	P-t-X	19, 21
I	End-Use Flexibility	10, 16, 23, 24, 25, 26
J	Energy Communities	27
K	ICT	28

The assessment of the perimeter of the different initiatives considered has been carried out using a qualitative approach, based on relevance scale ranging from the attribute “not relevant”, to the attributed “core activity”.

Figure 10 shows, for each European initiative considered, the fraction of the integrated energy system addressed (in terms of inclusion in the workstream of the initiatives of activities, also marginal, addressing the different aggregated components of the energy system). It can be observed that several initiatives (e.g. PPPs, IWG Batteries, etc.) are very focused on specific system component, while others range widely across the entire system (e.g. ETIP SNET, ETIP DHC+, ERA-Net REGSYS).

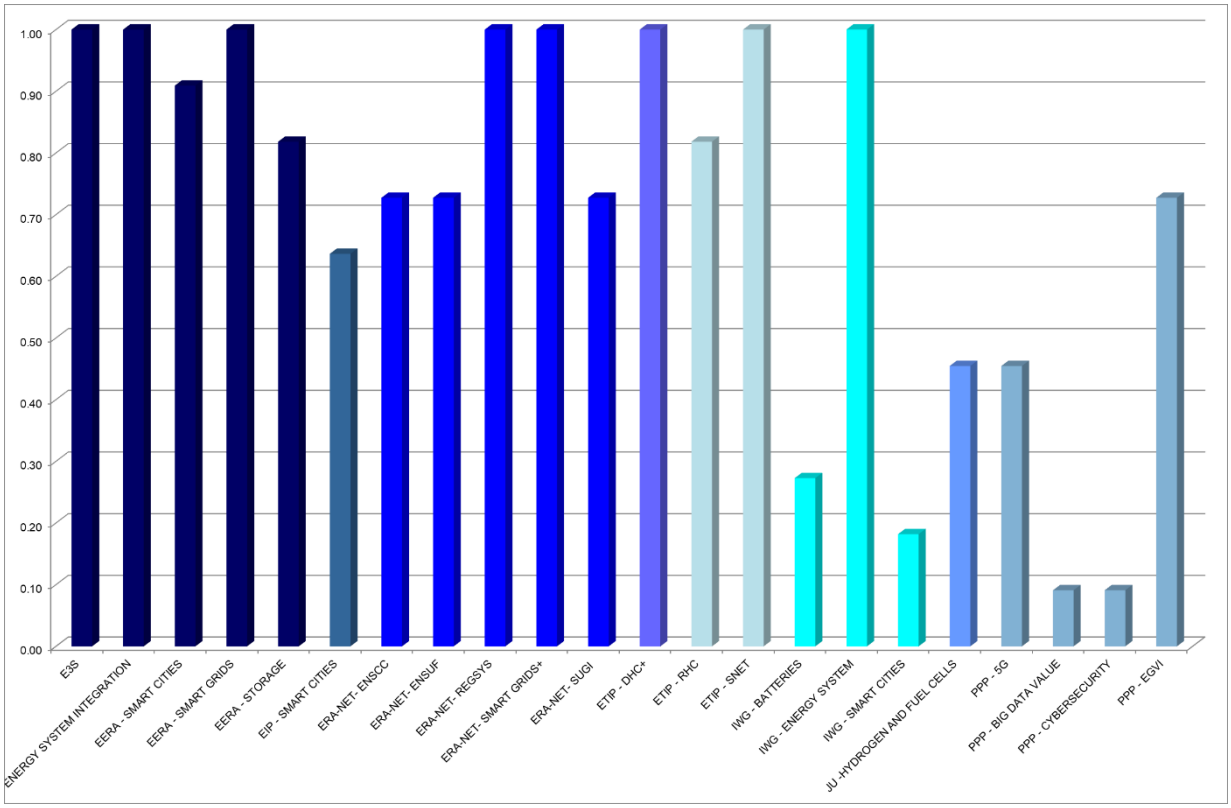


Figure 10: Fraction of the energy system addressed by the European initiatives considered

Weighing the above results with the level of relevance of each of the system components addressed, the figure is modified as in FIGURE 11, showing that some of the initiatives consider the energy system extensively, devoting high attention to every component of the system itself (see for example ETIP-SNET, ERA-Net REGSYS and IWG ENERGY SYSTEM), while others, although embracing most of the energy system in their scope, focus their real attention towards more specific components.

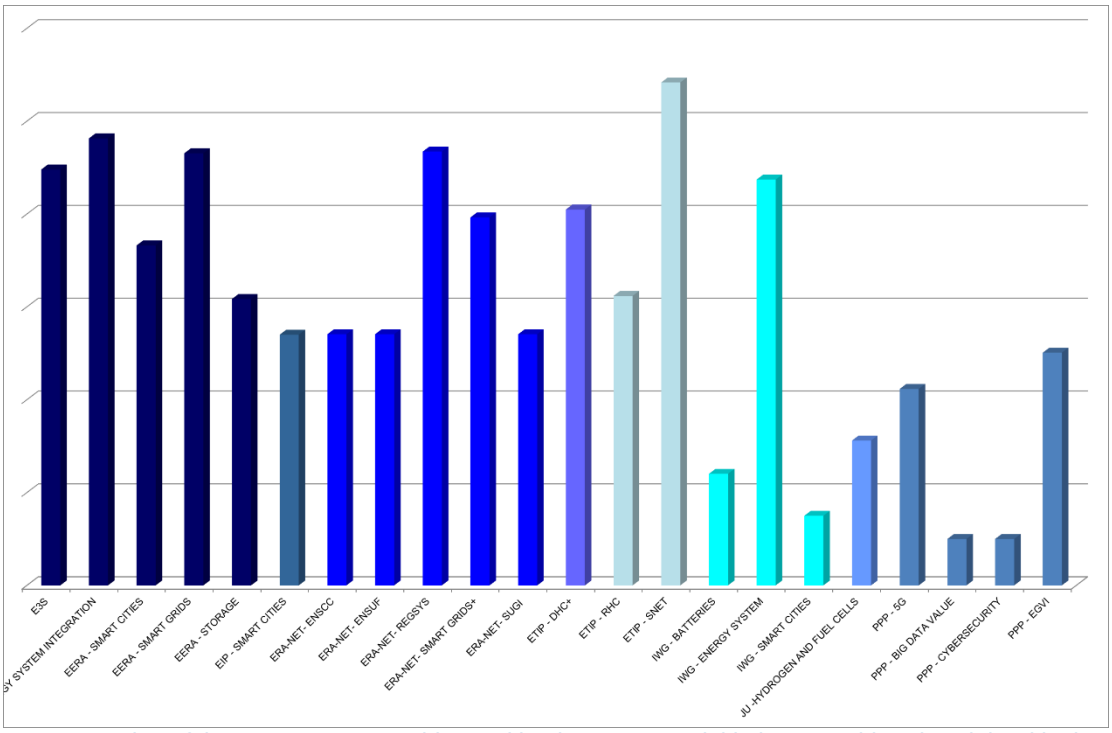


Figure 11: Fraction of the energy system addressed by the European initiatives considered, weighted by level of relevance – vertical axis not labelled – figure to be used for relative comparisons only

Reversing the approach to analyse the coverage by the European initiatives of the different portions of the energy system, the result is shown in the Figure 12. The diagram shows, in relative terms, the cumulated scores obtained for each fraction of the energy system, according to the aggregated analysis as considered in TABLE 2. The cumulated scores are calculated considering both the number of initiatives addressing the specific portion of system and the level of given relevance. Globally, the highest scores (in relative terms) are obtained by the themes pertaining to the Energy Communities (i.e. addressing widely not only the energy system but wider aspects such as governance, mobility, sustainability etc.) followed by the ICT (i.e. overarching across the entire system). Electricity networks are high in the focus as well as the flexibility tools and means achievable by end-use applications, mobility, energy networks and system integration. Renewables integration, and generation flexibility are also widely addressed, while Power-to-X and storage are partly addressed and not yet in the general focus, at least by the initiatives here considered.

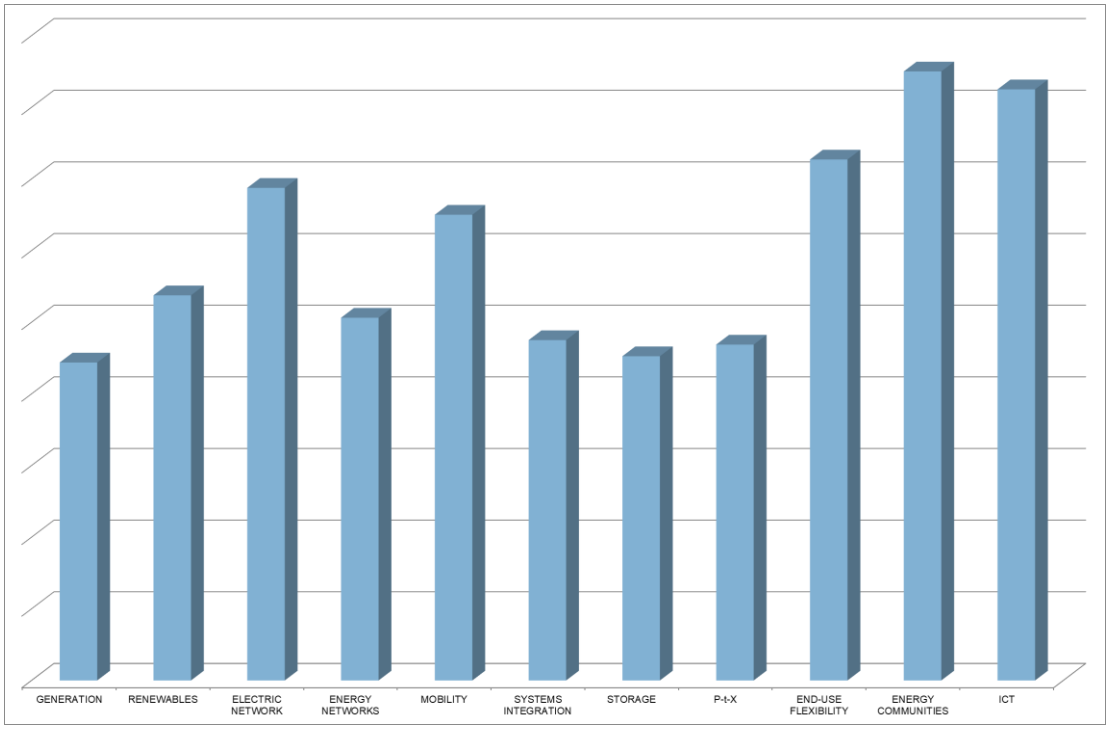


Figure 12: Level of coverage of the different portions of energy system by the European initiatives considered, weighted by level of relevance – vertical axis not labelled – figure to be used for relative comparisons only

A similar analysis has been carried out considering the initiatives at a global scale. Figure 12 shows the fraction of the integrated energy system addressed, while Figure 13 shows these results in relative terms, weighted with the level of relevance of each system component addressed. As can be seen comparing the data in Figure 11 and Figure 13 (represented on the same scale – no label is reported on the scale as the message is essentially in relative terms), European initiatives span across the entire energy system more than the global ones. Some of the TCPs of the IEA (e.g. ECES TCP, DHC TCP), MI (IC1, IC7) and less intensively CEM (21 CPP) address a wide portion of the integrated energy system.

The analysis of the coverage by the global initiatives of the different portions of the energy system, is shown in the Figure 15. The diagram shows in relative terms the cumulated scores obtained for each fraction of the energy system, according to the aggregated analysis as considered in Table 2. Here again Energy Communities aspects are the most addressed, followed by electric networks and ICT. End-use flexibility as well as mobility are also global priorities.

A comparison of coverage from European and global initiatives (from Figure 12 and Figure 15 respectively) is shown in Figure 16; it illustrates that the focus of global initiatives is more devoted to specific technologies (generation, renewables, electricity networks) or compartments (mobility): in these sectors the specific priority appears higher than that of European initiatives. On the other hand, European initiatives have a wider attention on system integration and non-electricity carriers (gas, heating, cooling, Power-to-X etc.). Energy communities and ICT aspects are higher in ranking than the global ones.

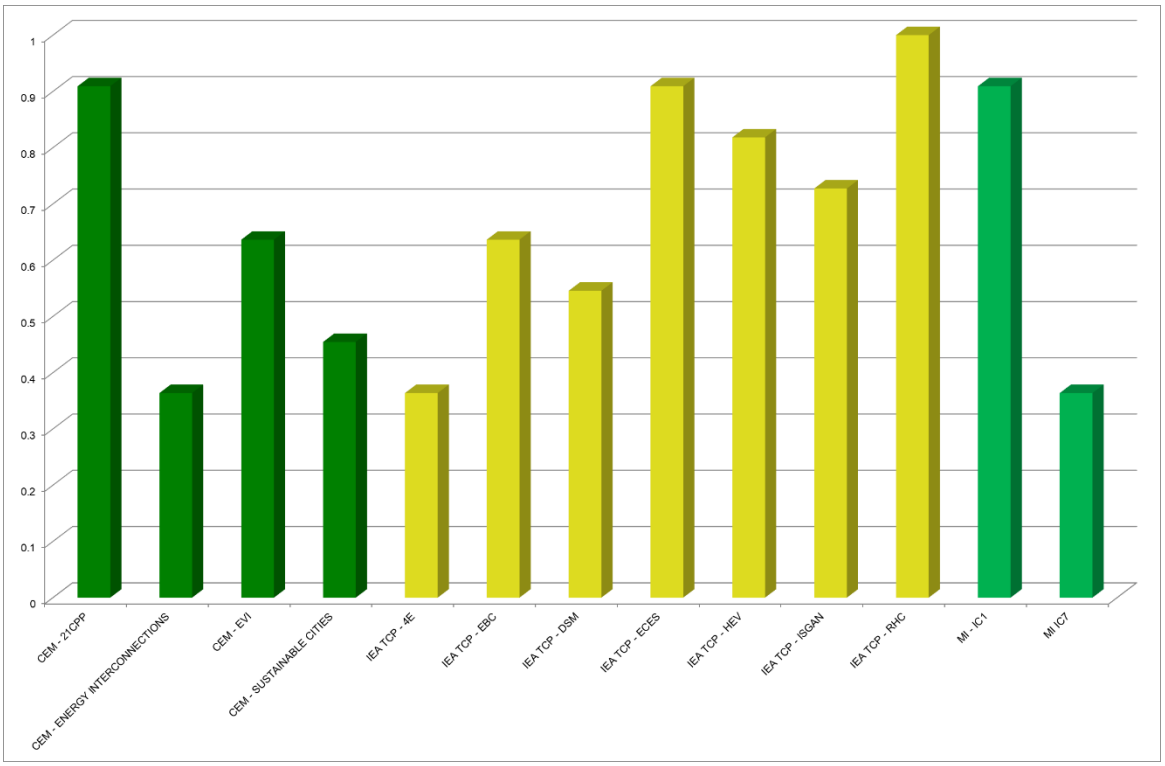


Figure 13: Fraction of the energy system addressed by the global initiatives considered

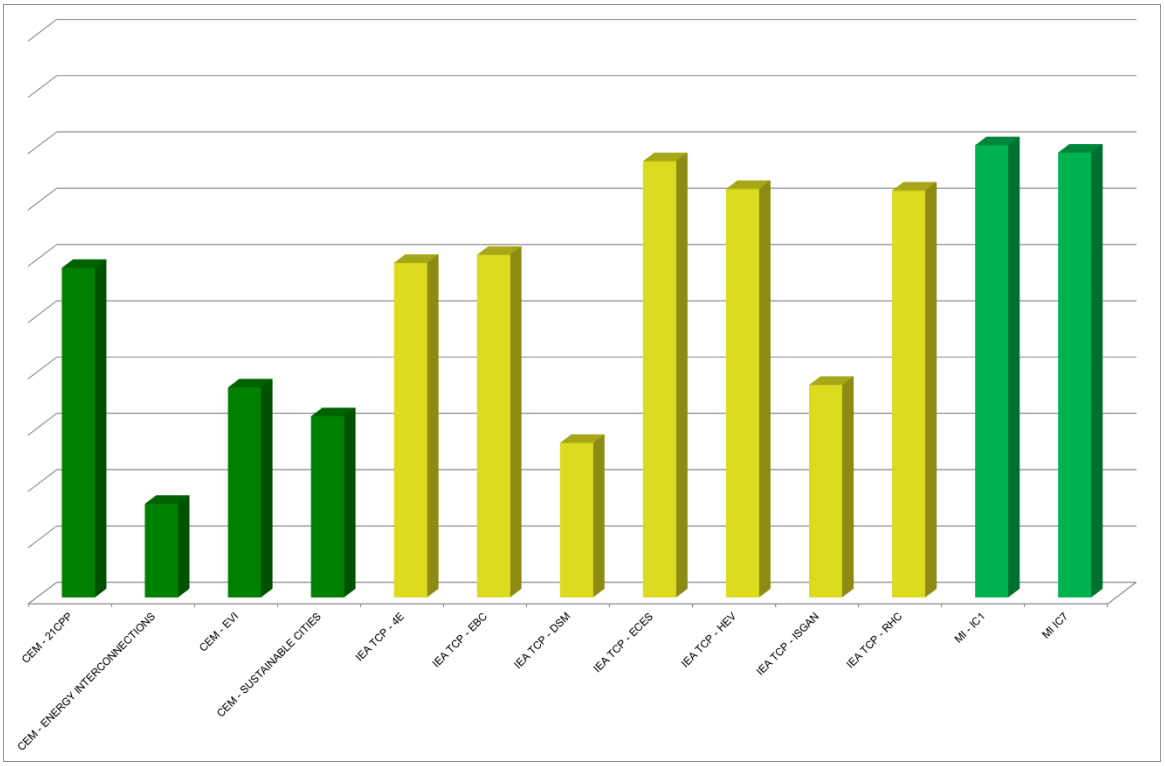


Figure 14: Fraction of the energy system addressed by the global initiatives considered weighed by the level of relevance – vertical axis not labelled, figure to be used for relative comparisons only.

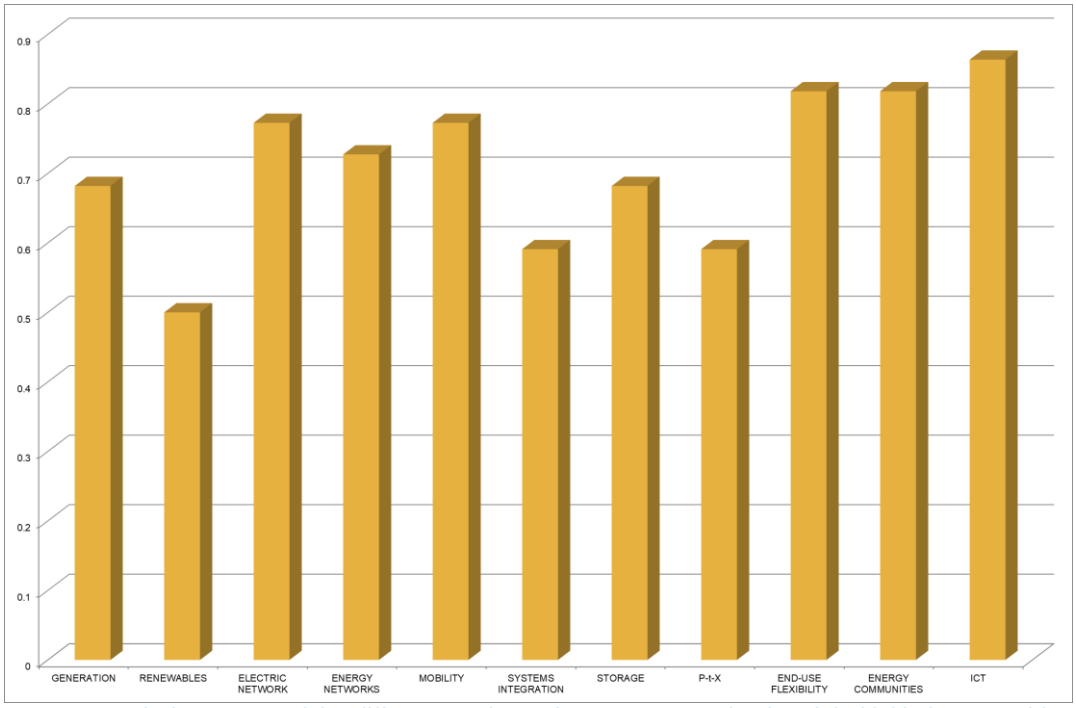


Figure 15: Level of coverage of the different portions of energy system by the global initiatives considered, weighted by level of relevance – vertical axis not labelled – figure to be used for relative comparisons only

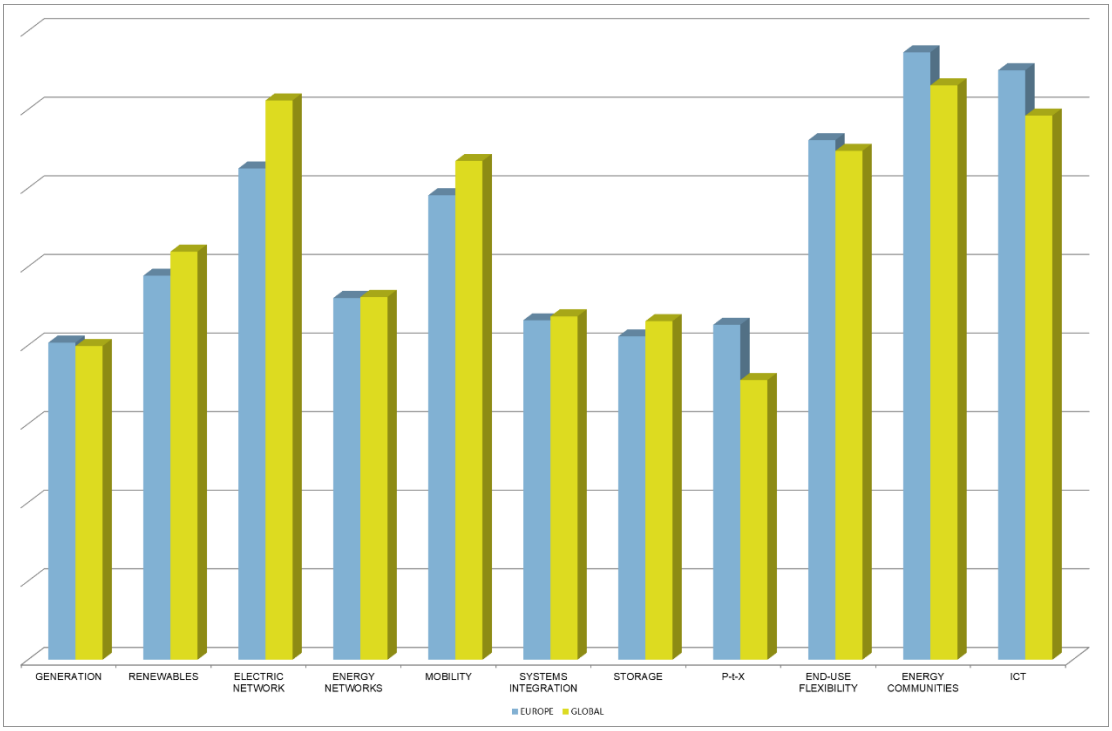


Figure 16: Comparison of the level of coverage of the different portions of energy system by the European and the global initiatives considered, weighted by level of relevance – vertical axis not labelled – figure to be used for relative comparisons only

The level of relevance of the different portions of the energy systems as perceived by the European initiatives is shown in the following Table 3. The code of colours adopted shows no dot (empty cell) when the initiatives listed in the rows do not consider the fraction of energy system listed in the columns.

Red dots are used when the subject is addressed but not relevant in the development strategy of the initiative, yellow dots for a partial relevance and green dots are shown when the fraction of energy system is considered core for the initiative.

Table 3: Level of relevance of the fractions of the energy system for the different European initiatives

		GENERATION	RENEWABLES	ELECTRIC NETWORK	ENERGY NETWORKS	MOBILITY	SYSTEMS INTEGRATION	STORAGE	P-t-X	END-USE FLEXIBILITY	ENERGY COMMUNITIES	ICT
EERA	E3S	🟢	🟢	🟡	🟡	🟡	🟡	🟡	🟡	🟢	🟢	🟡
EERA	ENERGY SYSTEM INTEGRATION	🟢	🟢	🟢	🟡	🟢	🟢	🟢	🟢	🟢	🟡	🟡
EERA	SMART CITIES	🔴	🟡	🟢	🟡	🟢	🔴	🔴		🟢	🟢	🟢
EERA	SMART GRIDS	🟡	🟢	🟢	🟡	🟢	🟡	🟢	🟡	🟢	🟢	🟢
EERA	STORAGE			🔴	🔴	🟢	🟡	🟢	🟢	🟡	🔴	🔴
EIP	SMART CITIES	🔴	🟡	🟢	🟢	🟢	🔴			🟡	🟢	🟢
ERA-NETs	ENSCC SMART CITIES AND COMMUNITIES	🔴		🟡	🔴	🔴		🔴		🟢	🟢	🟡
ERA-NETs	ENSUF SMART URBAN FUTURE	🔴		🟡	🔴	🔴		🔴		🟢	🟢	🟡
ERA-NETs	REGSYS	🔴	🟢	🟢	🟢	🟡	🟢	🔴	🟢	🟢	🟢	🟢
ERA-NETs	SMART GRIDS PLUS	🔴	🟢	🟢	🟡	🟡	🟡	🔴	🔴	🟢	🟢	🟢
ERA-NETs	SUGI - SMART URBANISATION	🔴		🟡	🔴	🔴		🔴		🟢	🟢	🟡
ETIPs	DHC+	🟡	🟢	🟡	🔴	🔴	🟡	🔴	🟢	🟢	🟢	🟡
ETIPs	RHC	🔴	🟡	🔴	🟡		🟡		🟡	🟡	🟢	🟡
ETIPs	SNET	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢
IWG	BATTERIES					🟢		🔴	🔴			
IWG	ENERGY SYSTEM	🟡	🟡	🟢	🟢	🔴	🟡	🟡	🟡	🟢	🟢	🟢
IWG	SMART CITIES									🔴	🟢	
JTU	HYDROGEN AND FUEL CELLS	🔴		🔴	🔴		🔴		🔴			
PPP	5G			🟡		🟢				🔴	🟢	🟢
PPP	Big data value											🟢
PPP	Cybersecurity											🟢
PPP	European Green vehicles Initiative			🟡	🔴	🟢	🔴		🔴	🟡	🟡	🟡

As can be seen in Table 3, initiatives such as ETIP SNET cover extensively the entire energy system structure. This focus, in terms of portions of the system as well as of level of relevance, is quite variable: EERA E3S, Energy Systems Integration and Smart grids as well as ERA-Net RegSys and ETIP RHC+ are characterised by an overarching scope, while most of the other initiatives dedicate attention to more specialised subjects.

In order to assess the level of similarity of the different initiatives in terms of portion of energy systems and the related relevance, a comparative analysis is carried out based on the root means square error approach. The complete results of the analysis are reported in the Annex II.

Focusing the attention to the ETIP SNET, the representation of the similarity analysis is shown in Figure 17: with ETIP SNET at the centre of the graph, the distance of the icons representing the other initiatives with respect to the centre is proportional to the difference in approach from the ETIP SNET: the closer the icon to the figure centre (ETIP SNET) the more the initiative resembles the ETIP SNET in terms of portions and intensities of relevance.

The 4 quadrants categorize the European initiatives by main type. Relative positions are to be considered only in terms of radial distance (i.e. distance from the centre of the figure). Different angular positions inside each quadrant (i.e. the position around the clock) are used only for graphical clarity and are not linked to specific attributes of initiatives.

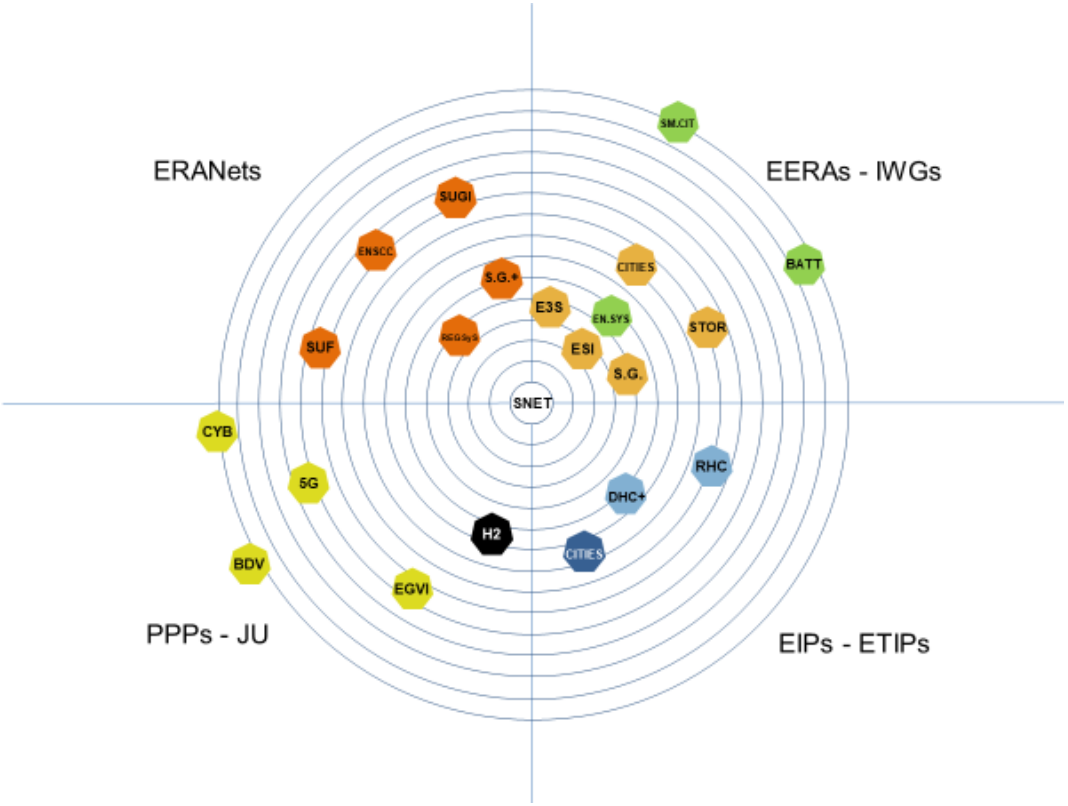


Figure 17: Similarity analysis of European initiatives with respect to the ETIP SNET

Along the same line, Table 4 illustrates the level of relevance perceived by the global initiatives considered. Similar colour codes are used as in Table 3. Here again, TCP ECES and DSM are close to ETIP SNET as well as Mission Innovation IC1.

Table 4: Level of relevance of the fractions of the energy system for the different global initiatives

		GENERATION	RENEWABLES	ELECTRIC NETWORK	ENERGY NETWORKS	MOBILITY	SYSTEMS INTEGRATION	STORAGE	P-t-X	END-USE FLEXIBILITY	ENERGY COMMUNITIES	ICT
CEM	21CPP	🟢	🟢	🟢	🟡	🟡	🟡	🔴		🟡	🟡	🟢
CEM	ENERGY INTERCONNECTIONS	🔴	🔴	🟢								
CEM	EVI			🟢		🟢			🟡	🔴	🟢	🟡
CEM	SUSTAINABLE CITIES				🟡	🔴	🔴		🟡	🟢	🟢	
IEA - TCPs	4E	🟡	🟡	🟢	🟡	🔴	🟡	🔴	🔴	🟡	🟢	🟢
IEA - TCPs	BUILDINGS AND COMMUNITIES	🔴	🔴	🟢	🟡	🟡	🔴	🟡	🔴	🟢	🟢	🟢
IEA - TCPs	DHC		🔴		🟡		🔴		🔴	🔴	🟢	
IEA - TCPs	DSM	🔴	🟡	🟢	🟢	🟢	🟡	🟡	🟢	🟢	🟢	🟢
IEA - TCPs	ECES	🟡	🟢	🟡	🟢	🟢	🟢	🟢		🟢	🟢	🟢
IEA - TCPs	HEV	🔴	🟡	🟢		🟢			🔴	🔴		🟢
IEA - TCPs	ISGAN	🟡	🟢	🟢	🔴	🟢	🔴	🟡	🟢	🟢	🟢	🟢
MISSION INNOVATION	IC#1 SMART grids	🟡	🟢	🟢	🟡	🟢	🟢	🟢	🟢	🟢	🟢	🟢
MISSION INNOVATION	IC#7 HEATING AND COOLING	🟡	🟢	🟢	🟢	🟢	🟢	🟢		🟢	🟢	🟢

Figure 18: Similarity analysis of global initiatives with respect to the ETIP SNET

4.2 ANALYSIS BY APPROACH

Depending on the stakeholders involved, their scope, resources and participants, collaboration activities are characterised by different approaches to the evolution of the energy system. In view of a rational analysis, the following set of potential approaches has been identified:

- **Technology**: the developments carried out in the initiative are focussed on technical aspects and on the technological innovation;
- **Economy**: the initiative focusses on market developments, cast-benefits analysis, economic impact of the developments etc;
- **Environment**: the initiative addresses the aspects of environmental sustainability by means of Life cycle assessment studies, environmental impact analysis, GHG reduction potential etc.
- **Policy**: the initiative addresses the aspects of system governance and decision making, looking at policy aspects such as energy strategy, research strategies, system transition etc.;
- **Society**: the initiative considers societal aspects such as job creation, skills developments, welfare etc;
- **Human sciences**: the initiative focusses on the user experience, involvement, engagement, reaction and behaviour;

The collaboration contexts addressed are very extensive and most of them consider several aspects at the same time. For example, the ETIP SNET, through its working groups, considers the different aspects above, with a similarly high level of attention. This is true also for other initiatives, especially dealing with sustainable cities. The relative level of relevance of approaches from the European initiatives is reported in Figure 19. The vertical scale is not shown because the data are normalised and the information to be extracted is only in relative terms. The indication that emerges shows that most of the initiatives have a privileged focus on technologies, and deal with economical, and policy aspects with high attention. Environmental concerns come next and, far beyond, are societal and human sciences.

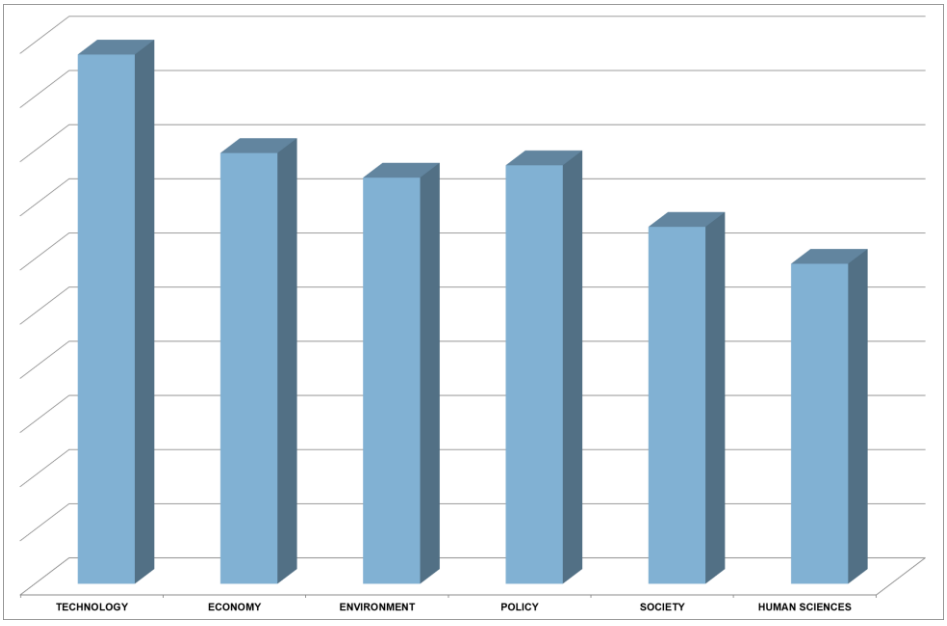


Figure 19: Approaches adopted by the European initiatives (integral value)

For the sake of clarity and reproducibility of the results, the complete set of information on the relevance of approach is reported in Table 5. The code of colours adopted shows a green dot if the specific item is core to the initiative, while a yellow dot is marked when the approach is part of the initiative, without being its core. No dot means that the specific approach is not part of the programme of work.

Table 5: Complete set of data related to the approach adopted by the different European initiatives

	Boundaries of the scope and activities of the initiatives	TECHNOLOGY	ECONOMY	ENVIRONMENT	POLICY	SOCIETY	HUMAN SCIENCES
EERA	E3S	●	●	●	●	●	●
EERA	ENERGY SYSTEM INTEGRATION	●	●	●	●	●	●
EERA	SMART CITIES	●	●	●	●	●	●
EERA	SMART GRIDS	●	●		●		●
EERA	STORAGE	●	●	●	●	●	●
EIP	SMART CITIES	●	●	●	●	●	●
ERA-NETs	ENSCC SMART CITIES AND COMMUNITIES	●	●	●	●	●	●
ERA-NETs	ENSUF SMART URBAN FUTURE	●	●	●	●	●	●
ERA-NETs	REGSYS	●	●	●	●	●	●
ERA-NETs	SMART GRIDS PLUS	●	●	●	●	●	●
ERA-NETs	SUGI - SMART URBANISATION	●	●	●	●	●	●
ETIPs	DHC+	●	●	●	●	●	●
ETIPs	RHC	●	●	●	●	●	●
ETIPs	SNET	●	●	●	●	●	●
IWG	BATTERIES	●	●	●			
IWG	ENERGY SYSTEM	●	●	●		●	●
IWG	SMART CITIES	●	●	●	●	●	●
JTU	HYDROGEN AND FUEL CELLS	●	●	●			
PPP	5G	●	●	●	●	●	
PPP	Big data value	●	●	●	●	●	
PPP	Cybersecurity	●	●	●	●	●	
PPP	European Green vehicles Initiative	●		●	●	●	●

Along the same path, a similar analysis is carried out in the international context. The integral data are reported in Figure 20 and the complete data, according to the same colour code, is shown in Table 6.

In comparison, the level of relevance of technological aspects is quite similar amongst the entire span of initiatives (European and global), while more emphasis on environmental, policy and societal aspects is evident in European projects.

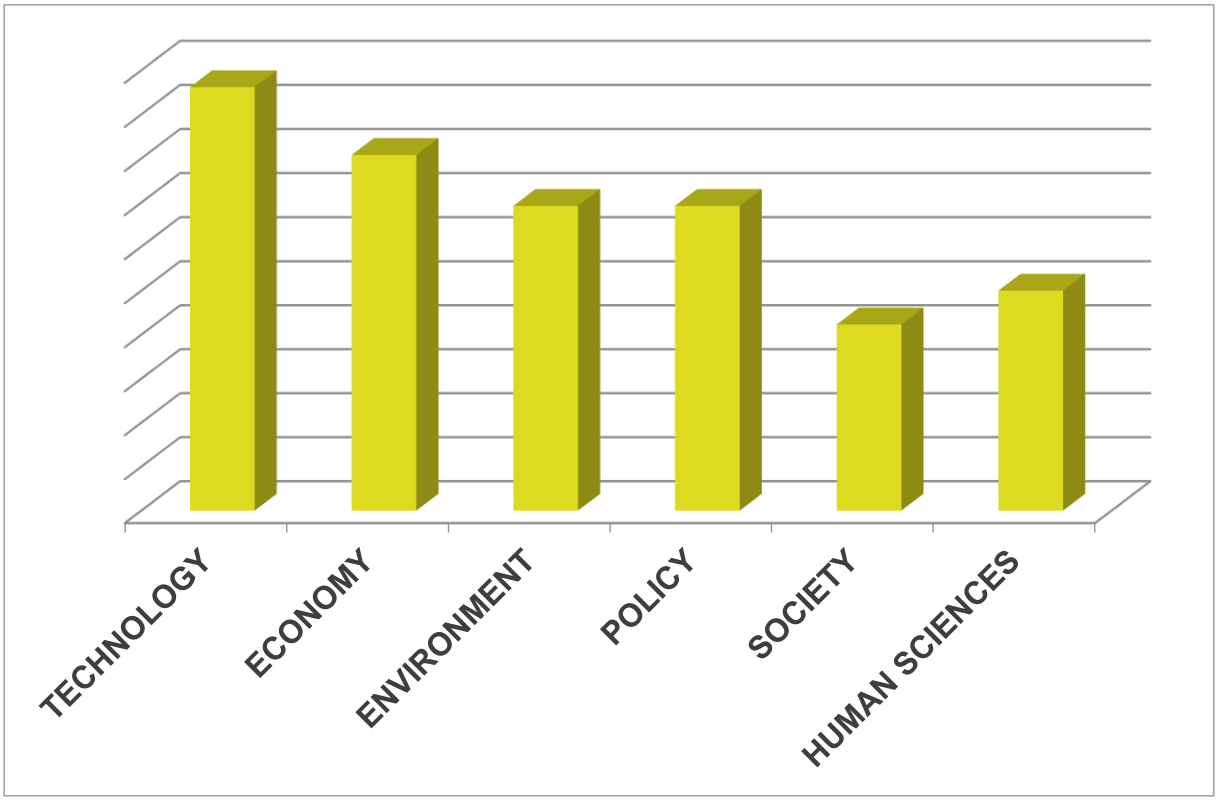


Figure 20: Approaches adopted by the global initiatives (integral value)

Table 6: Complete set of data related to the approach adopted by the different global initiatives

	Boundaries of the scope and activities of the initiatives	TECHNOLOGY	ECONOMY	ENVIRONMENT	POLICY	SOCIETY	HUMAN SCIENCES
CEM	**21CPP**	●	●	●	●	●	●
CEM	**ENERGY INTERCONNECTIONS**	●	●	●	●	●	●
CEM	**EVI**	●	●	●	●	●	
CEM	**SUSTAINABLE CITIES**	●	●	●	●	●	●
IEA - TCPs	**4E**	●	●	●	●	●	●
IEA - TCPs	**BUILDINGS AND COMMUNITIES**	●	●	●	●		●
IEA - TCPs	**DHC**	●	●	●	●	●	
IEA - TCPs	**DSM**	●	●	●	●	●	●
IEA - TCPs	**ECES**	●	●	●	●	●	●
IEA - TCPs	**HEV**	●	●	●	●	●	●
IEA - TCPs	**ISGAN**	●	●	●	●	●	●
MISSION INNOVATION	**IC#1 SMART grids**	●	●				
MISSION INNOVATION	**IC#7 HEATING AND COOLING**	●	●	●			

4.3 COMBINED ANALYSIS

Combining the two previous criteria (subject relevance and approach), we can better understand, for each of the sectors of the energy system, the level of coverage by approach. Considering the European initiatives, as illustrated in Figure 21, one can initially notice that, considering the level of relevance by energy system portion as shown in Figure 12, where Energy Communities, End-use Flexibility, ICT and Electric Network aspects emerge with respect to other energy system portions, each aspect is addressed by the initiatives with a prevalence of technological approach, followed by environmental, policy and economic considerations. Societal and human aspects are systematically addressed in a second order. This gap is even more pronounced in global initiatives as can be seen in Figure 22.

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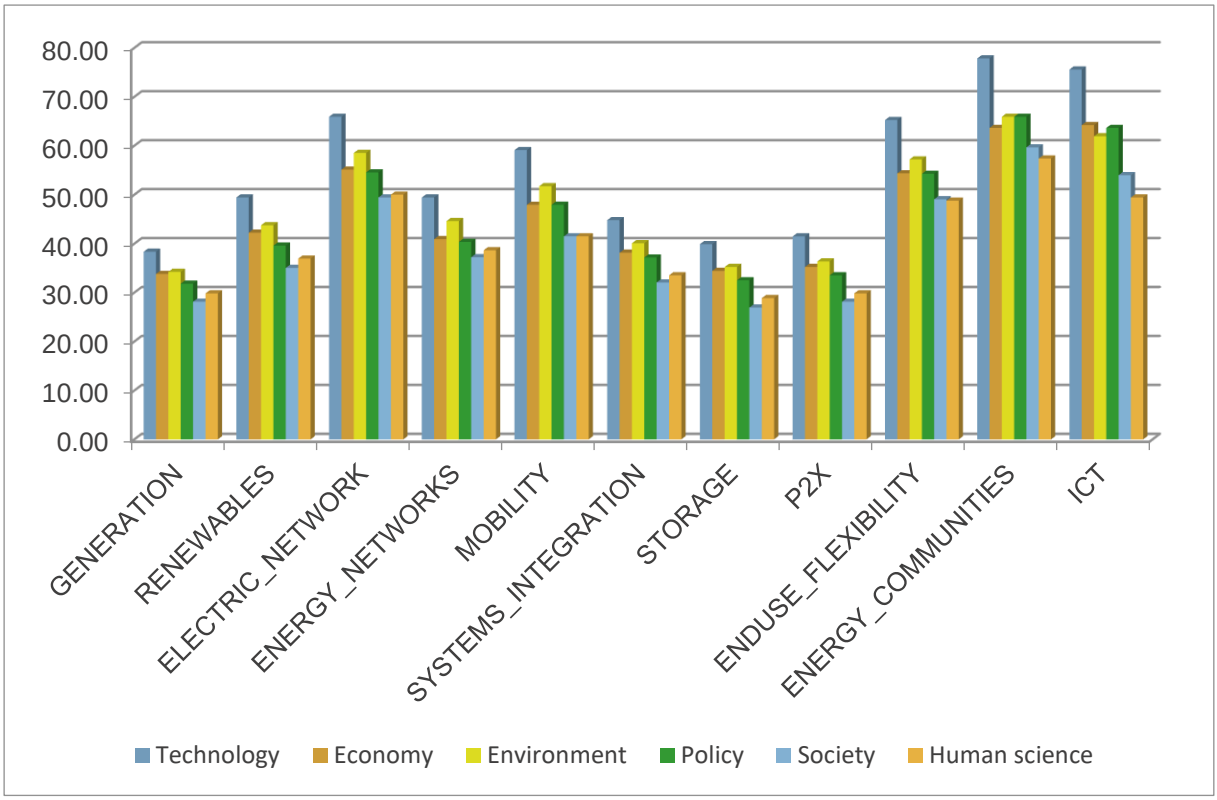

Figure 21: Combined analysis of European initiatives considering level of relevance of the portions of the energy system and the related type of approach to the subjects

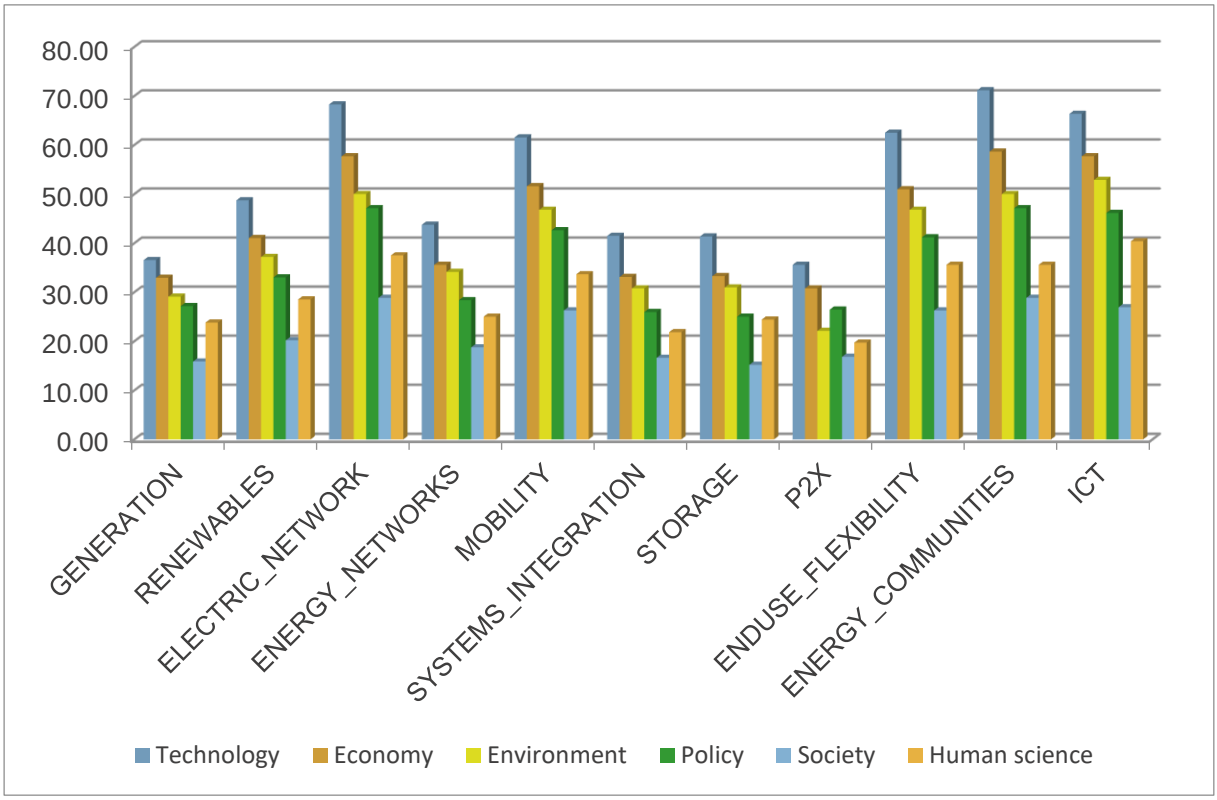

Figure 22: Combined analysis of global initiatives considering level of relevance of the portions of the energy system and the related type of approach to the subjects

4.4 ANALYSIS BY TECHNOLOGY READINESS LEVEL

The range of TRLs considered in this study is illustrated in the FIGURE 23 and Figure 24 for the European and global initiatives respectively. The average TRL is shown together with its spread. As can be expected, EERAs show the lowest range, being focussed on methodological and mid-long term applied research, while ETIPs address the demonstration phase and IWGs as well as EIPs the field implementation. ERA-Nets and PPPs stand in the middle. At global level, Mission Innovation, in similarity with EERA, addresses longer development timespans, while CEM initiatives specifically look after widespread on-site implementation. TCPs, depending on the specific subjects, range across TRL5, with some exceptions such as 4E (addressing ready-to-market equipment), ISGAN (considering real systems and their developments and best practices) and DHC.

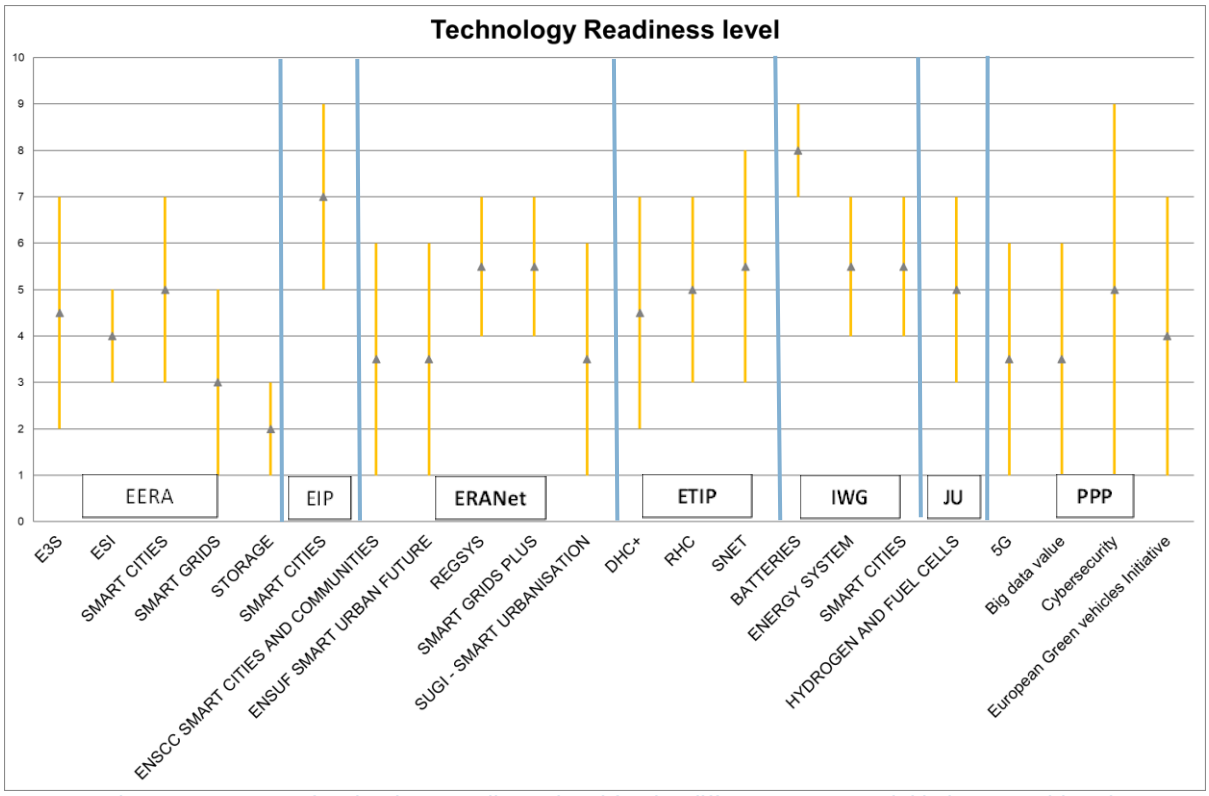

Figure 23: Range of technology readiness level for the different European initiatives considered

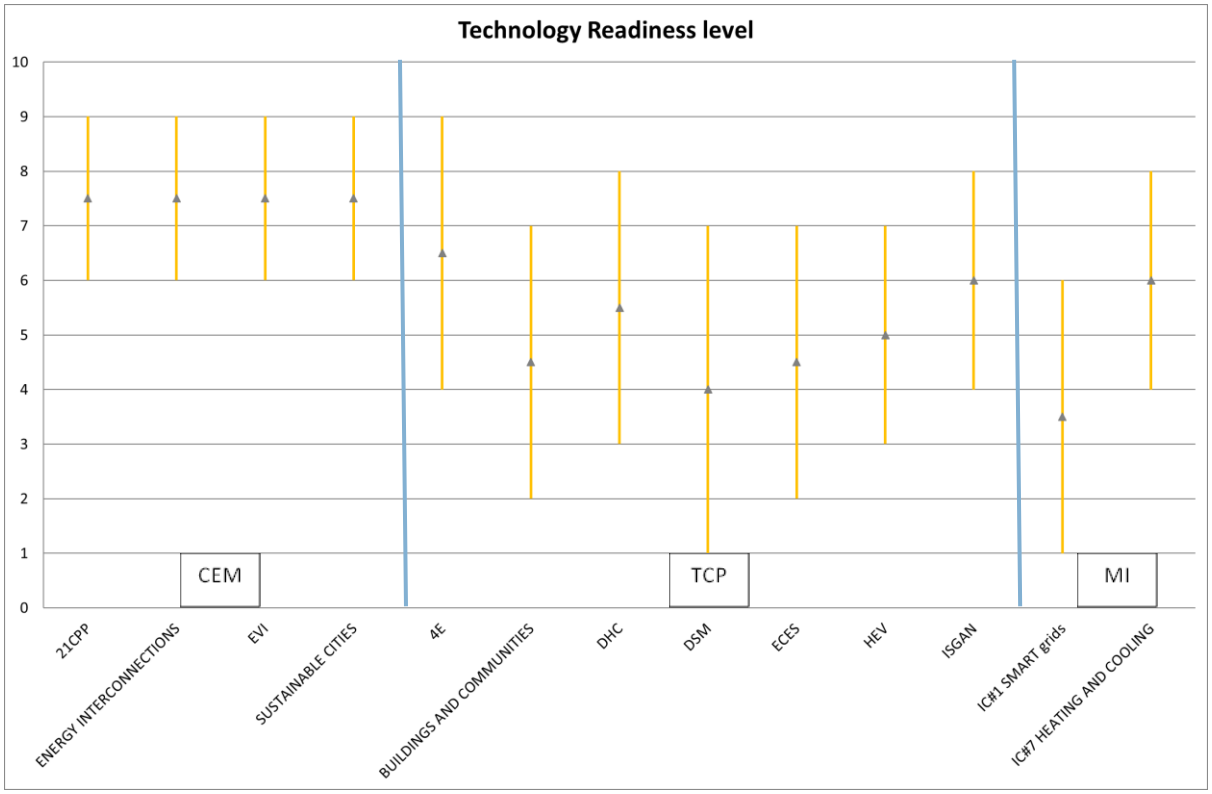

Figure 24: Range of technology readiness level for the different global initiatives considered

4.5 GEOGRAPHY OF THE INITIATIVES

As it has been widely documented by the JRC in its periodical reports on Smart grids projects in Europe [7], a very extensive set of activities, projects and demonstrations are being carried out all over the continent. This is confirmed by the extensive participation to the initiatives considered in this study. Figure 25 shows over the map of Europe, the presence of national representatives in the different levels of governance of the initiatives considered (e.g. Governing Boards, Executive Committees, Focus groups, working groups, flagships etc.). European countries have also a wide participation in the global context, as shown in Figures 26 and 27, related to CEM and IEA TCPs respectively.

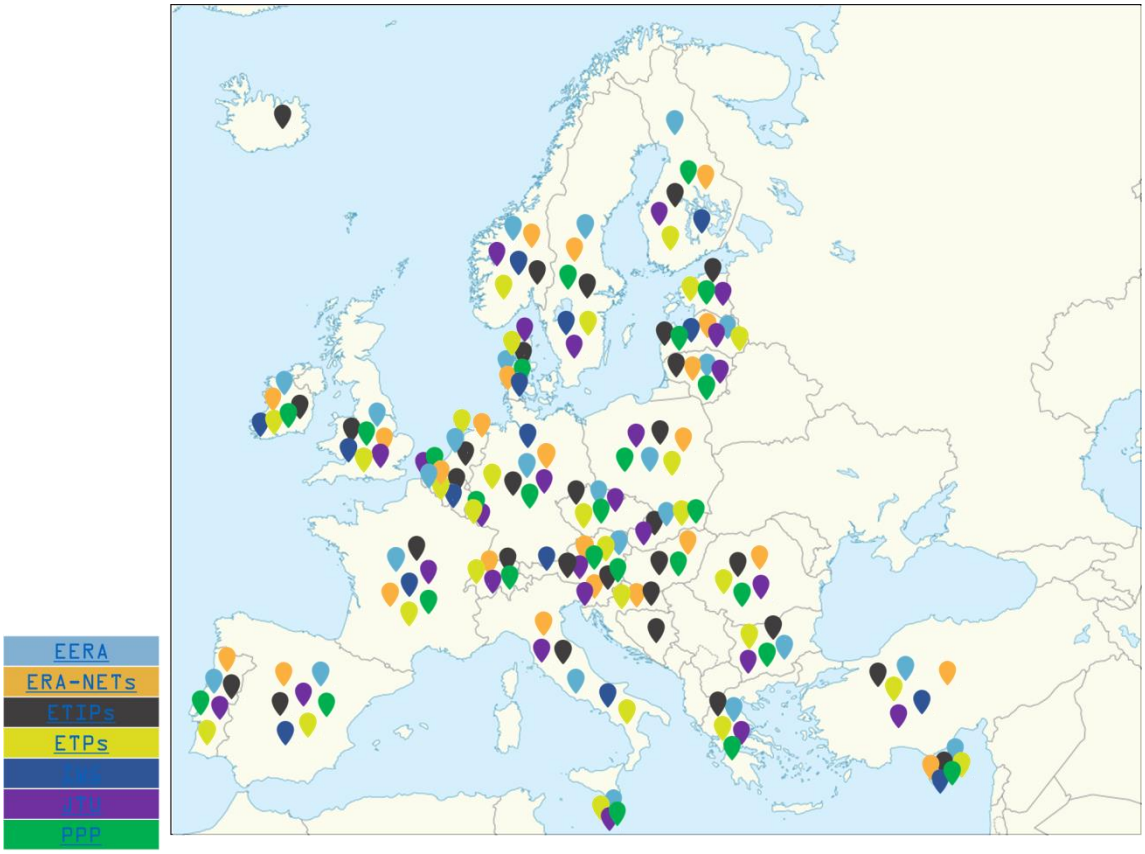

Figure 25: Presence of representatives from the different European countries in the different categories of initiatives considered

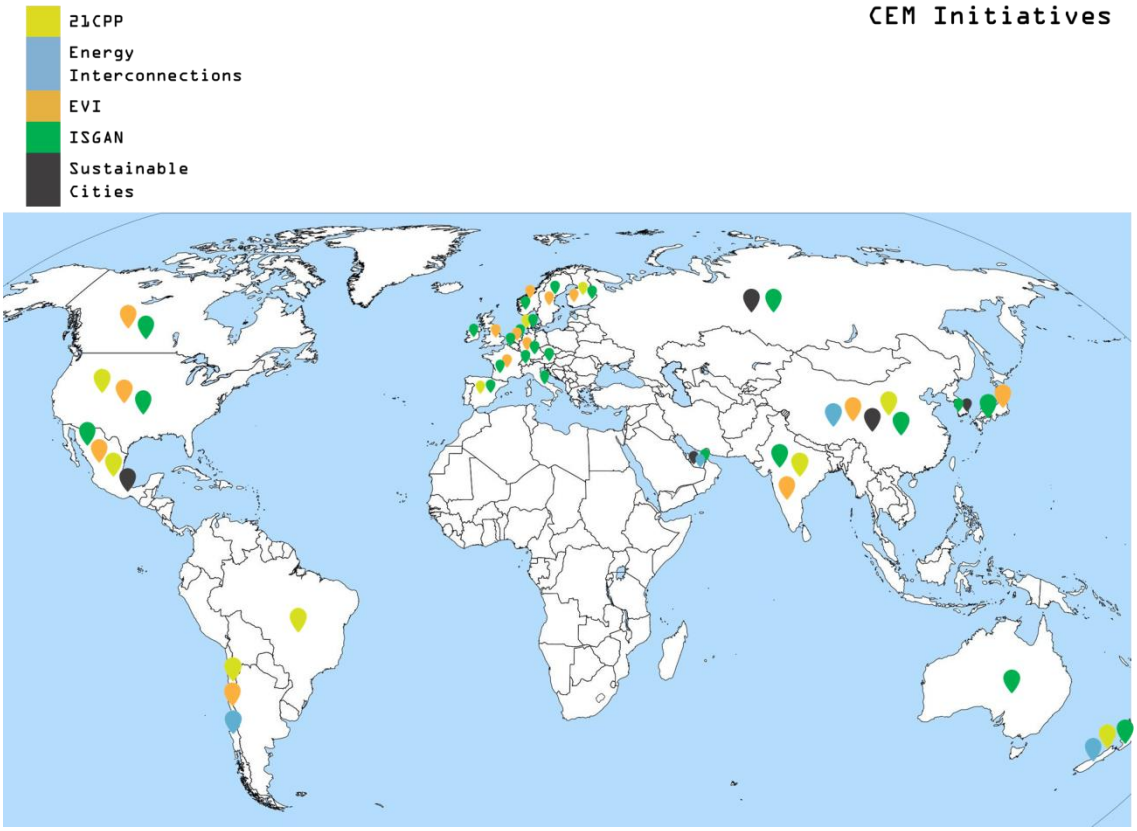

Figure 26: Presence of national representatives in different initiatives of the clean energy ministerial

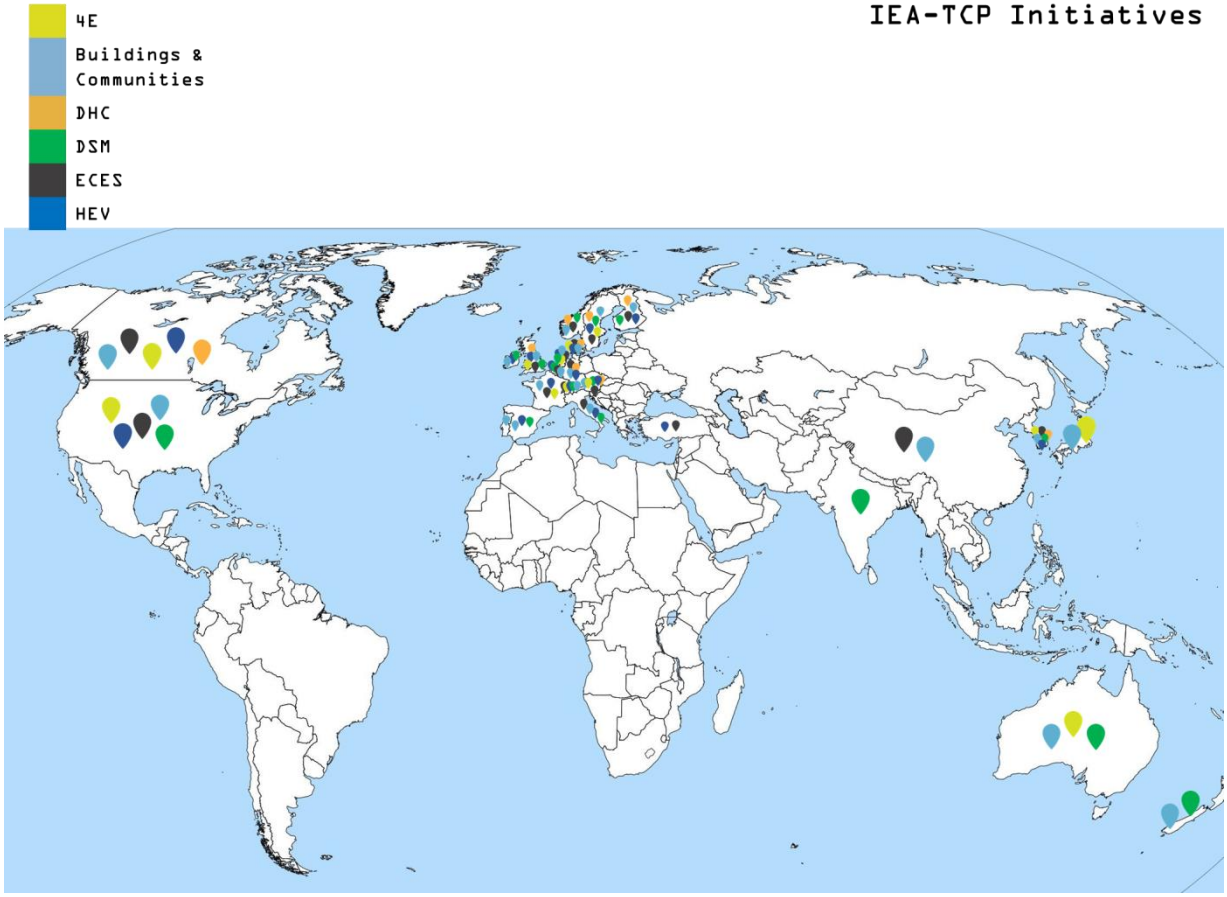

Figure 27: Presence of national representatives in different initiatives of the IEA - TCPs

4.6 ACTIVE STAKEHOLDERS

The activities related to the development of the energy system are of extreme interest for a wide variety of potential stakeholders. The analysis carried out in this study has subdivided the participants in different categories, namely:

- **Government**: including policy makers, agencies connected to governments, funding departments of governments
- **Academia and Research:** universities, public research centres, Private (industrial) research centres, Consultants
- **Regulators:** Energy regulation, RES subsidiy management, Other regulators
- **Private Sector**: Industry experts
- **Other:** e.g. Municipalities, NGOs, Social Entrepreneurs, SMEs, Commercial funders and investors, etc.

The overall picture is reported in Table 7 and Table 8 for European and global initiatives, respectively.

Table 7: Stakeholders involved in the European initiatives considered

		GOVERNMENT			ACADEMIA AND RESEARCH				REGULATORS			PRIVATE SECTOR	
		policy makers	agencies connected to governments	funding departments of governments	University	Public research centre	Private (industrial) research centres	Consultants	Energy regulation	RES subsidiy management	Other regulators	Industry experts	other
INITIATVE	ENTITY												
EERA	E3S	🔴	🔴	🔴	🟢	🟢	🔴	🔴	🔴	🔴	🔴	🔴	🔴
EERA	ENERGY SYSTEM INTEGRATION	🔴	🔴	🔴	🟢	🟢	🟢	🔴	🔴	🔴	🔴	🔴	🔴
EERA	SMART CITIES	🟢	🟢	🔴	🟢	🟢	🟢	🟢	🟢	🔴	🔴	🟢	🔴
EERA	SMART GRIDS	🔴	🟢	🔴	🟢	🟢	🟢	🟢	🔴	🔴	🔴	🟢	🔴
EERA	STORAGE	🔴	🔴	🔴	🟢	🟢	🔴	🔴	🔴	🔴	🔴	🔴	🔴
EIP	SMART CITIES	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🔴
ERA-NETs	ENSCC SMART CITIES AND COMMUNITIES	🟢	🟢	🟢	🟢	🟢	🟢	🔴	🔴	🔴	🔴	🟢	Municipalities, NGOs, Social Entrepreneurs
ERA-NETs	ENSUF SMART URBAN FUTURE	🟢	🟢	🟢	🟢	🟢	🟢	🔴	🔴	🔴	🔴	🟢	Municipalities, NGOs, Social Entrepreneurs
ERA-NETs	REGSYS	🟢	🟢	🟢	🟢	🟢	🟢	🔴	🔴	🔴	🔴	🔴	🔴
ERA-NETs	SMART GRIDS PLUS	🟢	🟢	🟢	🟢	🟢	🟢	🔴	🔴	🔴	🔴	🔴	🔴
ERA-NETs	SUGI - SMART URBANISATION	🟢	🟢	🟢	🟢	🟢	🟢	🔴	🔴	🔴	🔴	🟢	Municipalities, NGOs, Social Entrepreneurs
ETIPs	DHC+	🟢	🟢	🔴	🟢	🟢	🟢	🟢	🟢	🔴	🔴	🟢	cities
ETIPs	RHC	🔴	🔴	🔴	🟢	🟢	🟢	🟢	🔴	🔴	🔴	🟢	🔴
ETIPs	SNET	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🔴	🔴	🟢	🔴
IWG	BATTERIES	🔴	🟢	🟢	🟢	🟢	🟢	🔴	🔴	🔴	🔴	🟢	🔴
IWG	ENERGY SYSTEM	🔴	🟢	🟢	🟢	🟢	🟢	🔴	🔴	🔴	🔴	🟢	🔴
IWG	SMART CITIES	🔴	🟢	🟢	🟢	🟢	🟢	🔴	🔴	🔴	🔴	🟢	🔴
JTU	HYDROGEN AND FUEL CELLS	🔴	🟢	🟢	🟢	🟢	🟢	🔴	🔴	🔴	🔴	🟢	🔴
PPP	5G	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🔴	🔴	🔴	🟢	telecom industries
PPP	Big data value	🟢	🔴	🔴	🟢	🟢	🟢	🟢	🔴	🔴	🟢	🟢	🔴
PPP	Cybersecurity	🟢	🔴	🔴	🟢	🟢	🟢	🟢	🔴	🔴	🟢	🟢	🔴
PPP	European Green vehicles Initiative	🟢	🔴	🔴	🟢	🟢	🟢	🔴	🔴	🔴	🔴	🟢	SMEs are also involved, representatives of the smart systems industry as well as OEMs and suppliers

Table 8: Stakeholders involved in the global initiatives considered

		GOVERNMENT			ACADEMIA AND RESEARCH				REGULATORS			PRIVATE SECTOR	
		policy makers	agencies connected to governments	funding departments of governments	University	Public research centre	Private (industrial) research centres	Consultants	Energy regulation	RES subsidiy management	Other regulators	Industry experts	other
INITIATVE	ENTITY												
CEM	21CPP	●	●	●	●	●	●	●	●	●	●	●	●
CEM	ENERGY INTERCONNECTIONS	●	●	●	●	●	●	●	●	●	●	●	●
CEM	EVI	●	●	●	●	●	●	●	●	●	●	●	●
CEM	SUSTAINABLE CITIES	●	●	●	●	●	●	●	●	●	●	●	●
IEA - TCPs	4E	●	●	●	●	●	●	●	●	●	●	●	●
IEA - TCPs	BUILDINGS AND COMMUNITIES	●	●	●	●	●	●	●	●	●	●	●	●
IEA - TCPs	DHC	●	●	●	●	●	●	●	●	●	●	●	●
IEA - TCPs	DSM	●	●	●	●	●	●	●	●	●	●	●	●
IEA - TCPs	ECES	●	●	●	●	●	●	●	●	●	●	●	●
IEA - TCPs	HEV	●	●	●	●	●	●	●	●	●	●	●	●
IEA - TCPs	ISGAN	●	●	●	●	●	●	●	●	●	●	●	●
MISSION INNOVATION	IC#1 SMART grids	●	●	●	●	●	●	●	●	●	●	●	●
MISSION INNOVATION	IC#7 HEATING AND COOLING	●	●	●	●	●	●	●	●	●	●	●	Commercial funders and investors

4.7 SYNERGIES

The analysis of synergies has been conducted by priorities. For each portion of the energy system (i.e. generation, renewables, electricity networks etc.) we have taken into account only the initiatives which consider that specific portion of the energy system as a core element in their strategy. We have then analysed the tasks or projects developed inside each initiative pertaining to that portion of energy system, considering that this would be the ideal starting point to check for potential synergies.

The results of this analysis are illustrated in Figure 28 to Figure 38, focusing on the European context. The different WGs, SPs, flagships etc. indicated for each portion of the energy system have a potential for active and fruitful collaboration. The code of colours adopted for the initiatives corresponds to that of Figure 17.

A careful analysis of scope, framework, methodologies and outcomes should be carried out to identify means and tools to accelerate the development of the technologies and solutions essential for enabling the energy transformation, by means of collaborations.

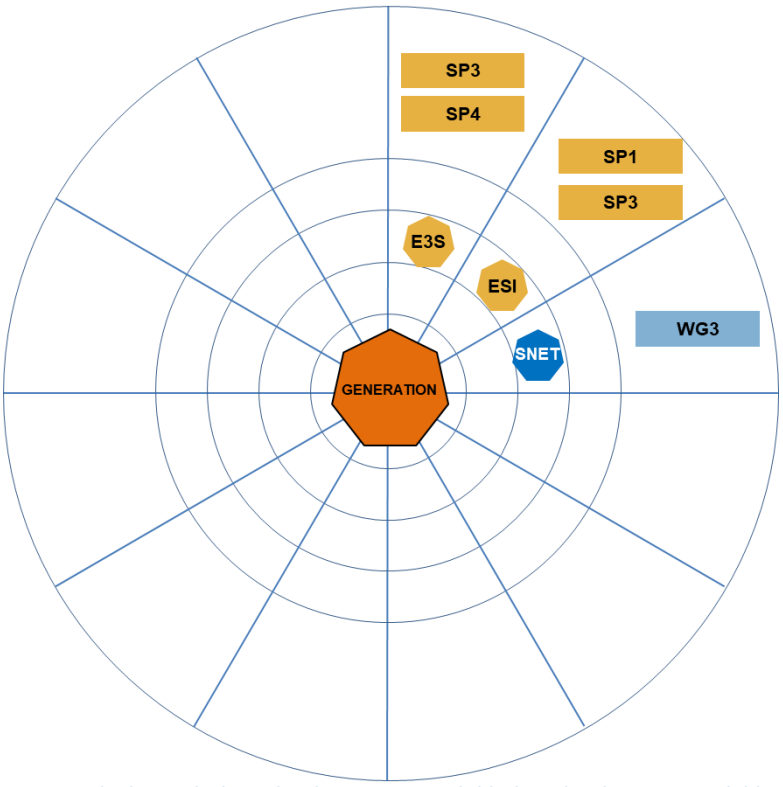

Figure 28: Synergy analysis carried out for the European initiatives having core activities in generation

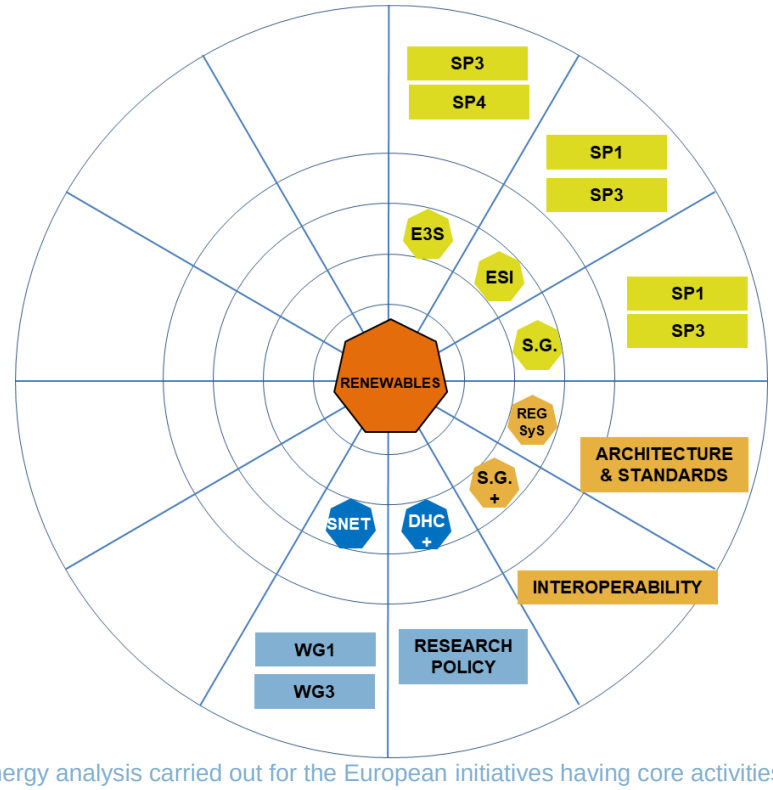

Figure 29: Synergy analysis carried out for the European initiatives having core activities in renewables

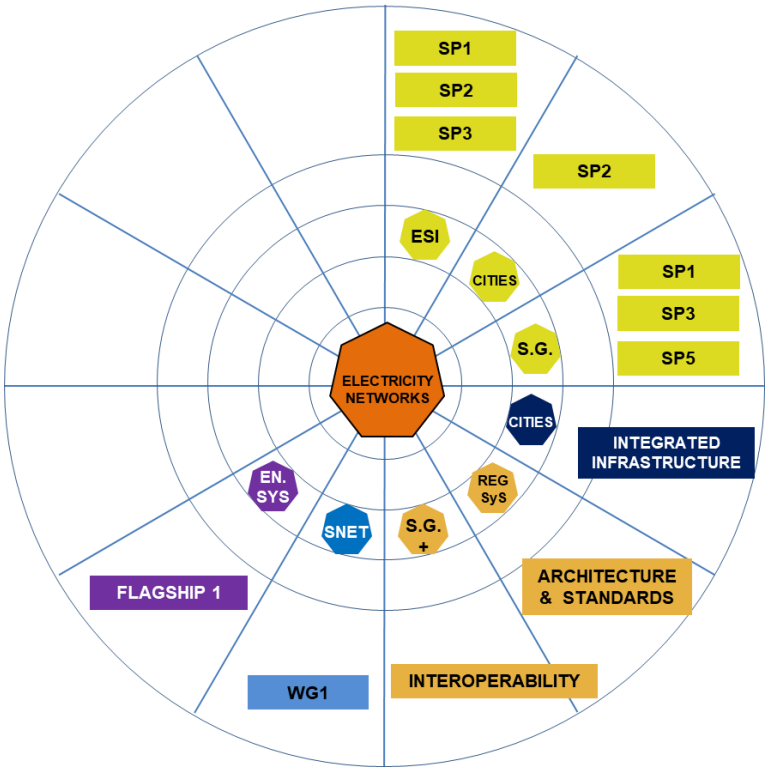

Figure 30: Synergy analysis carried out for the European initiatives having core activities in electricity networks

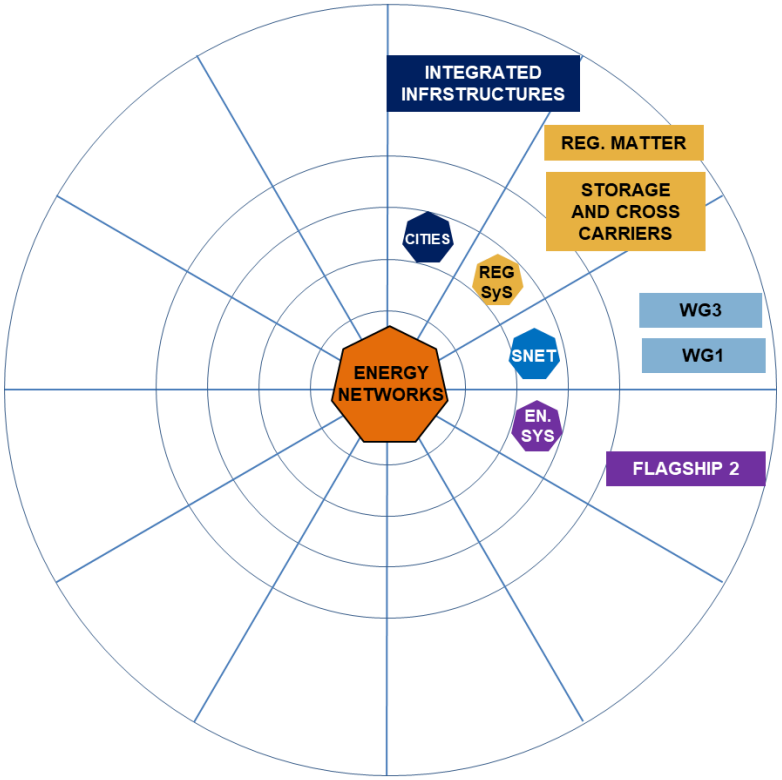

Figure 31: Synergy analysis carried out for the European initiatives having core activities in integrated energy networks

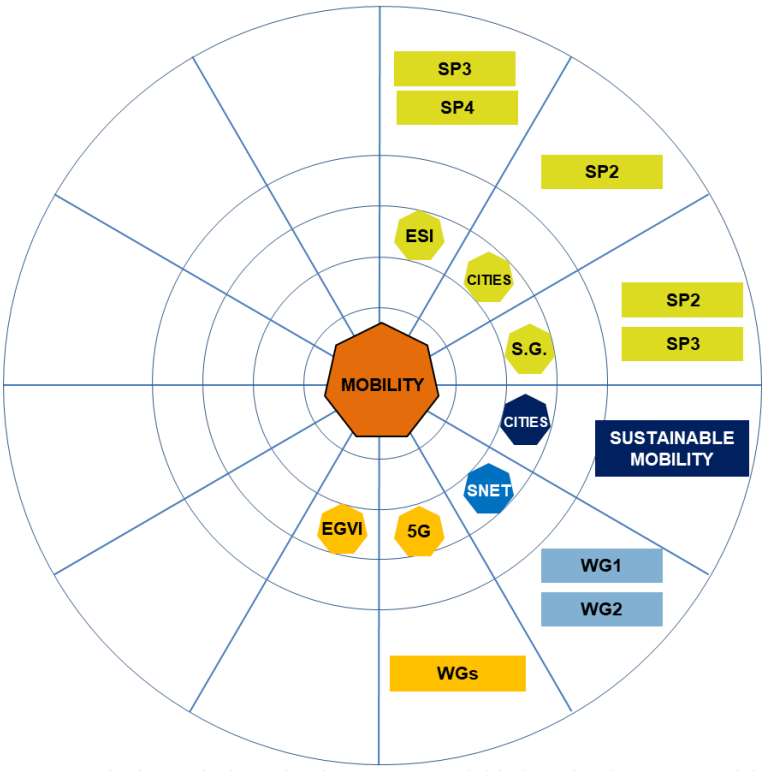

Figure 32: Synergy analysis carried out for the European initiatives having core activities in mobility

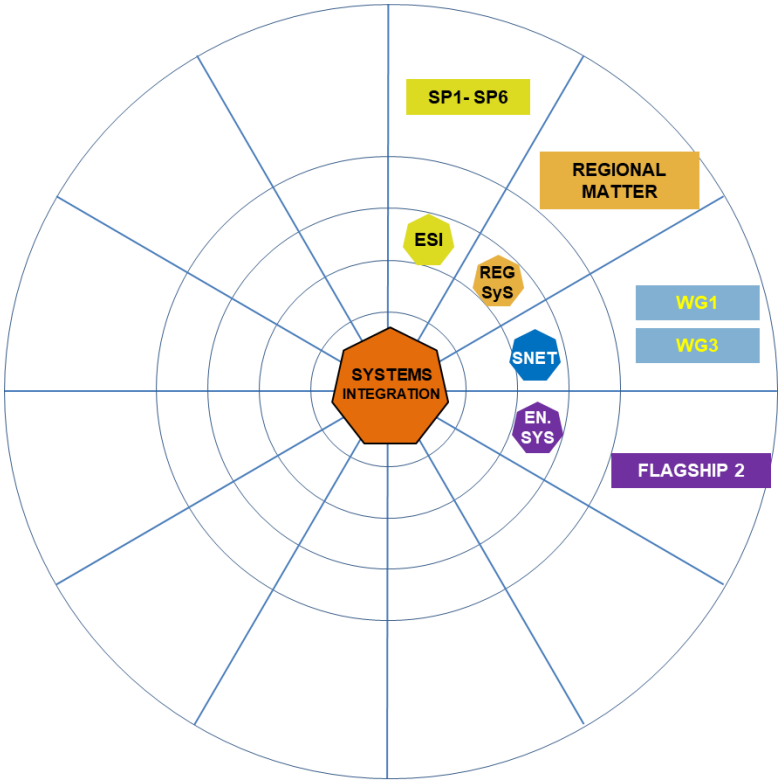

Figure 33: Synergy analysis carried out for the European initiatives having core activities in systems integration

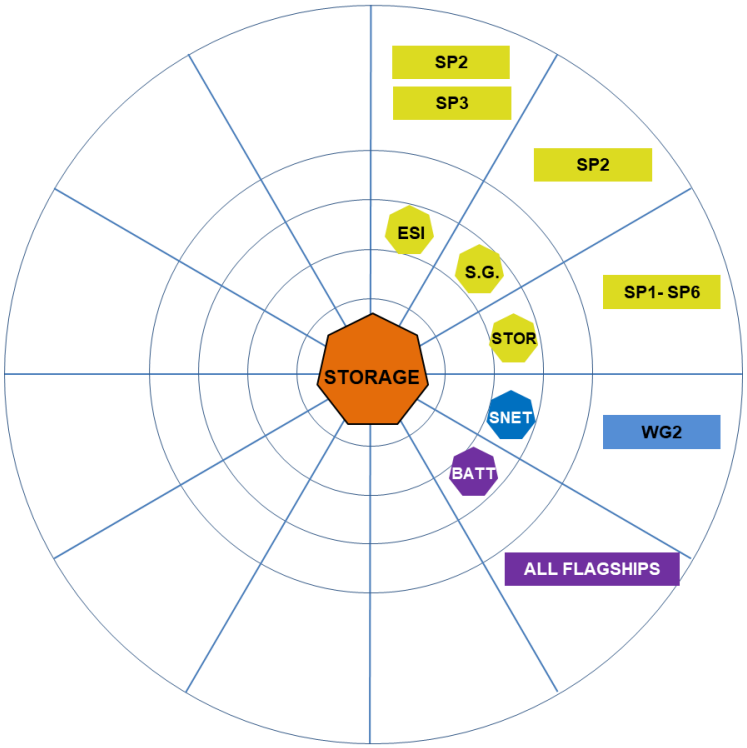

Figure 34: Synergy analysis carried out for the European initiatives having core activities in storage

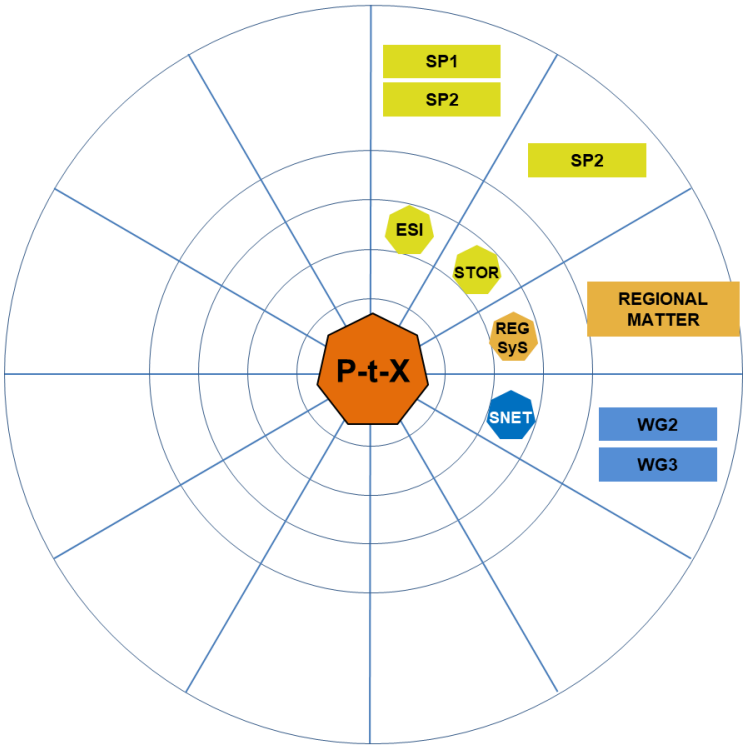

Figure 35: Synergy analysis carried out for the European initiatives having core activities in power-to-x conversion

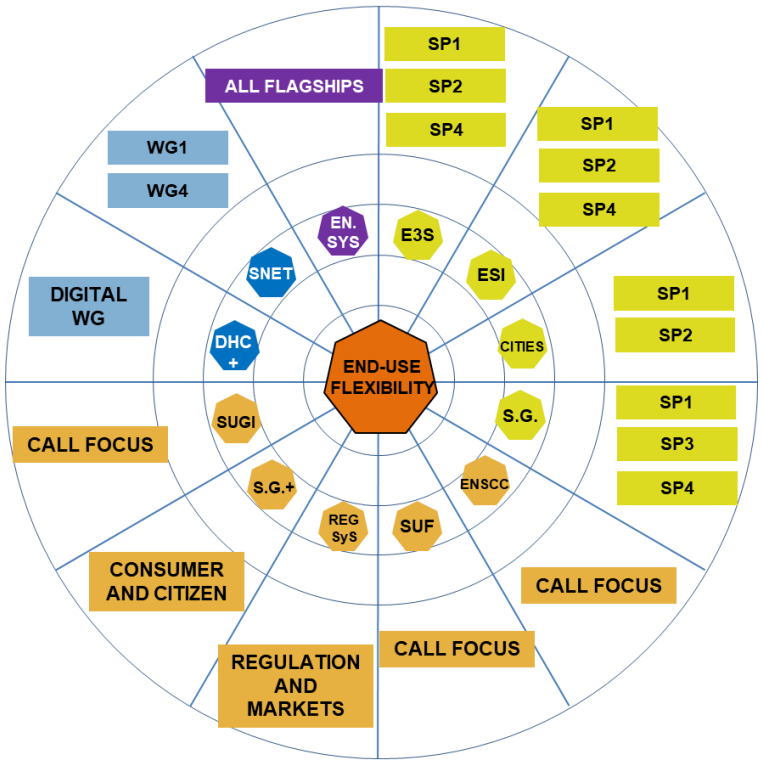

Figure 36: Synergy analysis carried out for the European initiatives having core activities in end-use flexibility

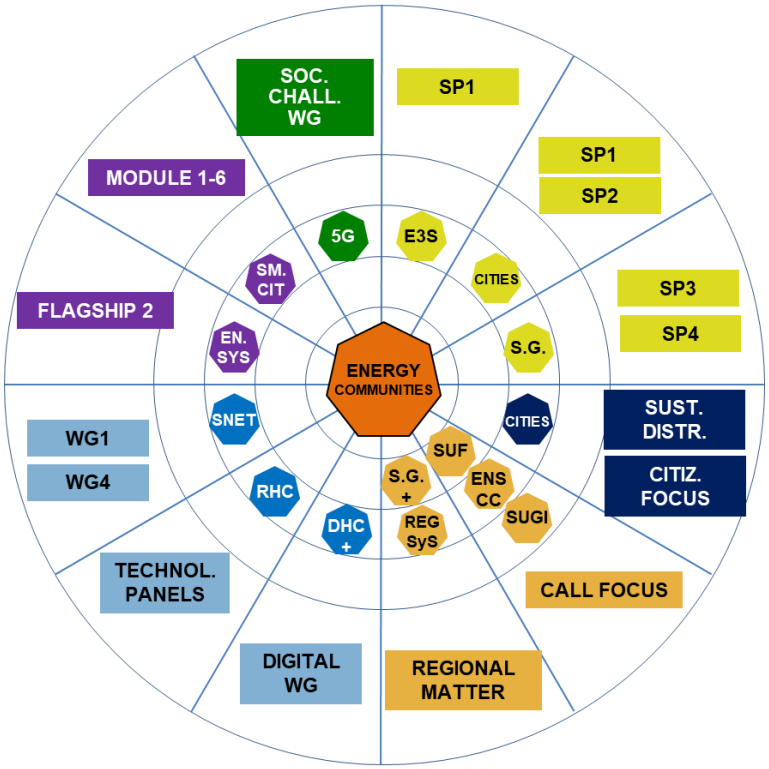

Figure 37: Synergy analysis carried out for the European initiatives having core activities in energy communities

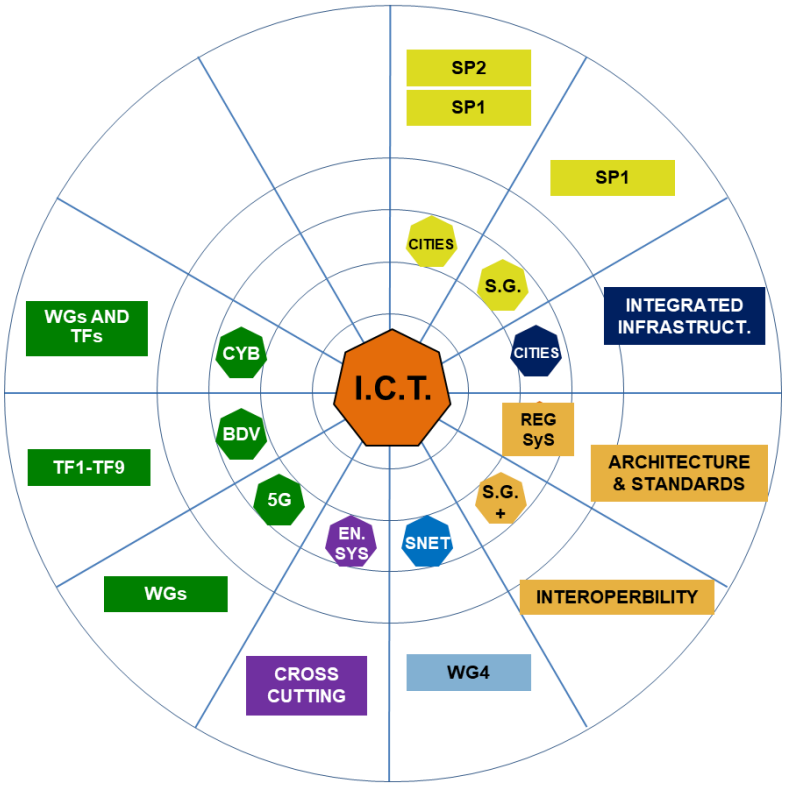

Figure 38: Synergy analysis carried out for the European initiatives having core activities in ICT

5 PRESENTATION OF THE RD&I DEFINITION VALUE CHAIN/FRAMEWORK FOR SMART ENERGY SYSTEMS

5.1 DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF RD&I TOPICS

5.1.1 EUROPEAN INITIATIVES

The analysis carried out in the present report confirms that European initiatives share the common objectives of the SET-Plan, and in particular:

- Contributing to the worldwide transition to a low carbon economy by 2050;
- Maintaining the EU industrial leadership on low-carbon energy technologies;
- Accelerating knowledge development, technology transfer and up-take;
- Fostering science for transforming energy technologies to achieve the 2020 Energy and Climate Change goals;

Each European initiative addresses the priorities in its specific field, in compliance with the scope given in the SET-Plan panorama (i.e. industry-led, public research focus, bridge public and private funding, etc.). All initiatives considered act according to their peculiarity, with the final scope to implement the Actions established by the SET-Plan, rationalizing efforts and expenses, limiting overlaps and identifying gaps (technological, regulatory, standardization, societal, investments etc.). Another similarity is the motivation to indicate the paths for the alignment of national and European research and development plans, fostering cohesion and common visions and acting towards inclusion of all the European Countries. According to the approach of the Integrated SET-Plan, most European initiatives consider the energy system as a whole, where all energy vectors are part of an integrated system in search of a necessary optimization: this is a peculiarity of the European approach, while initiatives at a global level tend to be more technology specific. Even in cases where the European initiatives address specific portions of the energy system (e.g. storage, heating, cooling or Hydrogen), the approach always considers the interfaces towards the integrated energy system. Vision documents, technology roadmaps, implementation plans developed in the frame of European initiatives are systematically the result of large consultations and consensus gathering amongst the vast plethora of stakeholders. This is achieved through scoping workshops, consultations and conferences.

EUROPEAN TECHNOLOGY AND INNOVATION PLATFORMS (ETIP)

By scope, the ETIPs develop research and innovation agendas and roadmaps for action at EU and national level to be supported by both private and public funding. They mobilise stakeholders to actively contribute to the agreed priorities and share information across the EU, providing consensus-based strategic advice on the SET-Plan, covering technical and non-technological aspects (e.g. industrial strategy, market opportunities, exploitation of research results, innovation barriers, need for specific research activities, strategy for international cooperation, education, environmental and social impacts) and addressing linkages with other sectors in view of increased system integration.

The different ETIPs are closely working together on interdisciplinary and overlapping issues to ensure R&I processes on a high level of expertise and a continual knowledge transfer. All ETIPs/EIPs considered in this report (i.e. ETIP SNET, ETIP RHC, ETIP DHC+ and EIP Smart cities) have in their programme of work the development of long-term visions, medium term R&D roadmaps and short-term indication of immediate research needs to be addressed by national or European calls.

EUROPEAN INNOVATION PARTNERSHIPS (EIP)

The partnerships are not a financing tool, but organisations that allows for the streamlining and optimization of the functioning of the other partnerships and the optimal use of the resources made available by the EU through programmes dedicated to research and innovation (e.g. Horizon 2020 or Horizon Europe).

The themes covered by the EIPs are identified by the European Commission, in agreement with the European Parliament and the Council, according to predefined guidelines and selective criteria. Five initiatives are active at the moment (EIP AHA Active & Healthy Aging, EIP AGRI Agriculture & Innovation, EIP RM Raw Materials, EIP Water, EIP SCC: Smart Cities and Communities). Their roadmapping exercise is more devoted to identifying and delivering business cases, in view of replication and scaling up.

THE EUROPEAN ENERGY RESEARCH ALLIANCE (EERA)

As an outstanding representation of the European public research community, EERA is directly involved in the SET-Plan target-setting process, addressing cross-actions between the disciplines, in an attempt to better address the challenges of an integrated energy system. Each JP provides recommendations for research, development and demonstration actions in its specific field, fostering the alignment amongst national research programmes (as much as reasonable) and their alignment towards the European SET-Plan goals.

All JPs considered in this report (i.e. JP Smart Grids, JP Storage, JP Smart cities, JP e3s) have therefore developed a Strategic Research Agenda considering the medium to long term development of technologies and solutions, identifying milestones for the development of technologies and solutions over the coming 10-20 year period and identifying the related critical needs and/or technology gaps that must be filled to meet technology performance and cost targets.

THE IMPLEMENTATION WORKING GROUPS (IWG)

IWGs have been established by the SET-Plan Governing Board to address and implement the 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 SET-Plan actions of interest in the context of the present report are Action 3.2 “Become a global role model in integrated, innovative solutions for the planning, deployment, and replication of Positive Energy Districts”, Action 4: “Increase the resilience and security of the energy system”, Action 7: “Become competitive in the global battery sector to drive e-mobility and stationary storage forward”.

SET-Plan countries represented in the IWGs by public officials or persons nominated by their respective governments, have committed themselves to use their energy R&I national programmes and policies to implement some of the R&I activities selected by the IWG, developing and pursuing joint research with other countries. The IWGs have identified specific Flagship R&I initiatives, to serve as projects illustrating how coordinated R&I, at national and EU level, can contribute to the achievement of the Action targets and entail activities of interest and visible to the public at large. Flagship initiatives are further detailed into specific activities depicted into Innovation fiches delineating the main aspects that can be considered in joint or coordinated national calls.

ERA-NET

The focus of ERA-Nets has progressively been shifted from the former funding of networks to the present approach of topping-up funding of single joint calls for transnational research and innovation in selected areas with high European added value and relevance. This is aimed at increasing substantially the share of funding that Member States dedicate jointly to challenge driven research and innovation agendas. Financial contributions of Member States can be in cash or in kind in order to broaden the

scope of ERA-Nets towards the coordination institutional funding of governmental research organisations.

In the specific case of the present report, ERA-Net instruments dedicated to the integrated energy system have been considered. To set up the respective programmes, scoping workshops are organized with all participating countries/regions to identify the common priorities around which to structure the calls for projects. In the specific case of Sg+/RegSys, an overarching feature of the calls is the systematic requirement to combine technological developments to market and user adoption measures, thus facilitating the implementation of solutions by means of an innovation eco-system, building bridges in the whole innovation chain.

EUROPEAN PUBLIC PRIVATE PARTNERSHIPS (PPP)

The PPPs are based on roadmaps for research and innovation activities which are the result of an open consultation process and which have been positively evaluated by the European Commission with the help of independent experts. The PPPs are implemented through open calls. All four PPPs considered in this report are founded on the development and implementation of a strategic roadmap for research, technological development and innovation in the specific field of interest.

5.1.2 GLOBAL INITIATIVES

This type of initiatives aims to be high-level fora to promote research, policies and programmes that advance clean energy technology, share lessons learned and best practices, and encourage the transition to a global clean energy economy. Their respective programme of work is based on areas of common interest amongst participating governments and other stakeholders and constitutes a very diversified environment in terms of geography, environment, level of infrastructure, economical and societal development, priorities and needs. In these initiatives, in addition to the aspects considered at European level, problems like the access to energy or the development of energy systems (mostly electricity) in remote and inaccessible areas play a key role.

The aim of these initiatives being the acceleration of the energy transition towards a decarbonisation at a global level, a very close attention is given to the definition and description of the state of the art, benchmarking, countries' achievements, best practices, adequate solutions to be replicated, successful policies and regulation. Original research is also carried out in the framework of some of these global initiatives and very positive fallouts are achieved in terms of pre-standardisation in the specific fields addressed. As far as the integrated energy system, as perceived in Europe, a limited attention is given to the overall picture (i.e. full integration of electricity, gas, heating, cooling, water, data etc.) as the specific goals of the initiatives here considered are more technologically focussed and address vector integration (if any) mostly at the edge of the system addressed.

It is moreover a fact that outside Europe the extension and strategic importance of natural gas distribution and its integration into a global energy optimisation is not perceived as a top priority. Increasing attention is given to electricity coupling with heating and cooling and to the water-energy nexus. Digitalisation of the energy system is an overarching priority and very extensive joint research is carried out, as demonstrated by the very important report on "Digitalisation of Energy" published by the IEA central offices. The different initiatives considered in this report are characterised by different scopes and stakeholders, and their relative planning, roadmapping exercise and prioritisation strongly depend on their primary objectives, for example:

- **IEA TCPs** aiming at the acceleration of technologies uptake and knowledge sharing, identify the R&D needs (technology, policy, regulation, society) and directly contribute with activities carried out by participants to bridge the gaps;
- **Mission Innovation** roadmapping and prioritisation addressed a longer-term perspective and identifies common research priorities to be addressed by participants individually and/or jointly to accelerate the market uptake and adoption of the technologies bridging the "valley of death" of innovation;

- **CEM**'s focus is more dedicated to deployment and attention is focussed on the adoption of policies by governments and regulators to catalyse the system evolution, through benchmarking, campaigns (e.g. EV 30@30 aiming at 30 million EVs on the road by 2030, etc.), policy support (e.g. the "ask an expert" resources at the Clean Energy Solutions Centre).

Timing considered by the initiatives spreads therefore from medium-long term application (MI) to overall development (IEA TCPs) and practical system implementation and adoption (CEM) and this influences their roadmapping and priority setting efforts.

INTERNATIONAL ENERGY AGENCY TECHNOLOGY COLLABORATION PROGRAMME (IEA TCP)

In terms of roadmapping and research priorities setting, IEA TCPs strongly contribute to the production of Technology Roadmaps and their continuous updates, under the Energy Technologies Network. These documents address globally the state of the art of the technologies considered at the light of outstanding achievements in the different participating countries and highlight the research and development needs as well as the policy, regulation and market issues to foster deployment. The approach adopted for the roadmaps, although formulated as overarching and global, highlights priorities and needs and fosters international collaboration. TCPs formulate their respective five-years programme of work which comprise a balanced set of general studies, assessments, demonstrations, comparative evaluations of various options of application, market studies, technology evaluations, highlighting policy and industrial opportunities and often including pre-standardisation and policy options to foster global acceptance of best practices successfully adopted in leading countries. Joint research on topics of interest is carried out directly in the initiative (task shared) or delegated to OAs (Operating Agents) (cost shared model).

CLEAN ENERGY MINISTERIAL (CEM)

The Clean Energy Ministerial is a high-level global forum focused on the promotion of policies and programmes that advance clean energy technology by means of lessons learned and best practices sharing, in view of encouraging the transition to a global clean energy economy. The CEM is currently the only regular meeting of energy ministers at which they exclusively discuss clean energy. The CEM also engages other ministries that play an important role in clean energy in some governments, such as ministries of science and technology or economics. The CEM also builds on and informs existing multilateral technical and policy work in cooperation with institutions such as the IEA, IPEEC (International Partnership for Energy Efficiency Cooperation), and IRENA (International Renewable Energy Agency).

The CEM's unique focus on clean energy and the broad set of participating ministers make it an especially promising forum for collaboration. Initiatives are based on areas of common interest amongst participating governments and other stakeholders. Although the CEM secretariat is hosted inside the central offices of the IEA, CEM is an independent organization and its members (presently 26) span across continents and include also non-IEA member countries (e.g. China, India, Brazil etc.). The CEM encourages robust involvement by key private-sector partners (including both industry and nongovernmental organizations). These partners are encouraged to provide high-level policy input that is gathered at each ministerial meeting and to participate directly in the technical work of the initiatives themselves.

Involvement by the private sector is essential to ensure that the CEM's full potential is realized. Year-round work through action-driven, transformative clean energy initiatives and campaigns expands the deployment of clean energy technologies, policies, and practice. Focus is therefore devoted to adoption and deployment through example, best practices, and campaigns to motivate and measure adoption. In terms of roadmapping and prioritizing, the focus is here on policies and their impact on field application and impact assessment.

MISSION INNOVATION (MI)

The focus of this global initiative (gathering 25 countries) is the commitment of participating countries to double their governments' clean energy research and development (R&D) investments over five years (2016-2021), while encouraging greater levels of private sector investment in transformative clean energy technologies, thus reaching by the end of the period a stable and constant engagement of 30b$/year public engagement. The additional resources invested are intended to dramatically accelerate the availability of the advanced technologies that will define a future global energy mix that is clean, affordable, and reliable.

MI members encourage mutually beneficial engagement with other partner countries in international collaborations, share information on national clean energy needs, plans, priorities, and supporting policies and programmes for clean energy innovation and work closely with the private sector as it increases its investment in the earlier-stage clean energy companies that emerge from government research and development programmes.

MI has selected several areas of potential joint research: Innovation challenges: the challenges are aimed at catalyzing our global research efforts in areas that could provide significant benefits in reducing greenhouse gas emissions, increasing energy security, and creating new opportunities for clean economic growth. Amongst the 8 innovation challenges (IC) identified, in the present report, attention is focused on IC1 (smart grids) and IC7 (affordable heating and cooling). Each IC identifies research priorities in its field of influence, reaching consensus amongst the participants. Programmes of work are identified as well as the workstreams to foster collaboration and share knowledge. In addition to the joint Information Sharing. Sharing data, priorities, and plans promotes transparency and integrity, facilitates stakeholder engagement, reveals collaboration opportunities, and can inspire and inform private sector investment decisions.

Innovation starts with government support for R&D, but it is businesses, entrepreneurs, and investors that turn innovations into products and companies that change the world: therefore, a strong relation with the industry is promoted.

5.2 FINANCING/IMPLEMENTATION OF RD&I STRATEGY

Some of the initiatives have as a key goal the formulation of priority and focus topics of future RD&I calls including their impacts. In addition, some of the initiative (ETIPs) also formulate robust information on what funding amounts are needed for what RD&I sub-topics. Only a few initiatives, however, provide partial funding themselves. If so, this is combined with other public (governmental) and/or funding from the industry.

ERA-NET

ERA-Net SES is funding RD&I projects through transnational coordinated calls. The two sub-initiatives with the **ERA-Net SES, ERA-Net SG+** (Smart Grids Plus) and **ERA-Net REGSYS** (Regional Systems), each made a single call where co-funding both from national or regional funding agencies or governments was combined with funding from the European Commission (within the EC FP9 and EC Horizon initiatives). Depending on the funding regulation of each national or regional funding agency, RD&I projects must contribute with their own in-kind finances to these joint ERA-Net SES calls. Besides the single call for SG+ and for REGSYS co-funded by the EC and European national/regional governments, ERA-Net SES also makes additional calls without EC-funding, i.e. where only the national government provide funding besides industrial and university in-kind contributions. **ERA-Net SCC** intends to fund research projects which follow the topics the ERA-Net SCC has defined. **ERA-Net SUF** aims to produce replicable results from the funded projects in order to create new standards in the Smart Urban Futures area.

Within **ERA-Net SUGI,** each national/regional funding agency will provide funds directly to their eligible investigators in accordance to the agencies' rules and regulations. Funds provided by the European Commission will be utilized to support eligible investigators in a maximum number of research projects**.**

EERA

EERA SG is strongly funded by the respective national funding agencies in the research carried out by the participants of the JP. The funding of the research can be through dedicated strategic research programmes or via more general programmes**. In EERA E3S**, each partner contributes to the Joint Program with an annual fee. In addition, the relevant partners organise and take part in the internal workshop and in institutional events with own resources.

JU

FCH JU supports cross-cutting research and development projects and enable the Transportation and Energy Pillars to facilitate the transition to market for FCH technologies. With the aim of accelerating the market introduction and deployment of the technologies stemming from the projects FCH JU supports funding/financial engineering activities that have been integrated recently into the Programme Office.

ETIP

The European Technology Platforms such as **ETIP SNET, ETIP DHC+, ETIP RHC** contribute to the RD&I topics by defining with all stakeholders RD&I roadmaps and RD&I implementations plans. They can be taken by the EC as input to the EU research work programmes in the Horizon 2020 RD&I calls and partially in the wider EU 2030 Energy and Climate Framework. Technology Platforms undertake consultations in the SET-Plan of the EC and provide input to its Member States driven SET-Plan RD&I Implementation Plans.

CEM

The **CEM 21CPP** initiative addresses policies to enhance financial sourcing of certain energy related areas (renewable energy, smart grids, and distributed energy resources). CEM-EVI seeks to implement its vision with continued annual financial support from participating countries, complementary funding from philanthropy organizations, and co-funding from the private sector. Some EVI members and their foundations support annual research and analysis works of the EVI coordinator.

IEA TCP

TCPs are also indirectly active in RD&I related matters: **TCP 4E** and **TCP DSM** do not address RD&I needs directly. However, they support RD&I indirectly by post-project monitoring, mapping, determining policy guidelines from project practice and in general to improve efficiency efforts. HEV **TCP** undertakes international collaboration in pre-competitive research and demonstration projects, functioning as a promoter for Research, Development, Demonstration, and Deployment (RDD&D) with the goal to involve shared resources from multiple countries. **TCP DSM** concentrates on the analysis of the role of customers in the implementation of effective smart grids services, on setting up tools and methods to helping the behaviour changers and on identification of the drivers for the transition of business models towards schemes enabling more effective market uptake of DSM energy services. **TCP ISGAN** finances specific projects of interest for the development of the TCP (e.g. the initiation of new activities such as the TCP ISGAN academy).

PPP

PPP BDV and PPP Cybersecurity indirectly support RD&I project funding by improving industrial competitiveness of Europe through innovative Big Data Value technologies, applications, services, solution. They leverage funding from Horizon2020 and maximising the impact of available industry funds through better coordination and better focus on a few technical priorities. **EGVI cPPP** intends to make various rounds of biennial calls for RD&I in the period until 2020. **5G PPP** intends to do large technological and business validation trials to account for regulatory barriers and those related to security of critical communications infrastructures.

MI

In **MI IC1**, each participating country finances its own research institution contributing to the general effort of doubling the public R&D funding on clean energy technologies and their integration and use in the timespan of 5 years. Open calls to MI IC1 country's members have been launched according to the above scheme. Examples of joint collaborative projects have been started involving for example India, Italy and China, Australia-China etc. In **MI IC7**, each participating country finances its own research institution contributing to the general effort of doubling, in the timespan of 5 years the public R&D funding on clean energy technologies and their integration and use.

SET IWG

SET IWG 4 has identified the following RD&I related activities: Share results by using the instruments of the knowledge management platforms (ETIP SNET supported) BRIDGE, (ETIP SNET supported) GridInnovationonline.eu, (ERA-Net SES supported) expera. Participation to related working groups, discussion papers, living documents etc. can also be envisaged. 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. The participants intend to organise joint transnational 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. the participants also intend to participate in the international context (e.g. Mission Innovation) considering a global programme setting, together with countries outside Europe.

Within **SET IWG BATTERIES**, the SET-Plan Member States participate in the work of the Action 7 TWG. They provide indications of their intended support to the ten R&I Activities (through nationally funded research, provision of State Aid or through a bi- or trilateral action with other Member States.
In **SET IWG SMART CITIES**, the budget for the initiative is focused on the public R&I funding of the participating countries dedicated towards PED (Positive Energy Districts) development: ERA-Nets and the annual joint calls are organised by the JPI Urban Europe Calls.

5.3 ANALYSIS OF THE IMPLEMENTATION

Some of the initiatives focus mainly on monitoring and evaluating the outcomes of RD&I calls and projects. They then produce analysis documentation which contributes to define future RD&I policies and priorities, as well as reporting on the impact of the present ones.

ETIP

The ETIPs, such as ETIP-SNET, follow an approach to feedback their analysis in a short period of time to the industry so that its solutions might be adapted faster. For this, ETIP-SNET gathers the best practices, experiences and technologies adopted by leading countries that can be easily adopted, adapted and replicated in other demanding countries, thus accelerating the development. In order to prevent this celerity from compromising quality, regular internal validations of the sectors' development must occur, as in ETIP DHC.

ERA-NET

Regarding ERA-Nets, like ERA-Net SES and SUGI, they aim to translate the progress made by their projects in mid-level TRLs into best practices in a close future. There is constant guidance provided to these projects to assure its added value to the European reality.

EERA

The European Energy Research Alliance's initiatives (EERA), namely EERA Smart Grids, aim to take a leading role in defining strategic paths by analyzing results from both past and present national and international RD&I projects of smart grids implementation in Europe.
This is done with regular workshops and institutional meetings, depending on the initiative. After this process, they follow up their leading role by coordinating research activities, like is the case with EERA Energy Storage.

PPP

Public Private Partnerships (PPP) aim at accelerating research and demonstration of technologies by promoting competitiveness and growth of each initiative's industry. In this way, following industrial leadership, they provide end users, both public and private with innovative technologies and solutions. These goals can be seen, for example, in PPP Big Data Value and PPP 5G.

CEM

The Clean Energy Ministerial (CEM) initiatives focus on regular reports on their respective areas of interest, offering a global view of the state of affairs and outlooks on future developments, going beyond the European reality.

Unlike other initiatives, they aim not just to actively participate, for example, in the financing and coordination of technological developments, but mostly in the creation and implementation of policies and regulations. This is the case in initiatives like CEM 21st Century Power Partnership.

MI

In the Mission Innovation framework there are several Innovation Challenges, being the most relevant one numbers 1 (Smart Grids) and 7 (Affordable Heating and Cooling of buildings). A common aspect to them is the elaboration of country reports which highlight the main achievements of national energy strategies. Beyond this, in Innovation Challenge 1 a hub has been created which gathers those achievements in leading countries that can be adapted and replicated in other countries to kick-start their developing.

IEA-TCP

The International Energy Agency's Technology Collaboration Programmes (IEA-TCP) have a global outreach. They have distinct analysis of their own implementation. One is the creation of common frameworks for future case studies in their area, based on the assessment made to past and present ones.
Others, as TCP Energy Conservation through Energy Storage, have a greater focus on success story monitoring which can be relevant to its policies. Many of them can be found in a database, detailing the progress made from initial development stages until market entry.
It is important to notice that TCPs' focus goes beyond direct technology implementations, also taking part in other aspects concerning energy transition (e.g. Behaviour changes by stakeholders). These activities are complemented in all IEA-TCPs by regular reports which can either be area, task or country specific. As is the case with IEA-TCP 4E, these reports can often demonstrate direct contributions to national policy development due to outcomes of the initiatives.

5.4 PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES

Smart energy networks are characterized by their numerous interfaces at all levels of the value chain: from generation to final use, stepping through all energy conversion, transport and distribution. In order to guarantee the optimized functionalities of the energy system, standardization and interoperability are key attributes of any equipment or solution to be applied along the energy systems. International standardization bodies have acknowledged this importance and have anticipated the absolute necessity to overcome the silo approach by technology or sector (electricity vs. gas, heat etc.) and address the overall system integration.

To this aim, the IEC (International Electrotechnical Commission) has created the System Committee on Smart Energy (SyC Smart Energy) with the aim to conduct standardization activities in the field of Smart Energy in order to provide systems level standardization, coordination and guidance in the areas of Smart Grid and Smart Energy, including interaction in the areas of Heat and Gas, to widely consult within the IEC community and the broader stakeholder community to provide overall systems level value, support and guidance to the TCs and other standard development groups, both inside and outside the IEC and to liaise and cooperate with the expert groups on Smart Cities and Systems Resource Group. Leveraging the Mandate from the European Commission M490/EN (Standardization Mandate to European Standardisation Organisations (ESOs) to support European Smart Grid deployment), CENELEC, the European Electricity Standardisation body has worked in coordination with the IEC to develop adequate system standards to complement and harmonise the equipment standards in view of their integration into the energy systems.

The system standardization activity is carried out through the following groups, which define and develop the integrated energy system standardization strategy, roadmap and tools:

- WG2 – Smart Energy Development Plan;
- WG3 - Smart Energy Roadmap;
- WG5 - Methodology And Tools.

Initiatives and projects at European and global level contribute, through their key exploitable results, to the development of standards with special reference to interoperability. In particular, **ERA-Net SES** promotes the use of standardised system architecture, through specific “living documents” and discussions in “working groups”, fostering the widest use of the SGAM (Smart Grids Architecture Model) in all projects under its framework. On the same principle, **ERA-Net SCC**, **ERA-Net SUGI** and **ERA-Net ENSUF** aim to produce replicable results from the funded projects in order to create new standards across the entire energy system. The contribution to standardisation of Joint programmes under EERA (e.g. **EERA SMART GRIDS**, **EERA ESI**, **EERA STORAGE**, **EERA SMART CITIES**) although not appearing at the forefront of their dissemination messages, has a strong potential, being the innovation level achieved quite outstanding. In fact, for example, the concept of Web-of-cells developed by the **EERA SMART GRIDS** JP may deserve a pre-standardisation activity and has been successfully presented in several scientific contexts (CIGRE, CIRED etc.).

Several network equipments are focusing on performance standards, such as batteries: **SET-PLAN IWG BATTERIES** addresses the necessities of development of real-life representative application-based duty cycle standards, testing standards and performance certificates with special reference to testing for state of charge and state of health estimation. Interoperability is also a matter of interest in global initiatives, such as **TCP ISGAN** where Annex 5 – Smart Grids International Research Facilities Network – SIRFN is an initiative dedicated to collaborative work in four key areas:

- Test protocols for advanced interoperability functions of distributed energy resources (DER);
- Smart grid modelling and simulation;
- Advanced laboratory testing methods;

- Power systems testing.

Interoperability is also a key element in the work plan of **MISSION INNOVATION IC1**. The interoperability of charging infrastructures (plugs) and accessibility of charging services, by means of the setting-up of recommendations for governments and industry is the focus of **TCP HEV** (Task 39). **TCP ECES**, dealing with storage has set up an internal activity aiming at identifying priorities for international standards and makes an effort to work with the IEC, CEN and ISO, as well as industries to ensure what test and performance standards are applicable.

A strong attention is also devoted to minimum performance standards (energy efficiency, safety, reliability etc.): the **TCP 4E** has a long history in the definition of performance standards for electrical equipment (e.g. Domestic refrigerated appliances, Televisions Residential split & unitary air conditioners, Domestic lighting, Washing machines, Laundry dryers, Notebook computers, Standby power, Vending machines, Retail display cabinets, Dishwashers, Set-top boxes, Distribution transformers, Electric Motors, Packaged Liquid Chillers, Water heaters) and its reports are considered a reliable benchmark at international level for producers, users and policy makers. Performance standards are also very important in the building sector:

TCP EBC has published in 2018 only, 22 Factsheet useful for standardization, guidelines to apply the methods in quality assessment procedures, harmonised guidelines on the environmental life cycle assessment, standardised templates for case studies, standardised energy calculation methodologies for air conditioning dimensioning for non-residential buildings. Environmental impact assessment by means of standardised approaches, such as LCA, is also a priority in the mobility field and is thoroughly addressed by **TCP HEV, CEM EVI**. Safety standards are developed by different initiatives with special reference to storage: **SET-PLAN IWG BATTERIES** looks for harmonisation of safety requirements is an important driver to further boost battery markets.

5.5 REGULATORY INNOVATIONS

ETIP SNET, RHC ETIP identify innovation barriers related to regulation and financing. **ETIP DHC+** identifies innovation and market uptake barriers related to technological, regulatory and economic issues.

EIP SCC intends to bridge the gap between EIP-SCC's members and policy makers.

ERA-Net SES provides living documents on and makes working groups address the regulatory and market issues which are aimed to identify barriers and needs emerging in the field of regulation and development of the markets. A platform for initiating and developing the expert discussions regarding the messages from the research community to the policy makers has been setup. Regulatory sandboxes are considered to promote and test innovation in the field. **ERA-Net SCC** has active participation of stakeholders in the evaluation of alternative solutions for urban development. It makes policy and market recommendations. Projects funded within the ERA-Net SCC address modelling and visualization tools for discussing policy scenarios between citizens and governments. The **ERA-Net SUGI** projects are multidisciplinary and typically involve city planners, urban farmers, scientists, entrepreneurs, community leaders, and engaged citizens. Project are often organized in the form of Urban Living labs, giving regulators and urban planners real life insights of the aspects investigated. The ERA-Net SUGI projects develop and propose guidelines and participatory assessment tool kits, through co-creation in Urban Living Labs, based on an integrated assessment of local-global interactions in the FWE nexus and transdisciplinary action-research.

The **EERA SG** and **EERA ESI** Programmes established a structured dialogue with government bodies (ministries, funding agencies, and other public research organizations) to communicate findings, activities and future research needs. They support regulators in order to promote a regulatory framework that encourages fair market access and efficient coordination amongst the different market players.

EERA Energy Storage advises policy makers by identifying regulatory hurdles and market failures hampering the business case for energy storage.

PPP BDV contributes to policy development, education and technology ramification in the widest possible sense and addressing ethical, legal and societal issues. **PPP Cybersecurity** brings together industrial and public resources to improve Europe's industrial policy on cybersecurity. **PPP 5G** makes large technological and business validation trials, which take into account all barriers and issues, including regulatory ones and those related to security of critical communications infrastructures.

IWG 4 has reached the development level of solutions for smart energy systems, which now raises the question of replicability and deployment and beyond the established set of research technology and innovation policy instruments categorised by the Technology Readiness Level (TRL) narrative. 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 is identified with respect to adequate forms of policy support regarding adequate institutional frameworks (including regulation, market structures, infrastructure investment mechanism …). Regulatory innovation zones (RIZ) are framed as an orchestrated set/mix of complementary policy actions combining R&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 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**).**

IWG Batteries enables access to finance for upscaling production and large-scale advanced battery production and deployment. It enables harmonisation of the different regulations concerning the transportation of dangerous goods to facilitate second use of EV batteries.

IWG Smart Cities accelerates the development of PEDs (Positive Energy Districts) and the associated regulatory aspects for their long term deployment. Energy Performance of Buildings must be scaling up by transforming regulations from a building-scale to a district-scale to respond to the increased technological complexity of PEDs and the need for licensing of new technologies, regulating the interests of various stakeholders and new cooperative innovation mechanisms, clearly specifying their responsibility and conditions for exchange of energy flows.

CEM 21CPP provides reports, workshops, bilateral meetings to get more insight on governmental issues.

CEM RGEI discusses conducive policy and regulatory frameworks regarding regional and global energy interconnection (RGEI).

CEM Sustainable Cities identifies policy recommendations to scale up the Ecoenergy Town approach for improving energy access problem in rural areas.

CEM EVI establishes policies to help the EV30@30 (30% Electric vehicles by 2030) goal become a reality and will direct involved ministries to engage through CEM EVI to report progress and share best practices. It addresses the most important policy needs for a timely and sustainable transition to electric mobility, based on the real-world experience of participating countries: In the early stages, public procurement schemes shall demonstrate the technology to the public providing the opportunity for public authorities to lead by example. Taxes that reflect the CO_2 emissions are important, as well as fiscal incentives at vehicle purchase and complementary measures that enhance the value proposition of driving electric on a daily basis (e.g. preferential parking rates, road toll rebates and low emission zones).

MI IC1 and MI IC7: Although regulation is not amongst the initial priorities of MI, technical and non-technical barriers to the implementation of the solutions and technologies will be addressed by MI IC1 and MI IC7. MI IC1 provides definite indication to the regulators for fostering the adoption of the smart

grids technologies worldwide. MI IC7 provides definite indication to the regulators for fostering the adoption of the exploitation of low-carbon energy sources for Heating/Cooling.

TCP ISGAN, in particular TCP ISGAN ANNEX 3, provides cost-benefits and socio-economic analyses of smart grids and related regulatory policies. It analyzes the benefits and costs of smart grid technologies, practices, and systems, from both top-down and bottom-up perspectives. Results are used to develop specific business cases, taking into account specific regulatory and market structures, as well as current system status, available generation assets and resources and demand profiles. Regulators, utilities and other electricity system stakeholders use these toolkits to define and decide on system needs and priorities for smart grid system investment and regulatory changes.

In **TCP ECES,** although regulation is not the primary focus, preventative measures and recommendations for national and international guidelines and standards are elaborated to avoid problems but also solutions for fixing and remediation (TCP ECES Annex 27).

In **TCP DSM**, policy relevance is central. Studies have been undertaken comparing similar behavioral interventions in member countries, work on energy saving in hospitals. Monitoring and Verification (M&V) has been taken up. Task 25 Phase II on business models has a specific component devoted to drawing out the policy implications of the work. Policy briefs are published according to research results outcomes.

In **TCP EBC,** projects and activities have produced long-lasting decision-making tools.

In **TCP HEV**, specific attention (Task 1) is given to regulation, standards, and policies: Best practices are evidenced in country reports and proposed for further implementations. Specific regulatory issues have been addressed on Light-Electric-Vehicle Parking and Charging Infrastructure (Task 239, Home grids and V2x technologies (Task 28), Small Electric vehicles (Task 32).

In the work of **TCP 4E**, many jurisdictions are analyzed to incentivize Voluntary Agreements (VAs) as an alternative mechanism to regulations for reaching similar policy objectives. Amongst the claimed attributes of VAs are that they place a lower regulatory burden on industry, may be quicker to initiate and more adaptable to rapid changes in technology. TCP 4E analysed in depth 50 VAs pertaining to the following categories: Industry-led VAs to set minimum performance levels, Industry-led VAs to establish (a form of) labelling, Government-defined voluntary energy labels, Government-defined mandatory energy labels, Government-defined voluntary performance requirements, Voluntary participation in regular, government-led S&L development

5.6 DISSEMINATION AND KNOWLEDGE SHARING ACTIVITIES

Every initiative organizes several internal meetings to share information and to make all its members and/or working groups updates about the needs and the progresses of the ongoing activities.

The dissemination activities here considered are mainly intended for a wider and common public. 14 items have been identified, divided into 3 clusters:

1. ***information provided via web***
   - news on web;
   - newsletter;
   - press release;
   - ongoing project snapshot;
   - environment for matchmaking future project partners;
   - campaigns.

2. ***events***

- workshops;
- webinars;
- conferences.

3. available publications

- strategy/roadmaps etc.;
- academic reports;
- technical reports;
- scaling-up;
- success stories.

Figure 39 represents how much (%) the European initiatives cover the dissemination activities. For the first cluster of activities, the majority (almost 60%) of the initiatives guarantee the disclosure of information via web (news on web). In the same cluster, providing a snapshot of the ongoing projects as well as providing an environment for matchmaking future project partners are quite relevant (around 40-60%). Among the items of the second cluster, the organization of workshops is the most relevant one (near 90% of the initiatives organize them), followed by conferences and webinars. About the publications, almost 60% of the initiatives provides Roadmap, guidelines or other policy documents, then technical report and success stories.

Figure 40 shows the percentage covered by the Global initiatives on the different dissemination activities. For the first cluster, more than 80% of initiatives provide news on web, newsletter and snapshot on ongoing projects. Looking at the second cluster, more than 80% of the Global initiatives organize workshops and 40-50% of them organize conference and webinars. Concerning the third cluster, technical reports and success stories (40 - 50%) are the main publications produced.

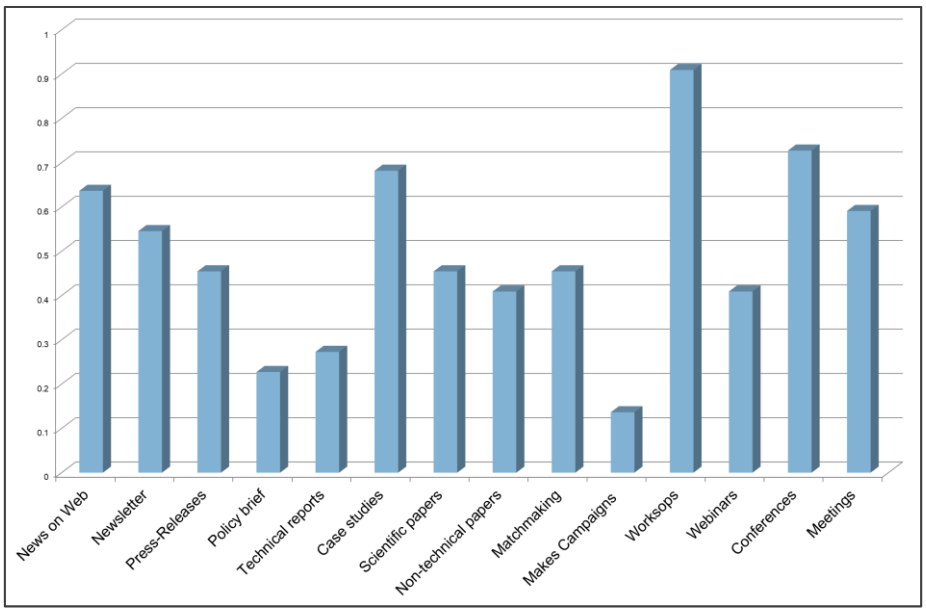

Figure 39: Fraction of the dissemination activities addressed by the European initiatives considered

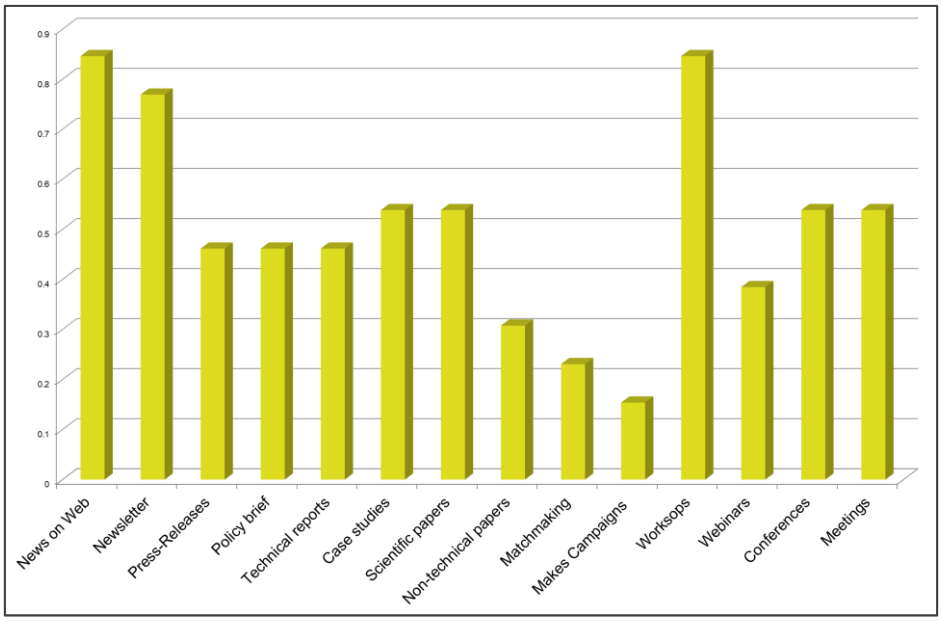

Figure 40: Fraction of the dissemination activities addressed by the global initiatives considered

Capacity building is also part of the responsibility of the initiatives: amongst the most advanced ones we can mention DSM University, the ISGAN ACADEMY and AGORA.

- IEA DSM University (DSMU): the DSMU is based on webinars developed through our own material and with invited material from external specialists in research and business and take place monthly. DSMU provides access to the knowledge developed in the TCP in a structured way. In addition, DSMU aims to be a community of practice on DSM themes. It is targeted at: Policymakers interested in learning about the costs and benefits of Demand Side Management and its impact on energy systems. Managers keen to learn more about Organisations, Governance, Planning, Programme Structuring and Implementation Methods. Programme Implementers wanting “Tricks of the Trade”;
- A similar approach is used in ISGAN Academy, where webinars are organized according to three main types of modules: fundamentals (ABC of network analysis, design and operation), smart grids (new features and potential of smart grids technologies such as renewables integration, smart metering, inverters etc.) and regional aspects (dealing with specific developments in different countries and regions;
- The JPI Urban Europe AGORA is a stakeholder platform to support exchange between different stakeholder groups (cities, business, research, societal organisations), facilitate strategic discussions and mobilization of new actors. In addition, a regular webinar format (Urban Lunch Talks) is currently established. And the Urban Europe Research Alliance is supported which is a network of research organisations connected to JPI Urban Europe, giving support for implementing the Strategic Research and Innovation Agenda.

Several other initiatives are taken in terms of guidelines, study tours, researchers exchange, round robin tests on equipment, experts support and sector-specific workshops and webinars.

6 RECOMMENDATIONS

Climate change requires dramatic and very rapid changes to the energy system in its entirety and along all its value chain: from generation to transmission, distribution, delivery, integration etc; the effort is so huge that no single actor can address it alone: this is valid both in terms of countries and in terms of technological and competences; the collaboration is therefore a must: European and international collaboration is an effective multiplier of methodologies, algorithms, results and limits the dispersion and repetition of efforts towards effective solutions, particularly in all "system" sectors where the lower the industrial risk and the greater the value of the push policy and prioritization of actions and learning from the experience of others.

The analysis carried out in this study has highlighted that the developments in the energy system are very high in the priorities of the European Union and abroad. Several initiatives have been set up and are actively working towards the common objective of accelerating the decarbonisation of the energy system by means of clean technologies applied and adopted in a modern marketplace leveraging all features and opportunities of an evolving society.

Looking at the panorama of initiatives dealing with the networks components of the energy system, the following observations and recommendations arise:

- The large number of initiatives implemented is a tangible sign of the importance given to the energy networks in the path towards decarbonisation: this needs to be fostered and continued;
- The analysis carried out in the present report confirms that European initiatives share the common objectives of the SET-Plan: i.e. Contributing to the worldwide transition to a low carbon economy by 2050, maintaining the EU industrial leadership on low-carbon energy technologies, Accelerating knowledge development, technology transfer and up-take, Fostering science for transforming energy technologies to achieve the 2020 Energy and Climate Change goals;
- According to the approach of the Integrated SET-Plan, most European initiatives consider the energy system as a whole, where all energy vectors are part of an integrated system in search of a necessary optimization;
- The countries participation in European initiatives is not even: the most active countries are present in virtually all instances, while others are absent from the panorama. Efforts shall be made to reach the global involvement around such a high priority goal;
- All portions of the energy system are covered by initiatives, but a stronger coordination is needed to streamline and optimise the achievement of key exploitable results. The most efficient decarbonisation options are strongly diversified according to the boundary conditions that shape the energy systems of different countries. It is therefore necessary to consider and develop the widest spectrum of technologies by leveraging local excellence and priorities. The international comparison has already proved to be able to favour the rapid reduction of costs of renewable sources, storage and network management technologies.
- Energy networks are characterized by such complexities that can hardly be fully understood by numerical simulations or by laboratory experiments. The large-scale demonstrators, interfaced or integrated into the real system, are an essential step to test the solidity and reliability of the solutions and to test the resilience of the system to the stresses of different origin and entity. International collaboration allows the development of large projects, reducing duplication and integrating regional specializations.
- The products of the initiatives (with special reference to roadmaps, implementation plans, research priorities etc.) are systematically the result of large consultations and consensus gathering amongst the vast plethora of stakeholders; this needs to be continued as a best practice;
- Each initiative considered aims at addressing the widest range of stakeholders along the value chain: this is positive on the one hand, because it avoids disconnection from the drivers (i.e. avoids that research activities be carried out without considering the final potential application in the real system), but mitigates focus and approach, flattening and reducing to uniformity most of the approach (e.g. having all stakeholders – from research to industry – represented at the same time

in the EERAs, ERA-Nets, ETIPs etc. will raise the risk of flattening the approach, thus repeating under different umbrella, similar development approaches.

- The level of TRL, although fairly well defined appears to be too vast: ETIPs and ERA-Nets should not start as low as TRL1, and EERAs should not consider TRLs greater than 6. This requires a careful analysis of the boundaries for each initiative without the fear of losing influence in the overall system;
- It is urgent to better delineate the boundaries and the approach adopted by the different initiatives considered: potential overlaps have been identified in the tasks and subprogrammes and efforts shall be made to clarify the goals and boundaries of each of them. Knowing that it is impossible and not productive to avoid a certain level of overlap, coordination shall be sponsored to have the widest possible consciousness about the approaches and results to foster mutual sharing and leverage strengths. Joint tasks can be implemented amongst initiatives to streamline and accelerate results harvesting. In the map of distances amongst initiatives, efforts shall be made to collaborate with the closest and most similar initiatives, to limit duplication but also complementarities shall be searched with the further initiatives to complete the range of influence.
- Standardization is a powerful vector of energy innovation and is based on close collaboration and international understanding. First of all, we need to remember how standardization sets precise and challenging objectives: the standardization of the energy performance of household appliances, emissions for road vehicles, etc. they provide a shared metric but also targets that must be attained as a minimum acceptable (and which often becomes a level of market exclusion). Standards are the engine for the dissemination of the best performing technologies, increasing the size of the energy products market (for example, making it possible to use the same light bulbs with low energy consumption worldwide) and helping consumers and investors to believe that new technologies will work as advertised. The development of standards is based on an intense scientific and technological collaboration that develops metrics, test and verification methodologies, performance benchmarks, certification schemes, etc.
- International collaboration is a useful training ground for discussing public funding schemes. Proven models can be adopted by the less equipped countries: in the energy decarbonisation sector, for example, the British Low Carbon Trust scheme facilitates public-private partnerships, or the German Fraunhofer model, able to do effectively meet university research and applied with the needs of industrial innovation. The Italian scheme of System Research is also a virtuous and solid example that funds strategic research of general interest.
- One of the objectives of international collaboration is to catalyse private investment flows, through "open innovation" or "public-private-partnerships - PPP" schemes. This approach is well understood in the ETIP SNET that places private (and regulated operators) in the coordination and addressing of the initiative, and from Mission Innovation that has prepared the Business and Investors Engagement (BIE) that involves business and investment experts in a continuous discussion of address to the perceived priorities and information on investment opportunities.
- One last aspect needs to be addressed when we speak about international collaboration: intellectual property: the protection of intellectual property (IP) in a field of scientific and technological collaboration is a very delicate aspect. In reality, the problem arises in a less driven way for energy networks which, by definition, must have open interface points, standardized and interoperable with generation, accumulation and use technologies. The topics of discussion and collaboration mainly concern tools and methods of planning, forecasting, supervision, integration and resilience that can often be discussed and experimented in common, comparing experiences and results. The PI topic was dealt with very thoroughly during the creation of the CERC (US-China Clean Energy Research Centre) [9], which, by adopting clear ex ante rules, protects the researchers involved by guaranteeing the rights to the technologies they create. The CERC protocol defines how PI can be shared or licensed in each country, guaranteeing rights in each territory with terms and conditions negotiated and clear from the beginning. For jointly funded research projects that create knowledge, project participants have the right to obtain a non-exclusive license.

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8 ANNEXES

8.1 LIST OF RESPONDENTS

LIST OF RESPONDENTS
STARDUST
BDVA
5G IA
Zero Emission neighbourhoods in Smart Cities
EIP-SCC Marketplace
Clean Energy International Incubation Center
European Innovation Partnership on Smart Cities and Communities (EIP-SCC)
DHC+ Technology Platform
Hybrid & Electric Vehicle Technology Collaboration Programme
ECTP / E2B Committee
21st Century Power Partnership
ISGAN
EERA Energy Systems Integration
MISSION INNOVATION IC 1 - SMART GRIDS
EERA JP Smart Grids
EGVI
IEA Energy in Buildings and Communities (EBC) TCP
JPI Urban Europe (incl. ERA-Net SCC, SUF and SUGI)
ENSCC
ERA-Net Smart Urban Future
ERA-Net SUGI
IEA End-Use Energy Efficient Equipment TCP (4E)
Fuel Cell & Hydrogen Joint Undertaking
EERA JP Energy Storage
PPP CYBERSECURITY
RHC-ETIP
SET-Plan Implementation Plan Action 7 Batteries for e-mobiity and stationary storage
IEA Demand Side Management Technology Collaboration Programme (DSM TCP)
Energy Storage TCP (ECES)
EERA JP e3s
EIP - SCC Marketplace

8.2 DETAILED RESPONSES FROM INITIATIVES

PPP	PPP	PPP	PPP	JTU	IWG	IWG	IWG	ETIPs	ETIPs	ETIPs	ERA-NETs	ERA-NETs	ERA-NETs	ERA-NETs	ERA-NETs	EIP	EERA	EERA	EERA	EERA	EERA	
European Green vehicles initiative	Cybersecurity	Big data value	5G	HYDROGEN AND FUEL CELLS	SMART CITIES	ENERGY SYSTEM	BATTERIES	SNET	RHC	DHC+	SUGI - SMART URBANISATION	SMART GRIDS PLUS	REGSYS	ENSUF-SMART URBAN FUTURE	ENSCC-SMART CITIES AND COMMUNITIES	SMART CITIES	STORAGE	SMART GRIDS	SMART CITIES	ENERGY SYSTEM INTEGRATION	ESS	
																						Fossil fuel generation - flexibility
																						Nuclear generation - flexibility
																						Large RES - integration
																						Distributed RES - integration
																						Bioenergy and circularity
																						Electricity networks (transmission - distribution - microgrids)
																						Gas networks
																						Heating&cooling networks
																						Mobility: electric and other forms
																						EV Charging stations integration
																						Vehicle to grid services
																						Small scale electicity storage
																						Large scale electricity storage
																						Gas storage
																						Heat storage
																						Pumped hydro storage
																						Hydrogen
																						Energy vector integration
																						Power-to-gas
																						Gas-to-power
																						Power-to-heat
																						Gas-to-heat
																						Heat pumps
																						Demand response
																						Consumer behaviour
																						Zero energy buldings
																						Local e nergy communities - smart cities
																						ICT and related aspects

8.3 MISSION INNOVATION - IC#1 - SMART GRIDS

MISSION INNOVATION
accelerating the clean energy revolution

MI Smart Grids

ABOUT

The Innovation Challenge on smart grids is part of the Mission Innovation framework, aiming at the doubling of public funding R&D in the period 2016-2021. Mission Innovation addresses 8 innovation challenges (IC), amongst which Smart Grids is IC1.

The IC1 on smart grids aims to developing and demonstrating the implementation of smart grids technologies in a variety of grid applications including demonstrating the robust, efficient, and reliable operation of regional and distribution grids as well as micro-grids in diverse geographic conditions. By 2030, the objectives are to develop technological solutions that can accommodate up to 100% renewable based power plants across the globe and to push forward the implementation of the above-mentioned solutions towards reliable clean energy solutions. Smart grids implementation involves a series of actions, which starts with innovation in technology to address the interfacing issues related to renewable energy sources, implementing models and studying various shortcomings related to the different sub systems such as energy storage, on/off grid operations, integration of large amount of decentralized renewable power in distribution networks and developing technologies at the level of consumers for demand side management (demand response).

Sub-Challenges in Smart Grids with Renewable Energy:

- Regional Grid Innovation: How to enable regional grid (GW-class) to scale up proportion of renewable electricity with few energy waste and reasonable security?
- Distribution Grid Innovation: How to enable distribution grid to accommodate high-penetration and large-scale (below 100 MW-class) distributed renewable electricity?
- Micro Grid Innovation: How to enable renewable energy-based micro grid to be affordable and valuable?
- Cross Innovation focusing on smart grids related fields including power electronics, electric materials, simulation, ICT, etc.

Smart Grids IC is involved in the following segments of the RD&I value chain:

R&I value chain	Actions
DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF R&I TOPICS	• A joint programme of work has been agreed upon to address the challenges related to enabling the use of up to 100% renewable energy into the grid and enable future grids that are powered by affordable, reliable, decentralised renewable electricity systems. • The R&D priorities agreed upon by the participating countries have been selected based on an initial series of topics proposed that was based on the European ETIP SNET roadmap 2017-2026: therefore, they are, as far as what pertains to the electricity portion of the energy system well aligned with the ETIP SNET framework, of course duly adapted to the different international contexts.
FINANCING / IMPLEMENTATION OF R&I STRATEGY	• Each participating country finances its own research institution contributing to the general effort of doubling the public R&D funding on clean energy technologies and their integration and use in the timespan of 5 years. • Open calls to IC1 country's members have been launched according to the above scheme. First examples of joint collaborative projects have been started involving for example India, Italy and China, Australia-China etc.

ANALYSIS OF THE IMPLEMENTATION	• Deliverables agreed upon in the IC1 initiative include Country Reports highlighting national energy strategies, lighthouse projects and the main achievements in the field of smart grids research. The first edition of the Country Report includes the state of implementation for 14 countries. • A key tool in view of the adoption of smart grids has been recently launched: the Smart Grids Innovation Accelerator (SGIA): a hub gathering the best practices, experiences and technologies adopted by led countries that can be easily adopted, adapted and replicated in other demanding countries, thus accelerating the development • IC1 has established a strong collaboration framework with the industry that will advise, influence and adopt the solutions coming out of the effort from MI countries.
PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES	• Activities carried out in the framework of this joint initiative will have fallouts on the standardization, being interoperability one of the key elements of the approach.
REGULATORY INNOVATIONS	• Although regulation is not amongst the initial priorities of MI, technical and not technical barriers to the implementation of the solutions and technologies will be addressed by IC1 thus providing definite indication to the regulators for fostering the adoption of the smart grids technologies worldwide.
DISSEMINATION AND KNOWLEDGE SHARING ACTIVITIES	• Dissemination is made by means of public workshops (twice a year) and technical reports published (e.g. country reports) reporting the results of the joint research. Being the work programme 2018-2020 adopted only very recently (Rome November 2018), no technical report is available yet at the date of the present report publication.

COMPOSITION/GOVERNANCE

Out of the 24 members of MI, 19 countries and EU represented by the European Commission are participating to MI IC1, amongst these China, India and Italy are co-leading the initiative. AT, AU, BR, CD, CN, DK, EU, FI, FR, DE, MX, IT, IN, NL, NO, KR, SA, SE, UK, US.

STRUCTURE

- Improve **storage integration** at all time scales (in operation for system services but also when performing planning studies as an additional degree of freedom) as a source of flexibility
- Use of **demand response** for system services with well-defined interactions among market players and network operators (and TSO-DSO exchange of information)
- Developing regional **electricity highways** with both AC and DC technologies
- New **planning tools** able to account for the full complexity of electricity networks (distributed and intermittent generation, variable and controllable loads, power electronics, storage)
- Identify and support improvements of suitable **flexibility options** (RES generation, flexible thermal power generation, load, network, storage, integration with other energy network) to ensure adequacy and security
- Study and demonstrate **new grid architectures both at transmission and distribution level** as a source of flexibility
- Novel/advanced **power electronics** technology for improving efficiency and controllability of smart grids

SUPPORTING TEAM/PROJECTS

The initiative is co-chaired by Italy, India and China.

KEY DELIVERABLES AND OUTPUTS

- Mission Innovation IC1 Country report: designed to be informative, strategically focused to serve the policy audience, and sufficiently detailed to meet the needs of researchers, stakeholders and investors. the purpose is to increase the reader's understanding of the global smart grids R&D status quo, development, and trends.

Website: http://mission-innovation.net/our-work/innovation-challenges/smart-grids-challenge/

8.4 MISSION INNOVATION - IC#7 - AFFORDABLE HEATING AND COOLING OF BUILDINGS

MISSION INNOVATION
accelerating the clean energy revolution

ABOUT

This initiative is part of the Mission Innovation framework, aiming at the doubling of public funding R&D in the period 2016-2021. Mission Innovation addresses 8 challenges, amongst which Heating and cooling.

The ultimate goal of the affordable heating and cooling of buildings Innovation Challenge is to develop core building heating and cooling systems and measures to improve building envelopes that deliver affordable heating and cooling without the carbon emissions. This Innovation Challenge provides a platform for international collaboration with the potential to considerably accelerate innovation in the heating and cooling arena. It involves the development of new solutions and taking cost out of existing and emerging solutions. This will be achieved through the collective research effort and the commitment to double spend on clean energy research.

This Innovation Challenge has four main areas of focus. In each case the need is to develop lower cost, practical alternatives to today's fossil fuel-based solutions:

- Energy savings and energy efficiency technologies and materials to reduce demand for heating and cooling.
- Low-carbon integrated equipment and systems to provide heating and cooling.
- Storage solutions to match energy supply to heating and cooling demand.
- Efficient transfer of heat from point of production / storage to point of use.

Affordable Heating and Cooling IC is involved in the following segments of the RD&I value chain:

R&I value chain	Actions
DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF R&I TOPICS	• Existing research activities will be reviewed, and workshops of international experts convened to identify gaps, develop targets to measure success and scope further research needs.
FINANCING / IMPLEMENTATION OF R&I STRATEGY	• Each participating country finances its own research institution contributing to the general effort of doubling, in the timespan of 5 years the public R&D funding on clean energy technologies and their integration and use.
ANALYSIS OF THE IMPLEMENTATION	• Deliverables agreed upon in the initiative include Country Reports highlighting the main achievements in the field of smart grids research.
PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES	• Activities carried out in the framework of this joint initiative will have fallouts on the standardization, being interoperability one of the key elements of the approach • Develop Data Standards to reduce the level of investment required to benchmark buildings and compare performance to allow innovators to identify opportunities and develop solutions with wide applicability.
REGULATORY INNOVATIONS	• Although regulation is not among the initial priorities of MI, the barriers to the implementation of the solutions and technologies and will give definite indication to the regulators for fostering the adoption of the exploitation of low -carbon energy sources for H/C

DISSEMINATION AND KNOWLEDGE SHARING ACTIVITIES	• Dissemination is made by means of the reports published (e.g. country reports) reporting the results of the joint research.

COMPOSITION/GOVERNANCE

The Affordable Heating and Cooling of Buildings Innovation Challenge is led by the United Kingdom, the United Arab Emirates, and the European Commission. Other participating members include: Australia, Brazil, Canada, China, Denmark, Finland, France, Germany, India, Italy, Mexico, Norway, Saudi Arabi a, Sweden, the Netherlands and the United States

STRUCTURE

The exploitation of low-carbon energy sources for H/C offers safe, reliable and increasingly cost-competitive solutions. In order to realise this potential, and considering the MI global context, we have agreed to focus on a number of relevant " cross-cutting" technologies:

- **Thermal energy storage**: Develop more compact thermal energy storage for domestic applications of storage periods typically up to 4 weeks long. This will require materials that have virtually no heat losses but can take advantage of optimized solar and wind sources without district heating and cooling network connection. Re-design large scale TES for district heating and cooling in order to match the seasonal supply and demand of a large number of renewable sources on a district level. This calls for new designs and novel materials to be used to achieve minimal surface area and double use of the top of the storage. Develop compact thermal energy storage for electricity load shifting. These storage devices will take up electricity from the grid at the peak times in a day, to be used in the building for heating, cooling or hot tap water at later times.
- **Heat pumps**: Four key activities were identified that needed to be overcome:
  - Converting low grade heat to power (Target 60 °C heat to power at 10-20% efficiency)
  - Efficient gas to heat and cold (Target Gas Utilisation Efficiency of 1.6 (air source), 1.7 (water source) and 2.0 (in lab)
  - Integrated heating and cooling solutions (COP of 5.0 is currently achievable theoretically but better deployment needed to achieve this in practice)
  - Improved demand side management (targets are highly grid specific but aim to ensure security and stability of supply
- **Non-atmospheric heat sinks and sources**; Develop indirect evaporative cooling of chiller by rejection of chiller waste heat against the wet bulb temperature of the building exhaust air. The basic principles are well understood but implementation and system integration challenges remain. Pilot projects should be conducted. Improve system integration and precise balancing of district-wide thermal networks connecting non-atmospheric sinks and sources with thermal energy storage. Establish the feasibility of adding active takers/providers of heat to address heating/cooling imbalance in the system. Introduce low -wavelength radiation to deep space using a special high emissivity and high albedo film to enhance direct radiative loss from chiller condenser coils.
- **Predictive maintenance and optimization**; Develop a Knowledge Hub as a way of pooling the collective international knowledge on the topic and commission studies and surveys to supplement knowledge across different countries and climates. Develop Data Standards to reduce the level of investment required to benchmark buildings and compare performance to allow innovators to identify opportunities and develop solutions with wide applicability. Establish an Open Data/ Building Emulator Platform to enable the development and testing of new solutions at much lower cost.
- **Physiological studies**: Develop methods to understand human thermal comfort needs using advancement in Information Technology (IT). Based on knowledge generated, enhance HVAC systems capabilities to provide thermal comfort. Develop metrics combining heating/ cooling energy performance with thermal comfort performance. Develop data platform helping innovators and investors to take informed decisions; to disseminate information about capabilities of various technologies at concept stage to attract investment; by informing about performance gaps of HVAC

systems, encourage innovators to apply their skills to meet challenges. Develop HVAC/Sensors & Control technologies that understand short period human comfort requirements.

- **Building-level integration:** Develop a big and open data platform for build and operational standards–the Open Data Sharing Project. Use automation and dynamic controls to tap into the potential for low-cost demand response from building HVAC systems. Develop solutions for non-air-conditioned buildings that do not use highly potent refrigerants and consume dramatically less energy, yet provide consumers with the cooling that they increasingly need. Improve system integration / prosumer networks focused around taking forward the concept of a “Better Box” described under the "Heat Pump" priority area.

SUPPORTING TEAM/PROJECTS

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KEY DELIVERABLES AND OUTPUTS

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Website: http://mission-innovation.net/our-work/innovation-challenges/affordable-heating-and-cooling-of-buildings/

8.5 TCP ECES - ENERGY CONSERVATION THROUGH ENERGY STORAGE

ABOUT

Energy Conservation through Energy Storage (ECES) is 1 of 39 Technical Collaboration Programmes (TCP's), part of the Energy Technology Network of the International Energy Agency (IEA). The mission of ECES is to facilitate research, development, implementation and integration of energy-storage technologies to optimize the energy efficiency of all kinds of energy system and to enable the increasing use of renewable energy instead of fossil fuels. The initiative considers projects with TRL from 5 to 7.

ECES is involved in the following segments of the RD&I value chain:

R&I value chain	Actions
DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF R&I TOPICS	The research and innovation activities are determined based on the priorities of ECES member countries and the outcomes of the recent IEA Technology Roadmap on Energy Storage. Furthermore, the strategic research agenda of the Cross-Cutting Panel of the European Technology Platform on Renewable Heating and Cooling is also taken as reference. The following main streams are determined: • Development of energy storage for energy savings and efficient use of energy in buildings and industry ○ High temperature heat storage for industrial purpose ○ Storage in buildings for efficiency improvement ○ effective storage solutions for heating and cooling in Smart Cities / Regions ○ Mobile storage options for surplus heat utilization ○ Stationary batteries ○ Distributed storage in district cooling systems ○ Local storage for free (night-time) cooling of buildings • The TCP addresses also economical-regulatory hurdles: non-discriminatory market access (level playing field), business cases/market design, regulatory hurdles (e.g. taxation), security of investment in uncertain market development
FINANCING / IMPLEMENTATION OF R&I STRATEGY	• The TCP does not have plans to finance R&D or technology developments in the field of storage.
ANALYSIS OF THE IMPLEMENTATION	• The TCP monitors the success stories which can be attributed to its policy relevance. Several successes are evidenced in numerous countries, i.e: In Belgium (underground heat and cold storage systems), Denmark (PTES - Pit Thermal Energy Storage), Germany (RD&D Initiative on Energy Storage Technologies – 200 projects), Japan (TES in over 30,000 buildings - offices, shopping centres, hospitals, factories etc.), the Netherlands (underground heat and cold storage systems (UTES) in commercial real estate), Sweden (ATES and BTES applications), Tukey

	(ATES plant in the Mediterranean climate was successfully demonstrated for a greenhouse). The TCP has set up a database of current energy storage projects that cover various technological sectors and a showcase of solutions that grew from laboratories to marketable products.
PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES	The first guidelines on underground energy storage technologies were written in Germany through the collaborative efforts in ECES. These guidelines have been transferred and adapted in different countries like Canada and Japan. The TCP aims at identifying priorities for international standards and makes an effort to work with the IEC, CEN and ISO, as well as industries; to ensure what test and performance standards are applicable. Although standardization is not the primary focus of ECES, some fallouts of the activities exists: • Standardised and scientifically proven approach and methodology to asses various storage devices for various applications (Annex 32); • Provision of generic open source models and data sets (Annex 32).
REGULATORY INNOVATIONS	• Although regulation is not the primary focus of ECES, some fallouts of the activities exists: • Preventative measures and recommendations for national and international guidelines and standards to avoid problems but also solutions for fixing and remediation (Annex 27).
DISSEMINATION AND KNOWLEDGE SHARING ACTIVITIES	• The main publications of ECES are the annual reports and brochure, which are available from the webpage. The final annex reports are published on the webpage.

COMPOSITION/GOVERNANCE

Participating countries in TCP ECES are Belgium, Canada, China, Denmark, Finland, France, Germany, Italy, Japan, South-Korea, Netherlands, Norway, Slovenia, Sweden, Switzerland, Turkey, United Kingdom, USA.

STRUCTURE

Some Annexes have been completed. Here below the running annexes are listed:

- **Annex 28: Distributed Energy Storage for the Integration of Renewable Energies:** The overall goal is to foster the role of Distributed Energy Storage (DES) and to better evaluate the potential storage capacities for the integration of renewables at an economical competitive level.
- **Annex 30: Thermal Energy Storage for Cost-Effective Energy Management & CO_2 Mitigation:** The main objective is to encourage the implementation of thermal energy storage systems and evaluate their potential with respect to CO_2 mitigation and cost-effective thermal energy management.
- **Annex 31: Energy storage with Net Zero Energy Buildings and Districts: Optimisation and Automation:** This Annex address the integration, control, and automation of energy storage with buildings, districts and/or local utilities. The focus is on the development of design methods, optimization, and control tools related to predicting, operating, and evaluating the performance of energy efficient buildings and districts when energy storage is available.
- **Annex 32: Modelling of Energy Storage for Simulation/ Optimization of Energy Systems:** The aim is to select always the best fitting storage systems with the best fitting operation mode to balance the energy system. The task is to develop a standardised and scientifically proven approach and

methodology to asses various storage devices for various applications: grid connected and grid operated, island grids/remote areas, industrial sites and residential areas.

- **Annex 33: Material and Component Development for Thermal Energy Storage:** Deals with advanced materials for latent and chemical thermal energy storage, Phase Change Materials (PCM) and Thermo Chemical Materials (TCM) .
- **Annex 27: Quality Management in Design, Construction and Operation of Borehole Systems:** Quality Management in Design, Construction and Operation of Borehole Systems (BoreSysQM) is elaborating reliable measures of quality management, to analyze this technology and failures in the different markets worldwide.

SUPPORTING TEAM/PROJECTS

The TCP is managed with resources from the participating countries. An operating agent takes care of the administrative aspects of the TCP

KEY DELIVERABLES AND OUTPUTS

- **Annual Report 2017:** an overview of the activities the Energy Storage TCP and the annexes.
- **IEA ECES Strategic Plan 2017 - 2021:** outlines the scope and goals for the years covering 2016 through 2021. This is an update on the previous strategic plan that was approved in 2011, by the Energy End-Use Working Party that prolonged ECES until February 2016. The strategic plan shall serve as the basic working document to guide the future work of the Executive Committee and shall also provide a comprehensive summary for other IEA Committees and for the IEA-Secretariat.

Website: https://iea-eces.org/

8.6 TCP 4E - ENERGY EFFICIENT END-USE EQUIPMENT

ABOUT

4E concentrates on non-transport energy using equipment and systems in the residential, commercial and industrial sectors. The 4E focus is on equipment types that contribute significantly to the total end-use energy consumption and/or have significant energy saving potential, 13 countries from the Asia-Pacific, Europe and North America participate in 4E to share information and transfer experience in order to support good policy development in the field of energy efficient appliances and equipment. The TRL considered by 4E are 5-8.

4E is involved in the following segments of the RD&I value chain:

R&I value chain	Actions
DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF R&I TOPICS	The main scope of 4E is not linked with the setting of R&D&I programmes, but to develop a range of information and tools to assist governments to develop better energy efficiency policies for appliance and equipment. 4E enables national energy efficiency programmes to be consistently evaluated and improved so that they are ambitious, internationally aligned and effective. Working together through 4E, governments can grow the impact of energy efficiency policies substantially, through: • Setting policies that reflect changes in technology and market conditions. • Expanding the scope of policies to cover more appliances and equipment. • Improving implementation and compliance through learning from the experience of others.
FINANCING / IMPLEMENTATION OF R&I STRATEGY	The TCP does not finance R&D or technology developments in the field of energy efficiency of electric equipment, as this is the responsibility of member governments. The collaborative work of 4E TCP may however, assist members to target areas for development under their national R&D programmes.
ANALYSIS OF THE IMPLEMENTATION	A recent survey showed that almost all members have used 4E materials in their national (or regional) policy development processes. 4E's international comparisons of appliance performance levels are used by policy makers to set national thresholds which enable their citizens to access the best performing products, now and into the future.
PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES	4E has completed international benchmarking projects for 16 products (Domestic refrigerated appliances, Televisions Residential split & unitary air conditioners, Domestic lighting, Washing machines, Laundry dryers, Notebook computers, Standby power, Vending machines, Retail display cabinets, Dishwashers, Set-top boxes, Distribution transformers, Electric Motors, Packaged Liquid Chillers, Water heaters). In 2017, a report on Domestic Water Heaters was published, covering storage, instantaneous and heat pump technologies, and electric and gas-fired equipment. 4E analysis is used directly, through its member countries, to influence the development and improvement of test standards for Motors, Motor Systems and Solid State Lighting.

REGULATORY INNOVATIONS	The work of 4E TCP is used by members to improve their energy efficiency regulations for a range of products, and to move towards closer harmonization of test procedures and performance requirements. 4E provides a forum for regulators to share information and collaborate on their MV&E practices to improve the compliance and enforcement of regulations. Additional policy options are also examined. For example, many jurisdictions look to Voluntary Agreements (VAs) as an alternative mechanism to regulations to reach similar policy objectives. Amongst the claimed attributes of VAs are that they place a lower regulatory burden on industry, may be quicker to initiate and more adaptable to rapid changes in technology. 4E analysed the impact of 50 Voluntary Agreements in order to identify strengths and weaknesses.
DISSEMINATION AND KNOWLEDGE SHARING ACTIVITIES	• The TCP is very active in its dissemination activities. In particular, in the period 2008-2017 the following material was produced: • Reports (226) • Policy briefs (110) • Newsletters (105) • Presentations (75) • Workshops (41) • Policy Exchanges (90) • Meetings (100) • Sofware tools (3) • Promotional materials (7)

COMPOSITION/GOVERNANCE

4E is managed by an Executive Committee (ExCo) comprising one voting delegate from each participating country. Like all IEA Technology Collaboration Programmes, participation is open to all countries.

4E activities are determined solely by its members, which are represented by ministries, departments or agencies responsible for national government energy efficiency policies. This structure ensures that the work of 4E is tied to the policy requirements of governments, and that the outputs have a tangible impact on their policies.

STRUCTURE

Research projects are established in the form of Technology Collaboration Programme Annexes. Current Annexes include:

- **Electric Motor Systems (EMSA):** encourages alignment on policies proven to be effective for motors and motor system. EMSA raises worldwide awareness of the efficiency potential of motor systems and provides guidance and tools to exploit this. EMSA works on specific topics related to motor systems efficiency (International standards, Regulatory assistance, Energy management systems, Energy audits for motor systems, Motor Systems Tool, Testing).
- **Solid State Lighting (SSL):** has the potential to provide high-quality, energy-efficient lighting that surpasses traditional technologies and offers a lower life-cycle cost. It develops tools, test methods and policies to ensure high quality LED lighting
- **Electronic Devices and Networks (EDNA**): EDNA focuses on “network connected devices”, monitoring the energy consumed by connected devices and their networks. EDNA identifies government policies to minimize energy consumption. EDNA aims to ensure that the next generation of such devices use electricity as efficiently as possible.

SUPPORTING TEAM/PROJECTS

As part of the IEA Energy Technology Network, 4E works closely with the IEA Secretariat and links with other Implementing Agreements studying energy use within buildings. Some 4E members also participate in the Super Efficient Appliance Deployment (SEAD) initiative, a project under both the CEM and IPEEC, as this brings opportunities to address similar objectives and to maximise effectiveness through joint activities. These and other organisations such as APEC, the World Bank, the World Economic Forum, international standards organizations and industry groups are part of an emerging network of public and private sector groups with an interest in end-use energy efficiency. Recognising the unique contribution that each is playing in the development of public policy, **4E** continues to engage with a wide range of these organisations to promote a better understanding of issues relating to the energy efficiency of end-use equipment.
In 2017, the total cost of 4E activities is estimated to be €2.2 million. 75% of resources were directed towards research, while expenditure on communication and outreach activities accounted for 19%.

KEY DELIVERABLES AND OUTPUTS

The detailed achievements in all areas of 4E work are identified in the 4E Annual Reports available on the website. All the publications are available at https://www.iea-4e.org/publications. Among these, the following are the more recent ones:
The detailed achievements in all areas of 4E work are identified in the 4E Annual Reports available on the website. All the publications are available at https://www.iea-4e.org/publications. Among these, the following are the more recent ones:

- IEA Technology Collaboration Programme on Energy Efficient End-Use Equipment (4E) - 2017 Annual Report: is the report describing how, during 2017, 4E has continued to develop a range of information and tools to assist governments to develop better energy efficiency policies for appliance and equipment.
- Policy Guidelines for Motor Driven Units
- Benchmarking Report: Domestic gas and electric, storage, instantaneous and heat pump water heaters
- Policy Brief - Intelligent Efficiency: Smart Homes
- Energy Harvesting Technologies for IoT Edge Devices
- The Effectiveness of Voluntary Agreements

Website: https://www.iea-4e.org/

8.7 TCP HEV - HYBRID & ELECTRIC VEHICLE

ABOUT

The TCP on Hybrid and Electric Vehicle Technologies and Programmes was formed in 1993 collaborate on pre-competitive research and to produce and disseminate balanced, objective information about advanced electric, hybrid, and fuel cell vehicles. HEV TCP enables member to discuss their respective needs, share key information, and learn from an ever-growing pool of experience from the development and deployment of hybrid and electric vehicles. The HEV TCP has 17-member countries.

The initiative is involved in the following segments of the RD&I value chain:

R&I value chain	Actions
DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF R&I TOPICS	• To collaborate on pre-competitive research projects and related topics and to investigate the need for further research in promising areas, providing a forum for different countries to co-operate in joint research and information exchange activities. This is done by means of general studies, assessments, demonstrations, comparative evaluations of various options of application, market studies, technology evaluations, highlighting industrial opportunities, and so forth. • To collaborate on pre-competitive research projects and related topics and to investigate the need for further research in promising areas.
FINANCING / IMPLEMENTATION OF R&I STRATEGY	• The TCP does not have plans to finance specific R&D demonstration projects or technology developments in the field of electric and hybrid vehicles; however, it aims at: • Facilitating international collaboration in pre-competitive research and demonstration projects; • Functioning as a promoter for Research, Development, Demonstration, and Deployment (RDD&D) involving shared resources from multiple countries
ANALYSIS OF THE IMPLEMENTATION	• The analysis of implementation is carried out on several axis: • Countries developments: continuous monitoring of developments in the different fields of interest to the TCP in participating countries (countries report) • Key developments and achievements along the different research paths identified: technical reports developed by the different tasks active in the TCP and presented in meetings, workshops, publications etc. • Success stories: lessons learned during the collaborative research are, when relevant organized and disseminated in the form of success stories t be used as benchmark and motivating examples.
	• The TCP acts directly in the field of pre-standardisation to facilitate the development of technology standards that can accelerate the deployment of H&EV:

PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES	• Task 19 "Life Cycle Assessment of EVs" to explore the sustainable manufacture and recycling of EVs and contribute to the implementation of rational, transparent and traceable LCA comparative studies. • Task 21 "Accelerated Ageing Testing for Li-ion Batteries" for collaboration on such testing efforts • Task 23 "Light EV parking and charging infrastructures" wrt ISO 4210-10, defining the Pedelec internationally within a harmonized standardization body. • Task 39 "Interoperability of E-mobility Services" share information and best practices to improve the interoperability and accessibility of charging services, setting-up recommendations for governments and industry how to improve the interoperability of charging services. The main focus is on "standard" charging services, but "smart" charging is also taken into account
REGULATORY INNOVATIONS	• Specific attention (Task 1) is given to Regulation, standards, and policies: best practices are evidenced in country reports and proposed for further implementations. • Specific regulatory issues have been addressed on Light-Electric-Vehicle Parking and Charging Infrastructure (Task 239, Home grids and V2x technologies (Task 28), Small Electric vehicles (Task 32).
DISSEMINATION AND KNOWLEDGE SHARING ACTIVITIES	• Being the IEA TCP aim to provide a platform for reliable information on hybrid and electric vehicles, the organization is very active in its dissemination activities. In particular, in the period 2015-2017 the following material was produced: • HEV-TCP Annual Report disseminated at major EV-related conferences • Tasks' final reports are regularly published on the initiative website • Scientific and dissemination papers are regularly presented at major conferences (e.g. International Electric Vehicle Symposium, European Electric Vehicle Conference etc.) • Round tables, panel discussions etc. are regularly animated by the TCP • "The Road Ahead IA-HEV Newsletter" is regularly published to present EV technology, market developments, and information from IA-HEV.

COMPOSITION/GOVERNANCE

Contracting Parties are either governments of IEA countries or parties designated by their respective governments.

STRUCTURE

Several tasks heave been completed during the previous phases of Programme. Focusing on the ongoing tasks, they include:

- **Task 1: Information Exchange:** Collects, analyzes, and disseminates information. Information exchange among member countries. Collect, analyze, and disseminate information relating to hybrid & electric vehicles from both member and nonmember countries.
- **Task 23,: Light-Electric-Vehicle Parking and Charging Infrastructure:** Address issues of parking and charging infrastructure of hybrid pedal/electric bikes (pedelecs) including charging standards.
- **Task 26: Wireless Power Transfer for EVs:** Develop a greater global understanding of WPT systems and interoperability through country-based standards study.
- **Task 30: Assessment of environmental effects of electric vehicles:** Collects and analyzes environmental benefits of EVs in comparison to conventional vehicles.
- **Task 31: Fuels and energy carriers for transport:** Provides a comprehensive overview of different fuel and drivetrain options.
- **Task 32: Small Electric Vehicles:** Technological progress and better market perspectives for SEVs. Promote development & commercialization of small electric vehicles by collecting and sharing pre-competitive information and exchanging best practices and ideas.
- **Task 33: Battery Electric Buses:** Analyses of the current state of technology & demonstration experiences of battery electric buses.
- **Task 34: Batteries:** Encourages the sharing and dissemination of current information about battery topics of interest to the vehicle community with a focus on safety. Focus on issues from basic electrochemical issues to in-vehicle issues such as safety, to end-of-life concerns such as 2nd use and disposal
- **Task 36: EV consumer adoption and use.** Develop a set of policyrelevant messages for policymakers & stakeholders
- **Task 37: Extreme Fast Charging:** This task focuses on charging at power levels up to and even exceeding 400 kW, often referred to as extreme fast charging (XFC) - technology, gaps, installations, and operations.
- **Task 39, Interoperability of e-Mobility Services:** This task focusses on the charging infrastructure and the interoperability aspects of e-mobility services.
- **Task 40: CRM4EV - Critical Raw Material for Electric Vehicles:** This Task will study key issues like supply and life cycle impacts of selected raw materials needed for a transition to electric vehicles.

SUPPORTING TEAM/PROJECTS

The work of HEV TCP is governed by the Executive Committee ("ExCo"), which consists of one member designated by each Contracting Party. Each topic is addressed in a Task, which is managed by an Operating Agent (OA).

KEY DELIVERABLES AND OUTPUTS

The Annual reports can be downloaded at http://www.ieahev.org/news/annual-reports/.
Other outstanding documents:

- "Annual report 2017: The electric drive automates"
- "Annual report 2016: The electric drive chauffeurs"
- "Annual report 2015: The electric drive commutes"
- "Annual report 2014: The electric drive delivers"
- "Electrification of transport logistic vehicles" – 2015
- Task 20 Final Report "Quick charging technology" - 2015
- Task 27 Final Report "Electrification of Transport Logistic Vehicles)"
- Task 28 Round table and special session on V2G technologies at the European Electric Vehicle Conference (March 2017).

Website: http://www.ieahev.org/

8.8 TCP DSM - DEMAND SIDE MANAGEMENT ENERGY EFFICIENCY

ABOUT

Created in 1993, the objectives of the IEA Technology Collaboration Programme on Demand Side Management (DSM TCP) are to: Conduct information exchange on technologies and programmes for demand-side management (DSM); support development and demonstration of DSM technologies; investigate techniques to implement demand-side technologies in the marketplace; and develop improved methods for incorporating demand-side options into resource planning.
The Mission of the TCP is to deliver materials that are readily applicable for stakeholders in crafting and implementing DSM policies and measures. The DSM TCP also delivers technology and applications that either facilitate operations of energy systems or facilitate the necessary market transformations. The evolution of the mission points toward becoming hub for socio-economic excellence in the Energy Technology Network, bringing multi-disciplinary expertise to policy relevant issues and providing the nexus between consumers and energy technologies.

DSM initiative is involved in the following segments of the RD&I value chain:

R&I value chain	Actions
DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF R&I TOPICS	• The main scope of DSM TCP is not linked with the setting of R&D&I programmes, but to conduct information exchange on technologies and programmes for demand-side management, investigating techniques to implement demand-side technologies in the marketplace and developing improved methods for incorporating demand-side options.
FINANCING / IMPLEMENTATION OF R&I STRATEGY	• The TCP does not have plans to finance specific R&D demonstration projects or technology developments in the field of DSM; however it aims at: • facilitating international collaboration in pre-competitive research and demonstration projects; • functioning as a promoter for Research, Development, Demonstration, and Deployment (RDD&D) involving shared resources from multiple countries; • The TCP addresses and self-finances (using a cost-shared model) the following activities types: • Mapping & Benchmarking of best practices; • Analysis of the role of customers in the implementation of effective smart grids services; • Setting up tools and methods to helping the behaviour changers; • Identification of the drivers for the transition of business models towards schemes enabling more effective market uptake of DSM energy services;
	The TCP addresses not only technologies but also the "soft" issues of energy transition. Tools developed by the TCP enables the greater deployment of demand side measures by governments and private sector actors. The research carried out in DSM is founded on the identification of best practices as the starting point for the development of innovative methods and tools. Moreover, the tools developed are often implemented

ANALYSIS OF THE IMPLEMENTATION	experimentally in specific real situations in the participating countries in view of validation and practical use. Examples of implementation are: • Integration of Demand Side Management, Energy Efficiency, Distributed Generation and Renewable Energy Sources (Task 17 Phase 3): analysis performed in terms of the local context of the participating country and the benefits of aggregation in real-world living lab environments with different types of individual demand; response technologies; • Behaviour Change in DSM: Helping the Behaviour Changers (Task 24 Phase 2): several award-winning pilots, including the Irish residential energy saving kit programme and the Atrium Health (largest health network in North America) "Energy Connect" programme. The Behaviour Changer Framework also won an award for most promising and innovative project at the 2017 ECEEE summer study. Deep Energy Retrofit: Life Cycle Cost Benefits Analyses and Multiple Benefits on Project Level: Simplified M&V (sM&V) + Quality Assurance Instruments (QAI) For Energy, Water and CO2 Savings: rea world experience from about 10 Integrated Energy Contracting projects in Austria; DENA (German Energy Agency) has decided to promote the concept and has published a guidebook for German market
PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES	• Standardisation is not the specific focus of the TCP.
REGULATORY INNOVATIONS	• Policy relevance is central in the work of the TCP Tasks have undertaken studies comparing similar behavioural interventions in member countries, work on energy saving in hospitals, and seen the concept of simplified Monitoring and Verification (M&V) taken up by the German Energy Agency. Task 25 Phase II on business models has a specific component devoted to drawing out the policy implications of the work. Policy briefs are published according to research results outcomes.
DISSEMINATION AND KNOWLEDGE SHARING ACTIVITIES	The DSM TCP is a leader in the IEA Energy Technology Network in the field of communications, using a variety of channels to disseminate the key results from the research programme, including a popular series of webinars hosted by the DSM University. The main dissemination and knowledge sharing activities developed and managed by DSM are: • publications, dealing with specific DSM advanced topics and reporting about the evolution of the DSM actions in several participating country in 2017 only, 21 Publications were made with special references to Task 24 and Task 25 • DSM University: 5 Webinars in 2017

	• Workshops and conferences - DSM Days: These workshops feature the dissemination of results from the DSM TCP work programme and presentations from policy makers and researchers; • Quarterly Spotlight newsletter, featuring articles from member country delegates, Task operating agents and guest writers.

COMPOSITION/GOVERNANCE

Contracting Parties are either governments of IEA countries or parties designated by their respective governments. Participants in the TCP represent 15 countries and 4 sponsors.

STRUCTURE

The main activity of the TCP is carried out through Tasks, organised into two clusters:

- Load shaping: This includes projects (Tasks) that seek to impact the shape of the load curve over very short (minutes-hours-days) to longer (days-weeks-seasons) time periods. Work within this cluster seeks to change the timing of energy consumption, increasing capacity for renewables and improving system efficiency and reliability.
- Load levelling: This includes Tasks that seek to shift the load curve to lower demand levels or shift loads from one energy system to another. Work within this cluster seeks to reduce the total demand for energy and to avoid the release of associated emissions.

On-going projects:

- **TASK 23: The Role of Customers in Delivering Effective Smart Grids**: This is the first project with an explicit end user perspective in this TCP. Recognizing the mismatch in focus between technology and end-user behaviour, Task 23 analysed the role of customers in delivering effective smart grids.
- **TASK 24: Behaviour Change in DSM: Phase I** of this activity focused on human energy-using behaviour, looking at the individual, societal and whole-system perspective of energy use. Review and evaluation of theories on energy behaviour is an important contribution of this Task. Building on this Task, the TCP intends to explore the practical sides of behavioural interventions.
- **Task 24 Phase II: Behaviour Change in DSM – Helping the Behaviour Changers**: to use a **Collective Impact Approach** methodology and **storytelling** as the overarching language and bring together Behaviour Changers from all sectors (industry, government, research, middle actors and the third sector) with the end users whose behaviour they are ultimately trying to change.
- **TASK 25: Business Models for a more effective market uptake of DSM energy** services: The DSM TCP investigated whether the design of business models could be a barrier for the market uptake of energy efficiency technologies. The distinction between a traditional technology push Business Model and a more service-oriented and end-user focused school of business models is at the core of this Task. The business models link up to several relevant DSM technologies.

SUPPORTING TEAM/PROJECTS

The TCP Tasks are all resourced using a mixed approach, i.e. with some cost-sharing and some task-sharing. Operating Agent costs are funded out of a pool of contributions from participating countries, while Tasks also require participating countries to provide national experts who give time to the completion of particular elements of the Tasks.

KEY DELIVERABLES AND OUTPUTS

All publications are available at http://www.ieadsm.org/publications/key-publications/. The key ones are the following:

- Task 24: Subtask 6 & 7 Case Study Analysis – ICT Use in higher Education – Netherlands (April 2017)
- Task 24: Subtask 6 & 7 – Background for Green Leases in Commercial Office Buildings in Sweden (May 2017)

- Task 16: Building deep energy retrofit: Using dynamic cash flow analysis and multiple benefits to convince investors (July 2017)
- Task 24: Co-creating behaviour change insights with Behaviour Changers from around the world (August 2017)
- Task 24: “Once upon a time…” Eliciting energy and behaviour change stories using a fairy tale story spine” (August 2017)
- Task 24: Advances in green leases and green leasing: Evidence from Sweden, Australia, and the UK (August 2017)
- Task 24: Narratives and Storytelling in Energy and Climate Change Research (September 2017)
- Task 25: Mind your business: entrepreneurs, their dynamic capabilities, context and new business models for energy efficiency services (October 2017)
- Task 24: Policy Brief (November 2017)
- Task 25: Effective business model design and entrepreneurial skills for energy efficiency services (November 2017)
- Task 25: Swedish context analysis and Business Models case studies for a more Effective uptake of DSM energy services for SMEs and communities (November 2017)
- Task 25: Swiss context analysis and Business Models case studies for a more Effective uptake of DSM energy services for SMEs and communities (November 2017)
- Task 25: Dutch context analysis and Business Models case studies for a more Effective uptake of DSM energy services for SMEs and communities (November 2017)
- DSM University: The TCP works with one of its sponsors (the European Copper Institute) and Leonardo Energy to deliver monthly webinars on a variety of DSM topics, including material from the TCP’s research programme and guest speakers from relevant organisations. 27 webinars have been delivered in the period 201
- DSM Days: These workshops draw participation from national experts in the host country and feature the dissemination of results from the DSM TCP work programme and presentations from policy makers and researchers in the host country.
- The TCP hosts a website, containing information about the TCP, ongoing and historic Tasks and news on the topic of DSM,
- The TCP publishes the quarterly Spotlight newsletter, featuring articles from member country delegates, Task operating agents and guest writers.

Website: http://www.ieadsm.org/

8.9 TCP EBC - ENERGY BUILDINGS AND COMMUNITIES

EBC
Energy in Buildings and Communities Programme

ABOUT

The IEA (International Energy Agency) Energy in Buildings and Community (EBC) Programme carries out research and development activities toward near-zero energy and carbon emissions in the built environment. These joint research projects are directed at energy saving technologies and activities that support technology application in practice. Results are also used in the formulation of international and national energy conservation policies and standards.

The initiative is involved in the following segments of the RD&I value chain:

R&I value chain	Actions
DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF R&I TOPICS	To accelerate the transformation of the built environment towards more energy efficient and sustainable buildings and communities, High Priority Research Themes: • Integrated planning and building design • Building energy systems • Building envelope • Community scale methods • Real building energy use
FINANCING / IMPLEMENTATION OF R&I STRATEGY	The TCP does not have plans to finance specific R&D demonstration projects or technology developments in the field of energy efficiency in buildings
ANALYSIS OF THE IMPLEMENTATION	Case studies and guidelines (by theme and nation) are regularly published. Examples are reported: • Register of energy and building stock data among participating countries and more widely; • Register of energy and buildings stock models; • Data schema for energy and building stock data for developing countries; • Series of reports on best practice and information reports on international data, models and method • Global thermal comfort database with a user interface including information on human thermal reactions together with their behaviours and the resulting energy use, • Report and databases containing information about pollutants in buildings and their transport properties

PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES	Many current and former research works from EBC are often directly used in the formulation of standards and codes
	• 22 Factsheet useful for standardization have been published in 2018 only:
	• Building Energy Performance Assessment Based on in-situ measurements:
	  ○ guidelines to apply the methods in quality assessment procedures
	• Assessing life Cycle Related Environmental impacts Caused by Buildings:
	  ○ Harmonised guidelines on the environmental life cycle assessment of buildings;

	○ National LCA databases used in the construction sector, including standardised characterisation of all relevant LCA databases; ○ Building case studies using a standardised template. • Towards Net Zero Energy Public Communities: ○ Guide for near zero energy planning in building communities; • Cost-effective Building Renovation at district level Combining Energy Efficiency & Renewables: ○ A methodology report on cost-effective building renovation at district level; ○ Guidebooks containing guidelines for policy makers and energy-related companies on how to encourage the market uptake of cost-effective strategies combining energy efficiency measures and renewable energy measures and guidelines for building owners and investors about cost-effective renovation strategies, including district-based solutions; • HVAC Energy Calculation methodologies for Non-residential Buildings: report including the results of the analysis on national energy calculation methodologies for HVAC systems for non-residential building.
REGULATORY INNOVATIONS	• EBC projects and activities have produced long-lasting decision-making tools; extensive examples can be found on the TCP website.
DISSEMINATION AND KNOWLEDGE SHARING ACTIVITIES	Nearly 450 publications are present in the EBC portfolio, including: • 39 factsheets and 12 datasheets • 22 case studies • 51 newsletters: EBC News • 13 annual reports • 38 project summary reports

COMPOSITION/GOVERNANCE

EBC has currently 26 member countries.

STRUCTURE

Working Groups are a less formal form of international collaboration. They may serve to collect knowledge on specific aspects between several countries, for preparing a new Annex project or to follow-up on a completed project.
Ongoing working groups are:

- **Working Group on Heating Ventilation and Air Conditioning (HVAC) Energy Calculation Methodologies for Non-residential Buildings**: in order to collect technical documents published world-wide on the calculation methodologies of energy use for HVAC systems in non-residential buildings and on their scientific basis including research works on their validation, analyze the collected documents and pick up characteristics of methodologies, which are appropriate for broader utilization as good practice examples, and identify areas in HVAC energy calculation methodologies lacking a scientific basis to suggest future R&D themes.
- **Working Group on Cities and Communities**: intends to integrate solutions provided at a strategic level with decisions at the urban scale. WGCC is an EBC-hosted (single-leadership) delegating

structure that is intended to share (provide and gain) information between multiple IEA TCPs and cities with a bi-directional approach.

Some ongoing projects include:

- No. 80 - Resilient Cooling
- No. 79 - Occupant-Centric Building Design and Operation
- No. 78 - Supplementing Ventilation with Gas-phase Air Cleaning, Implementation and Energy Implications
- No. 77 - EBC Annex 77 / SHC Task 61 Integrated Solutions for Daylight and Electric Lighting
- No. 76 - EBC Annex 76 / SHC Task 59 Deep Renovation of Historic Buildings Towards Lowest Possible Energy Demand and CO2 Emissions
- No. 74 - Competition and Living Lab Platform
- No. 73 - Towards Net Zero Energy Public Resilient Communities
- No. 72 - Assessing Life Cycle Related Environmental Impacts Caused by Buildings
- No. 71 - Building Energy Performance Assessment Based on In-situ Measurements
- No. 70 - Building Energy Epidemiology: Analysis of Real Building Energy Use at Scale
- No. 69 - Strategy and Practice of Adaptive Thermal Comfort in Low Energy Buildings
- No. 68 - Design and Operational Strategies for High IAQ in Low Energy Buildings
- No. 67 - Energy Flexible Buildings
- No. 64 - LowEx Communities - Optimised Performance of Energy Supply Systems with Exergy Principles
- No. 63 - Implementation of Energy Strategies in Communities
- No. 05 - Air Infiltration and Ventilation Centre

SUPPORTING TEAM/PROJECTS

There are eight IEA Buildings-related Technology Collaboration Programmes, coordinated through the IEA Buildings Coordination Group, and include: EBC, 4E, ECES, HPC, SHC, DHC included CHP, DSM, PVPS.
Furthermore, the IEA Future Buildings Forum (FBF) has been established to identify long-term energy, environmental, economic, and technological issues, assess their potential effect on future buildings and encourage research projects on these issues that will help to ensure that buildings contribute to a sustainable society by the year 2035 and beyond. Originally a resource only for the TCP on EBC, the role and activities of FBF have expanded to take account of the areas of interest of all buildings-related IEA TCPs.

KEY DELIVERABLES AND OUTPUTS

- EBC Strategic Plan 2014-2019: describes the concrete and focused R&D strategies for the five year period between March 2014 and February 2019. This is to support the realization of the energy savings potential of the buildings sector and to provide the scientific foundation for the transformation of the international energy economy.
- Project Summary Reports: draw technical synthesis from each Annex and make policy recommendations.
- Annual Report 2017: The Annual Report provides an overview of progress made by the EBC Programme, including summaries of new, ongoing and recently completed projects. It is consisting of three parts: the Chair's Statement, Project progress reports and practical background information. It also includes a summary of the latest outcomes of the Programme intended for policy and decision makers.

Website: http://www.iea-ebc.org/

8.10 TCP ISGAN - INTERNATIONAL SMART GRIDS ACTION NETWORK

ISGAN
INTERNATIONAL SMART GRID ACTION NETWORK

ABOUT

International Smart Grids Action Network (ISGAN) is an initiative operating as both an IEA TCP for a Co-operative Programme on Smart Grids and a Clean Energy Ministerial (CEM) initiative. ISGAN creates a strategic platform to support high-level government attention and action for the accelerated development and deployment of smarter, cleaner electricity grids around the world.

ISGAN is involved in the following segments of the RD&I value chain:

R&I value chain	Actions
DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF R&I TOPICS	• ISGAN has carried out, by means of ANNEX 1 (now completed) a thorough survey to identify participating countries' specific motivating drivers for pursuing smart grids, catalogue the wide range of smart grid activities underway, and collect and organize the wealth of experience being generated into a resource available first to ISGAN Participants and then a global audience.
FINANCING / IMPLEMENTATION OF R&I STRATEGY	• It finances specific projects of interest for the development of the TCP (e.g. the initiation of new activities such as the ISGAN academy), specific publications and the activities carried out for the normal functioning of the TCP (i.e. portion of the work of Operating Agent and secretariat not directly financed by hosting countries)
ANALYSIS OF THE IMPLEMENTATION	• ISGAN, by means of its ANNEX 2 carries out the assessment of current case studies on smart grid deployments. This includes creation of a common methodological framework for future case studies based on this assessment, and development of in-depth case studies using this framework. Capturing and communicating the lessons learned from real-life demonstration or deployment projects will help stakeholders understand the true promise and challenges of deploying smarter electricity grids. The following case books have been developed and published by ISGAN: Advanced metering infrastructures (AMI) Case Book, Consumer Engagement and empowerment (CE&E) Case Book, Demand Side Management (DSM) Case Book, Energy Storage Systems (ESS) Case Book
PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES	• ISGAN Smart Grid International Research Facility Network (SIRFN): gives participating countries the ability to evaluate pre-competitive technologies and systems approaches in a wide range of smart grid implementation use cases and geographies using common testing procedures. Research test-bed facilities are selected based on their complementary capabilities to conduct specialized, controlled laboratory evaluations of integrated smart grid technologies including cyber security, plug-in hybrid integration, load management, automated metering

	infrastructure, protection, network sensing, energy management, renewable energy integration and similar applications.
REGULATORY INNOVATIONS	• ISGAN ANNEX 3: Cost-Benefits and socio-economic analyses of smart grids and related regulatory policies: analyzes the benefits and costs of smart grid technologies, practices, and systems, from both top-down and bottom-up perspectives. Results are used to develop specific business cases, taking into account specific regulatory and market structures, as well as current system status, available generation assets and resources and demand profiles. Regulators, utilities and other electricity system stakeholders use these toolkits to define and decide on system needs and priorities for smart grid system investment and regulatory changes.
DISSEMINATION AND KNOWLEDGE SHARING ACTIVITIES	• ISGAN Annex 4: Synthesis of Insights for Decision Organize knowledge, identify key issues, distill important themes, and provide insightful analysis for the benefit of policymakers. It highlights existing lessons learned and best practices on smart grid and seeks to integrate and package knowledge in a form that can be used by the target audience. This Annex consolidates and disseminates the efforts of other ISGAN Annexes, and smart grid efforts beyond ISGAN when appropriate, towards greater reach and impact.; • ISGAN provides an important channel for communication of experience, trends, lessons learned, and visions in support of clean energy objectives as well as new flexible and resilient solutions for Smart Grids; • ISGAN is a partner to India Smart Grid Week, European Utility Week, and other National and international for a. ISGAN organizes Knowledge Transfer workshops.

COMPOSITION/GOVERNANCE

Experts from 25 Member Countries plus the European Commission are involved.

STRUCTURE

ISGAN's Annexes include:

- **Annex 1: Global Smart Grid Inventory (completed)**: the objective of this activity is to identify countries' specific motivating drivers for pursuing smart grids, catalogue the wide range of smart grid activities underway, and collect and organize the wealth of experience being generated into a resource available first to ISGAN Participants and then a global audience.
- **Annex 2: Smart Grids Case studies**: it has two priority workstreams, the first of which is an assessment of current **case studies** on smart grid deployments. A second key work stream is enabling in-depth peer-to-peer knowledge sharing.
- **Annex 3: Cost-benefit and socio-economic analyses of smart grids and related regulatory policies**: will analyze the benefits and costs of smart grid technologies, practices, and systems, from both top-down and bottom-up perspectives. From these analyses, toolkits will be developed to

inform smart grid policy at global, regional, national, and/or sub-national levels and deployment priorities at project- and utility-scales.

- **Annex 4: Synthesis for Decision Makers:** integrates the knowledge and lessons learned through the other ISGAN Annexes. This material may be delivered through a variety of media, such as reports, web sites, or videos, as appropriate for the specific information and targeted audience.
- **Annex 5: Smart Grid International Research Facility Network (SIRFN):** will give participating countries the ability to evaluate pre-competitive technologies and systems approaches in a wide range of smart grid implementation use cases and geographies using common testing procedures.
- **Annex 6: Power T&D Systems**: aims to establish a long term vision for the development of the future sustainable power systems. Annex 6 focuses on system-related challenges, with emphasis on the technologies, market solutions, and policies which contribute to the development of system solutions.
- **Annex 7: Smart Grid Transitions:** aims to investigate institutional change associated with Smart Grid deployment. This Annex, in particular, shall aim at supporting policymakers in the field of Smart Grids by focusing on the direction, efficacy and efficiency of the energy system transition.
- **Annex 8. ISGAN Academy on Smart Grids:** to offer the ISGAN community of high level engineers and decision makers a means of rational and efficient continuous technical skills complement and update in the field of smart grids

SUPPORTING TEAM/PROJECTS

ISGAN is governed by an Executive Committee comprising representatives of each of the member countries. In close collaboration with the Secretariat, a chair and three vice chairs also serve on the committee as the Presidium. ISGAN is supported by n Operating Agent (AT) and a Co-Secretariat (AT, IN). Several working groups are active for the seamless operation of the TCP: Budget Review Group, Annex Coordination Group, CEM Preparatory Team, ISGAN Awards Team, ISGAN Academy Committee, Strategic Communications and Private Sector Engagement Team

KEY DELIVERABLES AND OUTPUTS

- ISGAN Side Event at CEM9 – Policy Brief and Workshop Summary: Opportunities to Accelerate Smart Grid Deployment through Innovative Market Design - jointly organized with the Swedish Smart Grid Forum (23rd and 24th May - as part of the Nordic Clean Energy Week in Malmö and Copenhagen)
- ISGAN Annual Report 2017: Implementing Agreement for a Co-Operative Programme on Smart Grids. Annual Report 2017 for the period from March 1st 2017 to February 28th, 2018
- System Efficiency: In the era of deployment of a smarter and more sustainable energy system, an overall perspective of system efficiency becomes increasingly important. System efficiency is a multifaceted concept and this Report develops it in the dimensions of carbon dioxide (CO_2) emissions, energy and economic efficiency.
- Factsheet on ISGAN's Knowledge Transfer Project: briefly describes ISGAN's approach to the knowledge transfer project, a platform for meaningful dialogue and capacity building to facilitate smart grid deployment.
- Spotlight on customer engagement and empowerment: Case Book including 10 cases on Consumer Engagement & Empowerment of the top 10 winning projects from the 1st ISGAN Awards Competition. Countries that are included in the CaseBook are Belgium, Denmark, France, Japan, Portugal, Netherlands, and USA.

Website: http://www.iea-isgan.org/.

8.11 TCP DHC|CHP DISTRICT HEATING AND COOLING INCLUDING COMBINED HEAT AND POWER

IEA DHC|CHP

ABOUT

The Technology Collaboration Programme on District Heating and Cooling including Combined Heat and Power was founded as the Implementing Agreement for a Programme of Research, Development, and Demonstration on District Heating and Cooling, including the integration of Combined Heat and Power in 1983. Ten countries participated in the first round of projects (Annex I). More information about previous annexes can be found in the DHC research section on this site.

The Technology Collaboration Programme on District Heating and Cooling including Combined Heat and Power, deals with the design, performance and operation of distribution systems and consumer installations. The Agreement is dedicated to helping to make district heating and cooling and combined heat and power powerful tools for energy conservation and the reduction of environmental impacts of supplying heat. This is also reflected in the IEA DHC communication strategy.

DHC|CHP initiative is involved in the following segments of the RD&I value chain:

R&I value chain	Actions
DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF R&I TOPICS	• The mission of the IEA DHC|CHP is to conduct highly effective Research and Development as well as policy analysis of District Heating and Cooling Systems with low Environmental Impact through international collaboration.
FINANCING / IMPLEMENTATION OF R&I STRATEGY	• DHC|CHP is furthering this mission by selecting, managing and publishing collaborative co-funded projects collating and exchanging information on R&D projects between countries.
ANALYSIS OF THE IMPLEMENTATION	
PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES	
REGULATORY INNOVATIONS	• The DHC/CHP TCP has contended that District Heating and Cooling networks are not yet fully recognized. For this reason, the TCP turned its attention to the policy debate. As well as providing a policy paper, there has been participation with IEA Secretariat initiatives, most recently the CHP/DHC Collaborative. Through its Annex IX project 'Opportunities and Barriers...' this IA continues to provide direct information for decision-makers. This project will provide analysis for non-EU countries. Together with links with the Technology Platform project that focuses on EU countries, a comprehensive global assessment will be achieved.
DISSEMINATION AND	• In general, the DHC/CHP TCP seeks to determine the needs of its intended target audiences, identify the best ways to meet these through programmes of appropriate projects, and then manage and disseminate these as effectively as possible. This

KNOWLEDGE SHARING ACTIVITIES	involves liaising closely with the industry, participating in appropriate IEA Secretariat initiatives and maintaining effective communication channels with other relevant IAs. • Latest research presentations on the IEA DHC Youtube channel or event video of the 16th International Symposium on DHC are available.

COMPOSITION

Currently there are Contracting Parties from eleven countries: Austria, Canada, China, Denmark, Germany, Finland, France, Korea, Norway, Sweden, the United Kingdom and the United States of America.

WORKING GROUPS

The work programme is mostly conducted through cost-shared activities. Activities in the IEA DHC/CHP are organized into a series of Annexes. These Annexes contain several research projects. In the cost-shared Annexes these research projects are funded by the countries participating in the Annex. The task-shared Annexes allow to connect existing national projects via an international platform. Thus national projects can benefit from international experience and exchange. In 2017 Annex XI was completed and the final reports of the projects carried out can be downloaded.

- **Annex XII**: Bringing Countries Together To Research, Innovate And Grow District Heating And Cooling – Including CHP. Currently comprises the following projects:
  - Effects Of Loads On Asset Management Of The 4th Generation DH Networks: to deliver knowledge and methodologies for reliable and cost effective asset management of future 4GDH networks. The consequences of future load characteristics as well as fatigue theories and thermal ageing in combination with cyclic mechanical loads will be identified and investigated.
  - Methodology To Evaluate And Map The Potential Of Waste Heat From Industry: Service Sector And Sewage Water By Using Internationally Available Open Data: aims to analyze the potential of low-temperature waste heat. The project focuses on waste heat from small and medium industries and the service sector as well as from sewage water systems.
  - Integrated Cost-Effective Large-Scale Thermal Energy For Smart District Heating And Cooling: to disseminate up-to-date data, information and first-hand-experience on seasonal TES and on the other hand to find reliable and adequate analysis tools which assess the techno-economic potential of large scale ATES or PTES integration in DHC systems.
  - Stepwise Transition Strategy And Impact Assessment For Future District Heating Systems: develop a stepwise transition strategy including practical and highly replicable actions. The three aspects of building level actions, integration of new heat sources and energy system level benefits are investigated.
- **Annex TS2**: Implementation of Low Temperature District Heating Systems: facilitating the implementation of 4th generation District Heating (4GDH);
- **Annex TS3**: Hybrid Energy Networks: promoting the opportunities for district heating and cooling (DHC) networks by means of an integrated approach, creating a hybrid energy infrastructure between electric grids, gas grids and other energy vectors through various coupling points (CHP, power-to-heat/gas/…).

SUPPORTING TEAM/PROJECTS

Annexes are led by Operating Agents.

KEY DELIVERABLES AND OUTPUTS

The key publications available are the following:

Policy Paper : see the important role district heating can play in assisting countries to meet their Kyoto targets

Strategy document: IEA Implementing Agreement on District Heating and Cooling including the integration of CHP

Position paper: The Role of District Heating & Cooling and Combined Heat and Power Systems in Reducing Fossil Fuels Use and Combating Harmful Emissions

Website: https://www.iea-dhc.org/index.php?id=287

8.12 CEM 21CPP - 21ST CENTURY POWER PARTNERSHIP

ABOUT

The 21st Century Power Partnership (21CPP) is a multilateral effort of the Clean Energy Ministerial (CEM) and serves as a platform for public-private collaboration to advance integrated policy, regulatory, financial, and technical solutions for the large-scale deployment of renewable energy in combination with deep energy efficiency and smart grid solutions. It is a unique platform to support the development of integrated policy approaches required to support new generation, T&D construction and refurbishment, grid intelligence and end-use efficiency. By fostering multilateral engagements, 21CPP ensures global insight into the common and divergent features of power system transformation. By doing so, the initiative improves the efficacy of clean energy reform agendas and ensures that participating governments have access to international expert resources.

The initiative is involved in the following segments of the RD&I value chain:

R&I value chain	Actions
DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF R&I TOPICS	• The activities of the 21CPP is mostly focused on policy rather than on R&D. it considers the best policy practices developed by leading countries and offers practical advice to the other participating countries. Specific activities were carried out in collaboration with Brazils, China, Mexico, India and South Africa.
FINANCING / IMPLEMENTATION OF R&I STRATEGY	• The initiative addresses policies to enhance financial sourcing of renewable energy, smart grids, distributed energy resources.
ANALYSIS OF THE IMPLEMENTATION	• The focus of the activity is not linked to standardization but policy and regulation.
PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES	• Supporting country-level policy and regulatory implementation (already at work in India, Mexico, and South Africa): specific attention is given to support mechanisms for distributed and renewables integration and performance-based regulations
REGULATORY INNOVATIONS	• Reports, workshops, bilateral meetings, insight with governments
DISSEMINATION AND KNOWLEDGE SHARING ACTIVITIES	

COMPOSITION/GOVERNANCE

21CPP is an initiative participated by 9 Countries: India, Mexico, US, Brazil, China, Denmark, Finland, South Africa, Spain.

STRUCTURE

The work focuses on four key areas of activity to support national and regional initiatives in power sector transformation, developing and sharing knowledge, strengthening and disseminating tools, bolstering expert capacity, and supporting policy and regulatory implementation.

- **Supporting Country-Level Policy and Regulatory Implementation**: facilitates technical assistance and peer learning to support national and subnational activities by working with existing country and development assistance programmes.
- **Developing and Sharing Knowledge**: coordinates targeted knowledge exchange efforts across all initiatives participating in the Clean Energy Ministerial (CEM), with particular reference to ISGAN, Advanced Power System Flexibility Campaign.

- **Strengthening and Disseminating Tools**: identifies needs for new tools (or for enhancements to existing tools) for electricity sector analysis, planning, and management.

SUPPORTING TEAM/PROJECTS

Several organisations from leading countries support the project. In particular NREL (US), US Department of Energy, Children Investment Fund, William and Fiona Hewlett Foundation.

KEY DELIVERABLES AND OUTPUTS

The 21CPP publications provide information about and analysis of market design and regulatory issues for clean energy and 21st century power systems. Published work appears in scientific journals and the National Renewable Energy Laboratory publications database. The more recent ones are the following:

- Next-Generation Performance-Based Regulation: Emphasizing Utility Performance to Unleash Power Sector Innovation: May 2018 (Update). We have re-organized the original report into a new 3-volume series. Volume I, Volume II and Volume III.
- Status of Power System Transformation 2018: Advanced Power Plant Flexibility: The report is aimed at policy makers and regulators who are not experts in engineering, but who need to understand power plant flexibility in order to enhance system planning and upgrade policy, market and regulatory frameworks.
- Policies for enabling corporate sourcing of renewable energy internationally (2017)
- Greening the grid – pathways to integrate 175 GW of renewable energy in India (2017)
- 21st century power partnership fellowship report (2016)
- Evolving distributed generation support mechanisms (2017)

Website: https://www.21stcenturypower.org/

8.13 CEM EVI - ELECTRIC VEHICLES INITIATIVE

ABOUT

The Electric Vehicles Initiative (EVI), started in 2010 under the CEM, is a multi-government policy forum dedicated to accelerating the introduction and adoption of electric vehicles worldwide. Electrifying the global vehicle fleet is a key component of the CEM's goal of enhancing the use of clean energy. Vehicle electrification makes transportation more energy efficient, reduces greenhouse gas emissions and oil dependence, and improves local air quality. Electric vehicle charging could also act as distributed energy storage in support of integrating renewable energy into grid and off-grid energy systems.

The Electric Vehicles Initiative is also in the process of completing a major project aimed at facilitating policy adoption on electric mobility, working with the Global Environment Facility (GEF) and UN Environment, as well as other partners.

The initiative is involved in the following segments of the RD&I value chain:

R&I value chain	Actions
DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF R&I TOPICS	• EVI supports the design and implementation of EV deployment policies and programmes • EVI is actively working to link its activities with the opportunities arising from the work being developed with GEF (Global Environment Facility), UN Environment, and other partners, mainly focusing on developing and emerging economies • EVI supports governments in need of policy and technical assistance through training and capacity building • Outlining a vision for the future development of electric mobility, building consensus on major policy goals, as demonstrated by the EV30@30 Campaign, and benchmarking success against them
FINANCING / IMPLEMENTATION OF R&I STRATEGY	• EVI seek to implement its vision to further develop EVI itself through an expanded programme of work in 2018 and beyond, with continued annual financial support from participating countries, complementary funding from philanthropy organizations, and co-funding from the private sector. EVI members currently support, through annual contributions (currently close to EUR 300 thousand), research and analysis led by the EVI coordinator (the IEA) and supported by technical institutes in member countries. In addition to this, the William and Flora Hewlett Foundation are supporting the scale - up of the EVI coordinator's activities through a USD 400 thousand grant in the period 2018 - 2019.
ANALYSIS OF THE IMPLEMENTATION	• The Global EVI Outlook (latest edition 2018) offers a global view of the ongoing situation of the electric mobility worldwide. It addresses the sales of electric vehicles, the evolution of the electric stock (circulating), and the charging infrastructures. It also gives an outlook of the projected developments to 2030 taking into consideration the potential implementation of the EV30@30 campaign (30

	percent new electric vehicle sales by 2030) and the needs for materials, with special reference to the construction of batteries (e.g. cobalt and lithium)
PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES	• Commit to the deployment of a network of charging and fueling infrastructure consistent with the ambition of the campaign and partner with The Climate Group's EV100 initiative for its deployment in the private sector.
REGULATORY INNOVATIONS	• Establishing policies to help the EV30@30 goal become a reality and will direct their ministries to engage through EVI to report progress and share best practices. • The Global EVI Outlook (latest edition 2018) addresses the most important policy needs for a timely and sustainable transition to electric mobility, based on the real world experience of participating countries: In the early stages, public procurement schemes shall demonstrate the technology to the public providing the opportunity for public authorities to lead by example. Taxes that reflect the CO2 content are important, as well as fiscal incentives at vehicle purchase and complementary measures that enhance the value proposition of driving electric on a daily basis (e.g. preferential parking rates, road toll rebates and low emission zones).
DISSEMINATION AND KNOWLEDGE SHARING ACTIVITIES	• Campaigns are organized focusing on speeding up the deployment of electric vehicles. • Fostering information exchange workshops, meeting and events amongst participating countries, observers and partners, including private sector stakeholders • Fostering information exchange through roundtables and other major events, primarily in conjunction with CEM meetings. • Developing networking platforms (such as the Pilot City Programme) to facilitate exchanges and networking between relevant stakeholders also at the level of local administrations.

COMPOSITION/GOVERNANCE

EVI members include Canada, Chile, China, Finland, France, Germany, India, Japan, Mexico, the Netherlands, New Zealand, Norway, Portugal, Sweden, the United Kingdom and the United States. The International Energy Agency is the EVI Operating Agent.
The EVI has a broad range of partners, including regional institutions, international development agencies, multilateral development banks, global organisations, non-governmental organisations and networks.

STRUCTURE

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KEY DELIVERABLES AND OUTPUTS

- Released the 2018 and 2017 Global EV Outlook (GEVO).
- CEM 3030 Campaign Document aims to explain the importance of taking advantage of the opportunities supporting the market for electric 2-and 3-wheelers, electric passenger cars, light commercial vans, buses, and trucks (including battery-electric, plug-in hybrid, and fuel cell vehicles),

in accordance with each country's respective priorities and programmes. The EV30@30 Campaign sets a collective aspirational goal to reach 30% sales share for electric vehicles 1 by 2030.

- Technology Roadmap: Electric and Plug-in Hybrid Electric Vehicles (EV/PHEV) published in June 2011. The vision of this roadmap is to achieve widespread adoption and use of EVs and PHEVs worldwide by 2050 and, if possible, well before. The primary role of this EV/PHEV Roadmap is to help establish a vision for technology deployment; set approximate, feasible targets; and identify steps required to get there. It also outlines the role for different stakeholders and how they can work together to reach common objectives, and the role for government policy to support the process.
- EV100 is a global initiative bringing together forward looking companies committed to accelerating the transition to electric vehicles (EVs) and making electric transport the new normal by 2030.
- EVI partner US National Renewable Energy Laboratory (NREL) has published *Critical Elements of Vehicle-to-Grid Economics*, *Aligning PEV Charging Times with Electricity Supply Demand*, Vehicle Grid integration, Vehicle to Grid Cyber-security Brief and EV Fast Charging Infrastructure Brief (two of them are looking at the integration of electric vehicles to the electrical grid).

Website: http://www.cleanenergyministerial.org/initiative-clean-energy-ministerial/electric-vehicles-initiative

8.14 CEM RGEI - REGIONAL AND GLOBAL ENERGY INTERCONNECTION

CLEAN ENERGY MINISTERIAL
Advancing Clean Energy Together

ABOUT

This initiative facilitates the transition of energy systems to electricity-centered and interconnected modern energy systems, featuring high penetration of clean energy.
RGEI initiative is involved in the following segments of the RD&I value chain:

R&I value chain	Actions
DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF R&I TOPICS	• Building consensus on facilitating energy transition via increased proportion of renewable energy in energy consumption and enhanced grid interconnection. • Encouraging CEM member countries to engage in the process of RGEI and seize collaborative opportunities.
FINANCING / IMPLEMENTATION OF R&I STRATEGY	
ANALYSIS OF THE IMPLEMENTATION	
PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES	
REGULATORY INNOVATIONS	• Discussing conducive policy and regulatory framework regarding regional and global energy interconnection (RGEI).
DISSEMINATION AND KNOWLEDGE SHARING ACTIVITIES	

COMPOSITION/GOVERNANCE

Currently 6 countries are participating in RGEI initiative: Chile, China (leading Country), Finland, Korea, South Africa, United Arab Emirates.

STRUCTURE

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SUPPORTING TEAM/PROJECTS

This initiative proposes a co-operating agent model under this initiative: Global Energy Interconnection Development and Cooperation Organization (GEIDCO) is identified as one operating agent.

KEY DELIVERABLES AND OUTPUTS

Not yet available publicly

Website: http://www.cleanenergyministerial.org/initiative-clean-energy-ministerial/regional-and-global-energy-interconnection-rgei-initiative

8.15 CEM SCEET - SUSTAINABLE CITIES AND ECO-ENERGY TOWNS

Sustainable Cities and Eco-Towns

ABOUT

The challenge of transforming towns and cities into greener, sustainable, highly efficient areas requires global action focused on energy efficiency and energy system integration. The Sustainable Cities and Eco-energy town initiative of the Clean Energy Ministerial - launched at CEM8 in Beijing 2017) - aims to advance effective collaboration and accelerate implementation of policies on a national and local level. Through its work, the initiative facilitates sharing of best practices and learnings among cities and also addresses important energy issues in small and remote communities.
The initiative's goal is the overall improvement of energy efficiency and sustainability in cities and towns as well as rural areas for ensuring a secure and sustainable energy future, through effective benchmarking, knowledge transfer, creating and sharing of best practices, and implementing targeted campaigns.
The initiative targets closer working and reaping synergies from the national and local collaboration to improve standards of living in urban areas and a secure energy future in rural areas. Joint action and promotion of best practices can save 700 million tons of oil equivalent by 2025.

The initiative is involved in the following segments of the RD&I value chain:

R&I value chain	Actions
DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF R&I TOPICS	• The initiative's goal is overall improvement of energy efficiency and sustainability in cities and towns as well as rural areas for ensuring a secure and sustainable energy future, through effective benchmarking, knowledge transfer, creating and sharing of best practices, and implementing targeted campaigns. • The initiative fosters collaboration and knowledge transfer to strengthen the current links and activities in the participating countries and expedite the transition to cleaner and sustainable cities, towns, and rural areas.
FINANCING / IMPLEMENTATION OF R&I STRATEGY	
ANALYSIS OF THE IMPLEMENTATION	• Developed a benchmarking analysis of the best practices of implementation of higher standards in cities
PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES	• The initiative aims to develop benchmarking and an international database that will include best practices related to the issue of sustainable development of cities from all over the world
REGULATORY INNOVATIONS	• Identifying policy recommendations to scale up the Ecoenergy Town approach for improving energy access problem in rural areas
DISSEMINATION AND KNOWLEDGE SHARING ACTIVITIES	• The initiative aims to Engage with key stakeholders through workshops and international meetings: ○ International meeting of Mayors dedicated to energy efficiency and sustainable development of the cities • Eco-energy Town Workshop

COMPOSITION/GOVERNANCE

5 Countries are participating in the initiatives: China, Korea, Mexico, Russia, United Arab Emirates.

Korea Energy Economics Institute (KEEI) is serving as a temporary operating agent.

STRUCTURE
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SUPPORTING TEAM/PROJECTS
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KEY DELIVERABLES AND OUTPUTS
Analysis, recommendations and best practices:

- District energy use: successful cases of Ecoenergy Town approach, focusing on district energy using waste-to-energy technology. This initiative is conducted in collaboration with the United Nations Environment Programmes (UNEP), identifying policy recommendations to scale up the Ecoenergy Town approach for improving energy access problem in rural areas.
- Standards in cities: benchmarking analysis of the best practices of implementation of higher standards in cities.
- Best practices: Korea has shared Eco-energy Town model and experiences with Mongolia and Ethiopia by implementing Eco-energy project in these two countries since 2017

Engagement with the stakeholders:

- 1st Eco-energy Town Workshop (May 2017, Seoul Korea), where experts from CEM Member countries shared best practices of Eco-energy Town, identified challenges that national and local governments face in improving sustainable energy access for rural areas, and discussed the way to overcome challenges, focusing on promoting Eco-energy Town model.
- 2nd International Summit of Mayors (October 2017, Moscow, Russia) dedicated to issues of the energy efficiency and sustainable development of the cities.

Website: http://www.cleanenergyministerial.org/initiative-clean-energy-ministerial/sustainable-cities-and-eco-energy-towns

8.16 SET-PLAN IWG 4 - SMART ENERGY SYSTEMS

ABOUT

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.

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 adaption 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.

IWG4 is involved in the following segments of the RD&I value chain:

R&I value chain	Actions
DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF R&I TOPICS	• Observability and controllability: The final target of the RD&I activities is to upgrade and smarten the power system operation at all voltage levels. This target requires a stronger controllability of the power system at all geographical scales and at all time scales. • Load management and demand response: Demand response is potentially one of the most powerful tools for power system flexibility. Load control solutions, like peak shaving, load profile management, and 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. • 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, CHP (combined heat and power), renewables equipped with integrated storage, Power-to-Gas and Power-to-Liquid are considered. • 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.

	• Heating and cooling systems: integration from different sources of different temperature levels: aiming at addressing the technological aspects of DHC 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. • 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. • Multi-dimensional local systems for energy communities: 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. • Smart service co-creation frameworks to develop local and regional value chains: 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.
FINANCING / IMPLEMENTATION OF R&I STRATEGY	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 programme setting, together with countries outside Europe
ANALYSIS OF THE IMPLEMENTATION	

PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES	
REGULATORY INNOVATIONS	• 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. 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).Regulatory innovation zones (RIZ) can be framed as an orchestrated set/mix of complementary policy actions combining R&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).
DISSEMINATION AND KNOWLEDGE SHARING ACTIVITIES	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 • Organise exchanges with international organisations and initiatives such as the IEA, IRENA, Mission Innovation, WEF, to share results and best practices

COMPOSITION/GOVERNANCE

The governance of the IWG consists of two member state representatives acting as IW4 leads and experts from the participating countries actively contributing to all phases of the development of the work.

15 countries have expressed interest. 13 countries have effectively participated. 4 ETIPs were involved in the IWG activities.

STRUCTURE

- **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.
    - Develop and implement solutions to increase observability and controllability in the energy system;
    - 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;
    - Develop and implement solutions to increase flexibility of all types of generation;
    - Develop and implement solutions to enable Renewable Energy Sources to provide grid service;
    - Develop and implement solutions to improve the flexibility capabilities for new as well as retrofitted thermal power plants;
    - Reduce the cost of all energy storage solutions contributing to the minimisation of the overall system costs;
- **Flagship Initiative 2: Develop Integrated Local and Regional Energy Systems:** making it possible to efficiently provide, host and use 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 goals. They shall provide tailor-made solutions that meet the local and regional requirements and demand. Simultaneously, they shall link to a secure and resilient European energy system, enabling the participation in inter-regional exchange of energy and in sharing responsibility to maintain the overall system, considering a sustainable use of local and global resources.
    - Low temperatures for the efficient integration of different sources;
    - Increasing the flexibility of DH networks and enabling its efficient utilization;
    - RES integration at regional and local levels, including different energy vectors;
    - 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;
    - 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;
- Crosscutting Activities:
    - Systemic and socio-economic impact of digitalisation in the energy system;
    - Cybersecurity of critical energy infrastructure;
    - Market design for trading of heterogeneous flexibility products;
    - Regulatory innovation zones;
    - Process chain for interoperability of ICT systems;

SUPPORTING TEAM/PROJECTS

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KEY DELIVERABLES AND OUTPUTS

Implementation Plan :
https://setis.ec.europa.eu/system/files/set_plan_esystem_implementation_plan.pdf

Website: https://ec.europa.eu/energy/en/topics/technology-and-innovation/strategic-energy-technology-plan

8.17 SET-PLAN IWG 7 - BATTERIES

ABOUT

The IWG was assigned the task to prepare an Implementation Plan identifying the Research and Innovation (R&I) activities needed to achieve the battery targets agreed in the DoI for 2020 and 2030. More than 40 actors, representing the full battery value chain and consisting of representatives from industry, research and MS, have supported the work of the IWG.

The activities have been defined applying a challenge -based holistic approach. The IWG has also identified a number of issues related to market/market access and education/training/knowledge, which should complement R&I activities in a European initiative on batteries in order to meet the targets set in the DoI and to be globally competitive.

a) Performance targets: Successful deployment of batteries for automotive applications requires meeting performance criteria regarding energy/power density at both pack and celle level, and battery lifetime It is acknowledged that it may be difficult to achieve some targets concurrently, e.g. gravimetric versus volumetric energy density, gravimetric energy density versus fast charge time or energy versus power demand at cell level). Furthermore, some performance parameters are affected by use conditions (e.g. battery cycle life may strongly be strongly affected by the frequency of fast recharge). Such interdependencies need to be considered.

b) Cost targets: a cost target of 75 €/kWh is set to be achieved by 2030 (battery pack cost for automotive applications). The medium-term target date for cost targets is set to 2022 to allow more time for these targets to be met.

c) Manufacturing targets for automotive application, utility storage, recycling are identified as well.

R&I value chain	Actions
DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF R&I TOPICS	• The IWG has identified five Flagship R&I initiatives. They serve as projects illustrating how coordinated R&I, at national and EU level, can contribute to achievement of the DoI targets and entail activities of interest and visible to the public at large. The flagships are designed to facilitate the exchange of knowledge and transfer of experimental results and technologies across all the value chain segments including materials, manufacturing, application, second-use and recycling.
FINANCING / IMPLEMENTATION OF R&I STRATEGY	• Ten SET-Plan Member States participating in the work of the Action 7 IWG were requested to provide an indication of their intended support to the ten R&I Activities (through nationally funded research ' R', provision of State Aid ' S' or through a (bi/tri/n) lateral action (M) with other Member States).
ANALYSIS OF THE IMPLEMENTATION	
PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES	• Harmonisation of safety requirements is an important driver to further boost battery markets through increased customer acceptance. Furthermore, real-life representative application-based duty cycle standards, testing standards and performance certificates are to be developed and agreed upon. Currently there are no standardized tests for state of charge and state of health estimation. Work should be continued/intensified in relevant standardization fora. • In the context of revision of the Batteries directive, it is important to aim at tightening recycling norms so that maximum recovery of critical raw materials is guaranteed.

	• Establishment of best practice for battery connection rules for providing different grid services would be desirable. Furthermore, works would continue on interoperability issues at behind-the-meter level to facilitate deployment of batteries in the residential sector (by continuing present smart grid-related standardisation work within CEN/CENELEC/ETSI).
REGULATORY INNOVATIONS	• Access to finance for upscaling production and large-scale advanced battery production and deployment • Harmonisation of the different regulations for the transportation of dangerous goods to facilitate second use of EV batteries.
DISSEMINATION AND KNOWLEDGE SHARING ACTIVITIES	A holistic approach is proposed for: (a) the update of skills and training courses; (b) exchange of best practices between professionals, disciplines and institutions; (c) cooperation between relevant stakeholders in the market; (d) exchange of best practices on successful business models.

COMPOSITION/GOVERNANCE

The IWG is composed of a set of members representative of the battery value chain, considering the recommendations of the SET-Plan as maximum number of members. From a set of 20 Industrials + Research + 10 Member States, thanks to the dissemination efforts, new members have participated.

STRUCTURE

FLAGSHIP INITIATIVES

- **Material/Chemistry/Design + Recycling**: **Advanced materials for batteries**: The scope includes the development of battery materials and technologies for both automotive applications (advanced lithium-ion and post Li-ion) and for stationary energy storage applications (including but not limited to alternative ion-based systems (Na, Mg or Al), redox flow batteries and high temperature batteries). The current performance of Li-ion batteries can be at least doubled. For this purpose, focus is to be placed on high voltage 4.5-5V Li-ion and all solid Li-ion systems with a differentiation made for energy orientated applications, such as passenger cars (BEVs), light electric vehicles (e.g. bikes, motorcycles), buses, trains and power orientated applications, such as heavy-duty vehicles, maritime, (P)HEVs, etc. Higher performance needs the gradual introduction of new generation batteries (post Li-Ion) based on the development of a series of novel advanced materials. Promising technologies include Na-ion, Li-S and metal (Li, Fe or Zn)-air however issues related to poor cycle life, low power density, low efficiencies and limited safety need to be addressed. For stationary energy storage there is a need for significantly more research, to optimise power applications, such as frequency regulation, with a particular focus on lifetime. For energy applications, including home stationary systems, storage duration and cost should be improved. Both the optimisation of Li-ion batteries and the innovation and development of non-Li ion battery technologies (including molten-salt batteries, redox-flow batteries, metal-air, lithium-sulfur, new ion-based systems) specifically designed with high cycle life, long calendar life, optimised safety and low cost are considered.
- **Manufacturing: Eco-efficient production**: The short-term focus of this flagship initiative is the integration of close-to-market materials into mass production lines. Intensive development is required in order to obtain new components which are compatible with today's production equipment. New electrode recipes and compatible process parameters will be investigated. Similarly, inactive materials need improvements for better manufacturing. Environmentally friendly processes will be enabled such as water-based electro-decoating. This aspect will support the early scaling-up of battery cell manufacturing factories in Europe. In parallel, a longer-term focus on the development of new equipment for present and future cell chemistries should be progressive. It should enable product differentiation by addressing specific market trends: flexibility through

equipment modularity, higher environmental standards, and cost reduction through better production efficiency. Research and development for equipment compatible with future technologies such as all-solid-state batteries is also a focus. This aspect will support the medium -term scaling-up of cell manufacturing factories in Europe. Eco-design will be considered to advance battery recycling and second use; better knowledge on the design of batteries will improve their dismantling, repurposing and recycling.

- **Development of batteries with fast charging capability**. The availability of high-power fast charging stations enables long-distance e-mobility persuading more customers to opt for an electric vehicle. Fast charging facilities (superchargers 120 kW) are already installed by Tesla in a wide network. European industry members have partnered to create a large electric vehicle fast-charging station network in Europe with ultra-fast chargers of 350 kW. The effects of very high C-rates need to be studied, limiting factors determined, and eventually a complete overhaul of battery cell components (anodes, cathodes, current collectors, electrolytes and separator) and design will be needed for performance and safety improvement. Activities will be coordinated with the Energy Systems SET-Plan working group, which is addressing the impact of fast charging on the grid.
- **Second-use of EV batteries**. This has many advantages. Their total lifetime is increased which reduces the levelised cost of electricity of the battery. In addition, its environmental impact is improved as its lifetime is extended before it is recycled. The main challenges for a sustainable market for “second-use” batteries concern provision of a reasonable guarantee of the continued performance of batteries when they are reused either for EVs or for Stationary Energy Storage Systems. This may be achieved through knowledge recorded on the battery during its first lifetime. More generally, an Intelligent Life Long Battery Management System is needed. Designing batteries which are optimized anticipating battery second-use would encourage a second lifetime for the battery. Determination of the type of tests necessary to assess battery reliability, safety and performance at the end of its first use will be an area for research. Different micro-markets for second-use could be developed depending on the level of performance in the batteries and corresponding needs for different application types.
- **High Yield Recycling**. Li-ion battery recycling is not yet fully mature, despite the fact that recycling projects for such batteries have been ongoing for several years. R&I challenges include:
    - 1) Reversed logistics including development of low-cost packaging for safer and more efficient recycling;
    - 2) Development of an improved reversed logistics business model;
    - 3) Dismantling of industrial batteries, prior to recycling, i.e. removing ‘easy to recycle parts’ which reduces the needed recycling capacity and lowers the environmental footprint;
    - 4) Robust scaling up of metallurgical or chemical processes: Industrial and commercial processes already exist to recover Cu, Ni and Co (Co as a critical raw material is already fully recovered) but further improvements of current processes to increase the process efficiency and lower the environmental footprint are still possible;
    - 5) Designing cells for ease of disassembly and recyclability. The recycling performance will benefit from integration of this activity into the battery design and manufacturing processes.

SUPPORTING TEAM/PROJECTS

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KEY DELIVERABLES AND OUTPUTS

Implementation Plan:
https://setis.ec.europa.eu/system/files/set_plan_batteries_implementation_plan.pdf

Website: https://ec.europa.eu/energy/en/topics/technology-and-innovation/strategic-energy-technology-plan

8.18 SET-PLAN IWG 3.2 - SMART CITIES

ABOUT

The IWG of the European Strategic Energy Technology (SET)-Plan on Action 3.2 "Smart Cities and Communities" aims to support the planning, deployment and replication of 100 'Positive Energy Districts' by 2025 for sustainable urbanization. The working group has developed an integrative approach to Positive Energy Districts (PED) including technological, spatial, regulatory, financial, legal, environmental, social and economic perspectives. PEDs require interaction and integration between buildings, the users and the regional energy, mobility and ICT system, as well as an integrative approach including technology, spatial, regulatory, financial, legal, social and economic perspectives. In this context, a PED is seen as a district with annual net zero energy import, and net zero CO2 emission working towards an annual local surplus production of renewable energy.
SET-PLAN IWG SMART CITIES is involved in the following segments of the RD&I value chain:

R&I value chain	Actions
DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF R&I TOPICS	• The ambition is to have 100 Positive Energy Districts by 2025 in Europe. • Presentation, Publication and Dissemination of a Technology Roadmap for PED in the European Union towards 2025 • The strategy of the IWG has been established around the 6 main modules.
FINANCING / IMPLEMENTATION OF R&I STRATEGY	• The budget for the initiative is focused on the public R&I funding of the participating countries dedicated towards PED development: ERA-Nets and the annual joint calls organised by JPI Urban Europe
ANALYSIS OF THE IMPLEMENTATION	• Monitoring and evaluation of PED pilots (e.g. PED Labs, H2020 SCC Lighthouse Projects with a focus towards PED, etc.) to provide learnings for the guides and tools
PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES	• Replication, upscaling and mainstreaming enabling cooperative innovation, including replication profiles, feasibility studies, intellectual property rights, market access, and STI cooperation.
REGULATORY INNOVATIONS	• These lead to scaling up from Energy Performance of Buildings, transforming regulations from a building-scale to a district-scale to respond to the increased technological complexity of PEDs and the need for licensing of new technologies, regulating the interests of stakeholders and new cooperative innovation mechanisms, specifying their responsibility and conditions for exchange of energy flows.
DISSEMINATION AND KNOWLEDGE SHARING ACTIVITIES	• Support capacity building and education (trainings and curricula that build future knowledge base) based on PED Labs and pilots.

COMPOSITION/GOVERNANCE

The WG is chaired by national representatives from Austria and co-chaired by representatives from the European Regions Research and Innovation Network (ERRIN) and the European Construction Technology Platform (ECTP). Delegates from 17 countries are involved in the WG. They work in close cooperation with stakeholders from cities, industry, research organisations and citizen organisations.

The IWG is headed by an IP Steering Group composed of delegates of the countries involved in the Programme. It works in close connection with all other stakeholder involved in the Implementation Working Group. The Steering Group is supported by a Funding Agencies Group, which works in variable geometry, based on the financial involvement of the respective countries. All of this is underpinned by a well-established Programme Management Structure, which can be provided by the JPI Urban Europe.

STRUCTURE

- **Module 1: European Positive Energy Cities:** Set-up a dialogue among cities or national city networks on the planning, financing, deployment and replication of PEDs; ensure an integrated open innovation process in PED development. Mobilise cities with an ambition to develop "Positive Energy Districts for sustainable urbanization" (e.g. shown in Sustainable Energy Action Plans) for a European city-driven network towards PEDs in cooperation with public utilities, infrastructure operators, construction industry, real estate developers, research, and citizen organisations
- **Module 2: PED Labs**: Develop city -driven PED Labs according to individual cities' needs and approaches towards PED, in Europe and globally. PED Labs are designed for cities' needs and support concrete next steps in the planning and deployment phase, which includes a range of activities and steps towards PEDs (e.g. test new technologies, test new forms of stakeholder engagement, test new regulations, test new funding mechanisms)
- **Module 3: PED Guides and Tools**: Develop guides and tools based on the needs of the PED stakeholders and the learning experience from PED Labs as a basis for successful planning and designing, implementation and operation, as well as replication and mainstreaming of PEDs. Development of common criteria for national PED certification: The development of common criteria for PED certification could be the starting point for national or European level PED certificates. Guidance on regulations and legal frameworks for PEDs reveal differences in national level regulations and legal frameworks towards PED and provide good practice considering place-based differences. Guidance on funding models for PEDs: Analysis and recommendations for different funding models for PEDs for all relevant actors and all phases of PED development
- **Module 4: Replication and Mainstreaming of PED**: Support European cities in replication and mainstreaming to have 100 Positive Energy Districts in Europe committed by 2025: Individual cities and their cooperation partners from industry , infrastructure operators, research organisations and citizen organisations lead replication and mainstreaming of PED demo experiments, PED labs and knowledge derived from testing and implementing PED building blocks.
- **Module 5: PED Monitoring and Evaluation**: Monitor, evaluate and assess PED performance to support each module with relevant information for learning. Develop and a common monitoring and evaluation framework for PED planning, deployment and use/maintenance respecting place-based differences which can then be used and implemented on national and individual city
- **Module 6: Innovation Actions**: funded by national and transnational R&I funding aim to support innovation activities along the circular implementation pathway to avoid or alleviate potential risks and ensure knowledge flows through the different modules. Innovation Actions will be used to drive the pathway forward, e.g. to support cities and their cooperation partners to set-up PED Labs, the development of guides and tools, innovative activities in cities in the replication and mainstreaming process, the analysis and monitoring of PED and the development of a common framework.

SUPPORTING TEAM/PROJECTS

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REFERENCE PUBLICATIONS

Implementation plan:
https://setis.ec.europa.eu/system/files/setplan_smartcities_implementationplan.pdf
Website:https://ec.europa.eu/energy/en/topics/technology-and-innovation/strategic-energy-technology-plan

8.19 ETIP SNET - SMART NETWORKS FOR ENERGY TRANSITION

ABOUT

ETIP SNET (Smart Networks for Energy Transition) has been created by the European Commission in the framework of the new Integrated Roadmap Strategic Energy Technology Plan (SET-Plan) by bringing together a multitude of stakeholders and experts from the energy sector on a voluntary basis. It replaced the ETP SmartGrids (European Technology Platform for Electricity Networks of the Future) in 2016.

ETIP SNET activities consist in developing vision documents and prioritizing actions, aligned with tasks 4.1 and 4.2 of the SET-PLAN (4.1: An optimised European power grid / 4.2: Integrated local and regional energy systems). These activities concern TRL 4 to 9 projects at European level, including the 30 EU countries (28 EU Member States, Switzerland and Norway).

ETIP SNET is involved in the following segments of the value chain:

R&I value chain	Actions
DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF R&I TOPICS	• Set-out a vision for R&I for Smart Networks for Energy Transition and engage stakeholders in this vision. • Prepare and update the Strategic Research and Innovation Roadmap. • Provide input to the SET-Plan action 4 which addresses the technical challenges raised by the transformation of the energy system.
FINANCING / IMPLEMENTATION OF R&I STRATEGY	
ANALYSIS OF THE IMPLEMENTATION	• Prepare consolidated stakeholder views on Research and Innovation to European Energy Policy initiatives.
PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES	
REGULATORY INNOVATIONS	• Identify innovation barriers, notably related to regulation and financing.

COMPOSITION/GOVERNANCE

The ETIP gathers a wide range of stakeholders which are to contribute to the Energy Transition: TSOs, DSOs, Member States, Research & Academia, Storage (technology and services providers), Consumers (aggregated and not aggregated), Thermal Generation (flexible), ICT & Network solutions providers, Equipment Manufacturers & suppliers, Renewable Energy Sources, Sector Interface (Heat, Transport, Gas)

The **Governing Board (GB)** composed of over 30 people steers the platform where stakeholder associations are represented and liaises with the European Commission.

5 Working Groups where experts participate in the realization of strategic documents elaborated by the ETIP SNET (Vision 2050, R&I Roadmap, Implementation Plan).

A National Stakeholders Coordination Group liaises with various national actors such as funding agencies, ministries' representatives, national technology platforms, national research infrastructures and experts from national regulators.

STRUCTURE

- **WG1: Reliable, economic and efficient smart grid system:** Addresses business and technology trends contributing to the overall energy system optimization at affordable investment and operation costs.

- **WG2: Storage technologies and sector interfaces:** Addresses the technological and market developments related to energy storage solutions to ensure the required level of flexibility for the transmission and distribution of electricity.
- **WG3: Flexible Generation:** Considers the latest business and technology trends to address the needs for flexibility in the framework of an integrated energy system.
- **WG4: Digitisation of the electricity system and customer participation:** Addresses the use and impact of the Information and Communication Technologies as a pervasive tool along the entire value chain of the power generation, transportation and use.
- **WG5: Innovation implementation in the business environment:** Adopts a helicopter view on R&I projects and promotes their uptake by the industry so as to ensure Europe's energy transition; promotes research.
- **NSCG: National Stakeholders Coordination Group:** Provides a sounding board and exchange platform for national R&I stakeholders in the area of energy systems and networks.

SUPPORTING TEAM/PROJECTS

ETIP SNET is coordinated by the INTENSYS4EU (**INTegrated ENergy SYStem, a pathway for EUrope)** project, a coordination and support Action group supported by the European Commission's Horizon 2020 programme. It started its activities in October 2016 and will finalise in September 2020.

REFERENCE PUBLICATIONS

- ETIP SNET Vision 2050: basis for defining the specifications for further research and innovation needs in the transition from today towards Europe's energy systems of the future. Its purpose is to inspire all stakeholders to discover the RD&I challenges associated with a 2050 low-carbon, fully-integrated, and circular pan-European energy system with the electricity system as its backbone.
- Final 10-year ETIP SNET R&I roadmap covering 2017-26: provides a System view of the entire energy transition. It addresses a scope larger than smart electricity grids by encompassing interactions with the gas and heat networks and focuses on integration of all flexibility solutions into the power system.
- ETIP SNET Implementation Plan 2017-2020: aims at listing the short-term priorities for research and innovation (R&I) in relation with Smart Networks for the Energy Transition. The Implementation Plan is based upon the ETIP-SNET R&I roadmap 2017-2026.

Website: https://www.etip-snet.eu/about/etip-snet/

8.20 ETIP RHC - RENEWABLE HEATING AND COOLING

RHC Renewable Heating & Cooling
European Technology and Innovation Platform

ABOUT

The European Technology and Innovation Platform on Renewable Heating & Cooling (RHC-ETIP) brings together stakeholders from the biomass, geothermal, solar thermal and heat pump sectors – including the related industries such as district heating and cooling, thermal energy storage, and hybrid systems – to define a common strategy for increasing the use of renewable energy technologies for heating and cooling. Five major European organisations – EUREC, Bioenergy Europe (formerly known as AEBIOM), EGEC, Solar Heat Europe (formerly known as ESTIF) and EHPA – are leading the process towards the definition of a joint Vision and Strategic Research Agenda for the renewable heating and cooling sector.

RHC-ETIP is involved in the following segments of the RD&I value chain:

R&I value chain	Actions
DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF R&I TOPICS	Technology Roadmaps: • Common Implementation Roadmap for Renewable Heating and Cooling Technologies • Solar Heating and Cooling Technology Roadmap • Geothermal Technology Roadmap • Biomass Technology Roadmap • Cross-Cutting Technology Roadmap Strategic research priority • Strategic Research and Innovation Agenda for Renewable Heating & Cooling • Strategic Research Priorities for Solar Thermal Technology • Strategic Research Priorities for Biomass Technology • Strategic Research Priorities for Geothermal Technology • Strategic Research Priorities for Cross Cutting Technology Vision documents • Common Vision for the Renewable Heating and Cooling sector in Europe: 2020 - 2030 - 2050
FINANCING / IMPLEMENTATION OF R&I STRATEGY	
ANALYSIS OF THE IMPLEMENTATION	
PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES	
REGULATORY INNOVATIONS	• Identify innovation barriers, notably those related to regulation and financing
DISSEMINATION AND KNOWLEDGE SHARING ACTIVITIES	

COMPOSITION/GOVERNANCE

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STRUCTURE

The Board is the highest decision-making body of the RHC ETIP and is responsible for providing guidance to the activities of the RHC-ETIP. Ad hoc Horizontal Working Groups on research and policy topics contribute to the achievement of the RHC Objectives. The Secretariat of the RHC-ETIP is jointly managed by five associations. The RHC-ETIP consists of five Technology Panels which include

- **Solar Thermal Technology Panel**: The European Solar Thermal Technology Platform (ESTTP) was launched on 21 June 2005, at the 2nd European Solar Thermal Energy Conference (estec2005). This represents an important milestone in the evolution of solar thermal technology. ESTTP issued the "Strategic Research Priorities for Solar Thermal Technology" (SRP). While this document identifies the huge potential for technological developments in solar heating and cooling up to 2050, it also highlights the need for a significant increase in R&D activities and the corresponding investment costs. The SRP covers solar technologies for nearly-zero energy residential buildings, public and commercial buildings, district heating systems, industrial applications and solar assisted cooling systems. The SRP was implemented through the development of the technology roadmap for solar heating and cooling. This roadmap defines the research topics and related measures up to 2020; it also describes the research projects and resources entailed (research infrastructure, involved industry and budgets). Three pathways are identified, which the sector must tackle in parallel:
    - the development of solar compact hybrid systems (SCOHYS) to reduce the solar heat costs by 50% until 2020,
    - technological improvements in Solar-Active-Houses (SAH) as an attractive option to fulfill the requirement of nearly zero-energy buildings
    - development of systems supplying solar heat for industrial processes (SHIP).
- **Biomass Technology Panel:** The Biomass Technology Panel of the RHC-Platform brings together industrial and R&D stakeholders of the biomass sector, to define a common strategy to increase the use of biomass based heating and cooling in Europe in 2020 and beyond. The Biomass Technology Panel is composed of four Issue Groups:
    - Biomass fuels (whole supply chain)
    - Technologies for residential heating
    - Technologies for industries and district heating
    - Non-technological issues (markets, policies, communication, training)
- **Geothermal Technology Panel:** The panel aims at formulating a vision 2030 for the geothermal heating and cooling sector, presenting the contribution of the geothermal sector towards a 100 % Renewable heating and cooling scenario in Europe. The Geothermal Panel intends also to elaborate a detailed research strategy to reach ambitious objectives notably for costs reduction. The Geothermal Technology Panel is composed of three following Focus Groups:
    - Focus Group 1: Shallow geothermal heat pump systems
    - Focus Group 2: Deep geothermal
    - Focus Group 3: Non-technical issues: financial, policy, regulation, education, training
- **District Heating and Cooling and Thermal Energy Storage Technology Panel:** increases the overall efficiency of the energy system by recycling heat losses from a variety of energy conversion processes. Heat which otherwise would be unutilised is recovered and used to meet thermal demands in buildings and industries. Renewable sources which otherwise would be difficult to use, such as many forms of biomass and geothermal energy, can also be exploited. By aggregating a large number of small and variable heating and cooling demands, District Heating and District Cooling allow energy flows from multiple RES to be combined while reducing primary energy demand and carbon emissions in the community served.
- **Heat Pump Technology Panel**: The Panel works on the development of a strategy that will enable heat pumps to make a major contribution to the "Common Vision" of the RHC-Platform, which outlines how the European heating and cooling sector can be fully decarbonized by 2050. The main

target of this strategy will be to create the conditions to further boost the research, development and technological innovation of all existing and new heat pump applications.

SUPPORTING TEAM/PROJECTS

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KEY DELIVERABLES AND OUTPUTS

- Common Implementation Roadmap for Renewable Heating and Cooling Technologies: The Roadmap describes the top priority research themes and value chains with the highest impact on the societal challenges in Europe until 2020.
- Common Vision for the Renewable Heating and Cooling : The European Strategic Energy Technology Plan provides a framework to develop new industrial initiatives. In this view, the Technology Platform on Renewable Heating and Cooling is expected to provide the right impulse to ensure the deployment of future cost-effective technologies in the renewable heating and cooling sector.
- Strategic Research and Innovation Agenda: The European Strategic Energy Technology Plan provides a framework to develop new industrial initiatives. In this view, the Technology Platform on Renewable Heating and Cooling is expected to provide the right impulse to ensure the deployment of future cost effective technologies in the renewable heating and cooling sector.

Website: http://www.rhc-platform.org

8.21 TP DHC+ - DISTRICT HEATING AND COOLING+ TECHNOLOGY PLATFORM

ABOUT

The District Heating and Cooling plus (DHC+) Technology Platform comprises a variety of actors representing universities, private and public research institutes, manufacturers, suppliers and utilities focusing on R&D&I in the DHC sector including related energy sources and related fields such as digitalisation or system integration from across Europe. DHC+ was created to shape, coordinate and foster exchange on R&D&I efforts in the sector across borders, markets and technologies, and also to support the realisation and market uptake of innovative solutions in cooperation with local actors such as cities. The platform leads the work of the sector on its strategic research priorities and its vision as well as on specific roadmaps, e.g. on digitalisation. DHC+ also represents the sector in other platforms and for a such as RHC ETIP, ETIP SNET or Eufores. DHC+ also supports the next generation of researchers with its own Summer School and Student Awards.

DHC+ is involved in the following elements of the R&D value chain:

R&I value chain	Actions
DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF R&I TOPICS	• Strategic Research Agenda of the DHC sector • Vision document of the DHC sector • Digitalisation roadmap of the DHC sector • Contribution to ETIP SNET and RHC ETIP visions and research priorities • Contribution to IEA TCP DHC/CHP • Contribution to SET-Plan process in actions 1-6
FINANCING / IMPLEMENTATION OF R&I STRATEGY	• Contribution to EU research programme development • Contribution to SET-Plan process in actions 1-6 • Consortium building for research projects • Cooperation with ERA-NET, EIB, IEA and UNEP • Cooperation under national funding schemes • Private funding
ANALYSIS OF THE IMPLEMENTATION	• Regular internal evaluation of development of the sector and R&D&I achievements • Contribution to RHC ETIP report on the implementation of the cross-cutting panel/DHC & TES panel
PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES	• Collaboration on sector-specific and relevant standardisation efforts, e.g. coordination of work on standard on Eco-efficient Substations CWA 16975:2016
REGULATORY INNOVATIONS	• Identification of innovation and market uptake barriers related to technological, regulatory and economic issues
DISSEMINATION AND KNOWLEDGE SHARING ACTIVITIES	• Knowledge hub centralising information, studies, project outcomes on DHC and related technologies • Support of dissemination of project results as dissemination partner • Regular platform meetings to foster exchange • Utilisation of network to disseminate results

	• Collaboration with wider Euroheat & Power network • Organisation of and contribution to relevant events

COMPOSITION/GOVERNANCE

DHC+'s secretariat is run by Euroheat & Power, the European association of the DHC sector. It has its own membership pool. The DHC+ Steering Committee is the highest decision-making body and responsible for the overall activities of the platform. Decisions on research priorities and activities are taken jointly by the committee.
The secretariat:

- in collaboration with the members – represents the platform vis-à-vis EU, global and national institutions
- in collaboration with the members – represents the platform in/vis-à-vis
  - ETIPs, e.g. RHC ETIP and ETIP SNET
  - Stakeholder for a, e.g. Eufores
  - SET-Plan WGs, e.g. on action 3.2 or 6
  - IEA TCP DHC/CHP
  - ERA-Net
- Fosters the cooperation of its members and the wider sector on research, e.g. by building research consortia for H2020 projects or ERA-Net
- Organises communication, exchange and dissemination activities
- Coordinates the work on overarching issues such as the research agenda and visions.

STRUCTURE

- Research Policy: WG ResPol coordinates DHC+'s work on and contribution to the wider field of research policy, EU-activities such as the framework programmes and the SET-Plan, other ETIPs and fora. The WG aims at defining the sector top priorities and communicating them to other stakeholders, policy-makers and the public.
- Digitisation: The recently set up Digitalisation WG functions as a platform for exchange among DHC+ members, drives strategic work on the topic as well as eases the development of new (research) projects. Policy-work to facilitate innovation and structure work in order to facilitate the take-up of digital solutions is also part of the working group.
- Education & Training: WG E&T comprises academic and industrial stakeholders who are actively supporting international education & training initiatives in DHC. Two well established annual initiatives are the DHC+ Summer School and the DHC+ Student Awards. Additionally, the WG aims at developing an international Master programme on DHC, a Massive Open Online Course and, potentially, a DHC simulation game.
- Working Groups

SUPPORTING TEAM/PROJECTS

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KEY DELIVERABLES AND OUTPUTS

- Strategic Research Agenda: Supports European and national policymakers in defining research and development programmes. It presents the priorities of the DHC sector with a view to support European policies for the next few decades and to realise the Vision.
- Vision: Contains the European Vision for District Heating and Cooling (DHC) technology.
- Digitalisation Roadmap: Offers insights on how digitalisation impacts the industry, showcases the current state of the art, identifies barriers and presents objectives, targets and recommendations for each of the topics: Production Level, Distribution Level, Building Level, Consumption Level, Design & Planning and Sector Coupling& Integration of Multiple Sources.

Websites: www.dhcplus.eu

8.22 ERA-NET SES - SMART ENERGY SYSTEM

ABOUT

ERA-Net Smart Energy Systems (ERA-Net SES) provides a sustainable and service-oriented **joint programming platform to finance transnational** RDD projects, developing technologies and solutions in thematic areas like smart power grids, regional and local energy systems, heating and cooling networks, digital energy and smart services, etc. ERA-Net Smart Energy Systems provides a substantial contribution to turn the implementation plan of the European Strategic Energy Technology Plan (SET-Plan) Action 4 "Increase the resilience and security of the energy system" into action.
The initiative concerns projects with TRL from 3 to 7.
In order to address specific challenges, ERA-Net SES utilizes 2 Focus initiatives: **Smart Grids Plus (SG+**, initiative aiming to further the development and the integration of smart grids system-technologies, the stakeholder adoption and the market processes to help Europe achieving its 2020, 2035 and 2050 energy targets.) through applied research, piloting and demonstration, and **Regional and local energy systems and networks** (**REGSYS**, focusing on integration of energy supply from various sustainable and variable sources in order to secure optimal utilization of the limited local and regional infrastructure and resources, leveraging the synergies between different energy vectors and infrastructures to achieve optimal solutions for the regional or local energy systems.)**.**

ERA-Net SES is involved in the following segments of the RD&I value chain:

R&I value chain	Actions
DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF R&I TOPICS	• Contributes to turn the Implementation Plan of the SET-Plan Action 4 into action; • Scoping workshops are organized with all participating countries/regions to identify the common priorities around which to structure the calls for projects; an overarching feature of the calls is the requirement to proposers to combine technological developments to market and user adoption measures; • The boundaries of the calls are progressively expanding throughout the years: from smart grids to integration of storage to the development of local and regional energy communities considered as a whole; • Facilitates the implementation of solutions by means of an innovation eco-system, building bridges in the whole innovation chain.
FINANCING / IMPLEMENTATION OF R&I STRATEGY	• Through transnational coordinated calls, where each participating country/region finances its own portion of projects, often with a significant top-up from the EC to promote the effective collaboration and highlight the European added value
ANALYSIS OF THE IMPLEMENTATION	• Continuous monitoring and evaluation of the achievements of the projects and guidance with regards to the European added value, the contributions to the technology, market and adoption dimensions of the project outcomes. • Promotes among the projects and the expert community the concepts of TRL levels 3-7 that show potential to become best practice by 2030.

PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES	• System architecture and standardization is highly promoted, through specific “living documents” and discussions in “working groups”, to promote the widest use of the SGAM (Smart Grids Architecture Model) approach fostering interoperability • Some of the transnational RDI projects will either be using open source code in their deliverables or contribute their deliverables to the open source communities. • Some of the partners may contribute to standards, open or otherwise. In other cases, consortium partners will have to protect their IPR and products.
REGULATORY INNOVATIONS	• Specific living documents and working groups address the regulatory and market issues: these are aimed to identify barriers and needs emerging in the field of regulation and development of the market and promoting a platform for initiating and developing the expert discussions regarding the messages of the research community to the policy makers; • Regulatory sandboxes are considered to promote and test innovation in the field.
DISSEMINATION AND KNOWLEDGE SHARING ACTIVITIES	• The expera Knowledge Sharing Platform has been set up to facilitate knowledge sharing, as a common repository of information and knowledge of common interest for the projects; this knowledge community organizes both horizontal learning among demonstration and RDD projects and vertical learning between these projects, the related funding programmes and the international knowledge base; • Policy briefs: recommendations from the ERA-Net SES Knowledge Community to policy makers in the form of an informed opinion of key aspects. • Spotlights: magazine-type documents to keep experts updated on the ongoing activities and intermediate results of projects. Condensed information about specific new knowledge of high relevance for project participants and practitioners. • Expera Knowledge platform also provides material to be used in presentations and publications, or to be used by partner agencies and associated partners for mailings to their communities;

COMPOSITION/GOVERNANCE

The initiative is driven by public project financing agencies, coming from 30 participating countries and regions. In addition, among stakeholders that can benefit from the initiative are included policy makers, programme owners and managers, grid operators, industry and research.

STRUCTURE

The initiative is managed by a well-structured coordination system with Steering Board, Management Board, coordinator, consortium management, call management, various coordination and communications services and a Knowledge Community Management Team. With a system of Working Groups and Living Documents the initiative covers the following key areas of research interest:

System Architecture and Implementation Modeling: tackles the security issue by design and other architectural ways to ensure data security and privacy. The handling of big data and cloud computing approaches need to be mapped in architectures. Microgrids and cellular approaches to Smart Grid architectures will be discussed and evaluated regarding their usability for the ERA-Net SG + and other projects. This approach is particularly promising for the increase of the system's resilience. The work will strongly build on the European M /490 process and the Smart Grid Architecture Model (SGAM).
Storage and Cross Energy Carrier Synergies: storage and cross energy carrier synergies will become a cornerstone for a safe and stable energy supply in the future. There is a lot of research and market scale effects needed to make these technologies reliable and affordable. Regulation has to be adapted as well as new business models need to be found in order to make widespread application feasible.
Regulatory and Market Development: aims to identify barriers, new challenges and needs emerging both in the field of regulation and business models for RES integration, smart metering, demand response, storage. New trends in smart grid and storage regulation to face these challenges will be addressed, based on known positive experiences in pilot projects. The role of DSOs, TSOs and new market players in the future marketplaces will be analysed.
Consumer and Citizen Involvement: will assemble already existing knowledge on new approaches and techniques to include commercial and residential customers and to increase their flexibility and efficiency potentials**.**
Standards and Interoperability: tackles the increasing importance of data models, design methodologies and interoperability testing procedures, Smart Grids standardization, the most urgent standardization gaps and the interplay between “de facto” industry standards vs “de jure” international standards. Close cooperation with the System Architecture and Implementation Modelling Working Group is foreseen, with particular reference to the European M /490 process and the Smart Grid Architecture Model (SGAM), which is of great relevance for the implementation of interoperable systems.
Regional Matters: will come up with a consistent terminology for regional or local energy systems, describe how "optimal system operation" can be defined for a regional system and will describe how regional energy systems can cope with grid constraints. Further market and planning issues are covered her such as coordination and trading mechanisms with benefits to regional energy systems and interferences and synergies between local and regional planning and the establishment of new energy systems and markets.

SUPPORTING TEAM/PROJECTS

As an integral part of the ERA-Net SES Coordination, a team of the Knowledge Community Management (B.A.U.M., RSE, CLIC) manages Working Groups and Living Documents to create and maintain joint knowledge of the initiative and its projects.

KEY DELIVERABLES AND OUTPUTS

- Each project in the ERA-Net SES community has its own deliverables, products and key exploitable results. These are adequately disseminated according to the contractual clauses of each project, by means of reports, demonstrations, tools etc. on national and transnational basis.
- On an annual base, the Knowledge Community with the approval of the Steering Board of the initiative publishes Policy Briefs for policy and decision makers based on the findings from ERA-Net SES projects and the Working Groups.

Expera, the cooperation platform of the ERA-Net SES, with its Living Documents, Policy Briefs, Spotlights, expert and project repositories and access to Working Groups is a unique opportunity for experts to exchange their knowhow, opinions and expectations. Registered expert members and followers of the Knowledge Community have access to the expera Knowledge Platform at www.smartgridsplus.eu.

Website: https://www.eranet-smartenergysystems.eu/

8.23 ERA-NET SUGI – SUSTAINABLE URBANISATION GLOBAL INITIATIVE

Sustainable Urbanisation Global Initiative (SUGI)
FOOD-WATER-ENERGY NEXUS

ABOUT

The Sustainable Urbanisation Global Initiative (ERA-Net SUGI)/Food-Water-Energy Nexus is a call jointly established by the Belmont Forum and the Joint Programming Initiative Urban Europe. The cooperation was established in order to bring together the fragmented research and expertise across the globe to find innovative new solutions to the Food-Water-Energy Nexus challenge.
The Belmont Forum is a partnership of funding organizations, international science councils, and regional consortia committed to the advancement of interdisciplinary and transdisciplinary science.
JPI Urban Europe was created in 2010 to address the global urban challenges of today with the ambition to develop a European research and innovation hub on urban matters and create European solutions by means of coordinated research.
The initiative offers an opportunity for funding agencies, policy makers and research and innovation actors to tackle the challenge of urban transitions and to develop connections and collaborations worldwide. ERA-Net SUGI is supported through the ERA-Net funding mechanism by the European Commission, under Horizon 2020 Societal Challenge 5 Programme.

ERA-Net SUGI is involved in the following segments of the RD&I value chain:

R&I value chain	Actions
DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF R&I TOPICS	• Bring together actors to find innovative new solutions to the Food-Water-Energy Nexus challenge. • Defining relevant topics of research for the Food-Water-Energy Nexus challenge: Robust knowledge, indicators and assessments; Multi-level governance and management; Managing strategies and solutions.
FINANCING / IMPLEMENTATION OF R&I STRATEGY	• Each national/regional funding agency will provide funds directly to their eligible investigators in accordance to the agencies' rules and regulations. Funds provided by the European Commission will be utilized to support eligible investigators in a maximum number of research projects.
ANALYSIS OF THE IMPLEMENTATION	• Projects were encouraged to use Urban Living Lab or other formats for co-creation and involvement of all stakeholder groups (research, cities, business and societal actors). This shall support validation of concepts and development of solutions that fit different stakeholder needs.
PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES	• Efforts are made to develop and apply methods to assess the performances of processes involved in the FEW nexus and the related potential measures to improve efficiency, also at a city-scale.
REGULATORY INNOVATIONS	• The ERA-Net SUGI projects are multidisciplinary and typically involve city planners, urban farmers, scientists, entrepreneurs, community leaders, and engaged citizens. Project often are organised in the form of Urban Living labs, giving regulators and urban planners real life insights of the aspects investigated. • The ERA-Net SUGI projects develop and propose guidelines and participatory assessment tool kits,

	through co-creation in Urban Living Labs, based on an integrated assessment of local-global interactions in the FWE nexus and transdisciplinary action-research.
DISSEMINATION AND KNOWLEDGE SHARING ACTIVITIES	• The aim of ERA-Net SUGI projects is to make the linkages between energy-water-food understandable to the stakeholders (government, science, business, and citizens), and facilitating cooperation and knowledge exchange among them • Knowledge sharing, networking, programme seminars, dissemination of results and a website acting as an information and networking hub.

COMPOSITION/GOVERNANCE

ERA-Net SUGI is composed not only by the Belmont Forum and the Joint Programming Initiative Urban Europe. It foresees the participation of 19 Funding Agencies (FA) eligible for the EU top up, 18 from JPI Urban Europe and 1 from Argentina, and 6 FAs non-eligible for EU top up, under the umbrella of the Belmont forum, collaborating on a volunteer base.

STRUCTURE

It is currently funding 15 ongoing projects, for example:

- CITYFOOD: investigates quasi-closed loop integrated aqua-agriculture (IAAC) systems to address the global challenge of feeding rapidly growing urban populations and ensuring efficient water, energy, and nutrients management.
- GLOCULL: develops guidelines and a participatory assessment tool kit through co-creation in seven Urban Living Labs to identify whether solutions to one issue in the FWE nexus are sustainable across food, water and energy systems, both at the local and the global scale.
- METABOLIC: identify critical factors and define critical pathways of FWE delivery to urban centers using advanced tools such as artificial Intelligence, data mining, system dynamics modeling, agro-logistics and scenario analysis to understand the intertwined nature of FWE in terms of lifecycles, including production, processing, delivery, consumption, and disposal.
- SUNEX: provides an integrated modelling framework of advanced tools to model and assess the Food-Water-Energy (FWE) systems' demand and supply sides, capture their interdependencies and maximize synergies. With the case study cities different socio-economic and climate characteristics, different consumption patterns and different local and remote FWE resource shares are reflected.

SUPPORTING TEAM/PROJECTS

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KEY DELIVERABLES AND OUTPUTS

- ERA-Net SUGI Projects Catalogue: provides details on all the 15 projects funded by ERA-Net SUGI.
- ERA-Net SUGI Info Flyer: provides an overview of ERA-Net SUGI and the call topics.

Website: https://www. ERA-Net SUGI-nexus.org

8.24 ERA-NET SCC - SMART CITIES AND COMMUNITIES

URBAN EUROPE

ABOUT

As Smart Cities and Communities have been identified as key players for achieving the European 2020 energy targets, the main objective of this initiative is to stimulate successful practices and facilitate replicability within and across Smart Cities implementation projects in order to achieve a technological shift in the current energy system and provide smart and integrated solutions for urban communities.
The ERA-Net COFUND Smart Cities and Communities (ERA-Net SCC) is a joint effort of the Joint Programming Initiative (JPI) Urban Europe and the Smart Cities Member States Initiative. The ERA-Net SCC brought together 18 national and regional RTD funding agencies from 12 countries, with the aim of launching a call for transnational research and innovation projects. The European Commission supports the ERA-Net COFUND within the Horizon 2020 funding scheme.
The following four call topics were defined:

- Smart integrated urban energy and transport systems
- Smart tools and services for integrated urban energy and transport systems
- Smart data, big data
- Smart governance and smart citizens

ERA-Net SCC is involved in the following segments of the RD&I value chain:

R&I value chain	Actions
DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF R&I TOPICS	• Set-out research topics to stimulate projects within the Smart Cities and Communities area.
FINANCING / IMPLEMENTATION OF R&I STRATEGY	• Each national/regional funding agency will provide funds directly to their eligible investigators in accordance to the agencies' rules and regulations. Funds provided by the European Commission will be utilized to support eligible investigators in a maximum number of research projects.
ANALYSIS OF THE IMPLEMENTATION	
PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES	• Aims to produce replicable results from the funded projects in order to create new standards in the Smart Cities and Communities area. • Projects have the objective to foster energy networks interoperability.
REGULATORY INNOVATIONS	• Means of participation of all stakeholders in the evaluation of alternative solutions for urban development. • Policy and market recommendations, smart decision support tool are often issued by the projects financed under the ERA-Net SCC framework. • Projects address modelling and visualization tools for discussing policy scenarios between citizens and governments.
DISSEMINATION AND KNOWLEDGE SHARING ACTIVITIES	• The impact of the funded projects will create a broad variety of concepts, tools and demonstration activities from city planning to participatory energy management platforms. The ERA-Net and JPI Urban

	Europe support networking, knowledge sharing, dissemination and promotion of results

COMPOSITION/GOVERNANCE

The ERA-Net SCC gathers 18 national and regional RTD funding agencies from 12 countries: AT, BE, CY, FI, NL, NO, PT, RO, ES, SE, CH, TK. The ENSCC call and projects are embedded into and supported by the JPI Urban Europe programme.

STRUCTURE

It is currently funding 17 ongoing projects, such as:

- BREATHE: The project analyses the interactions between urban form, economic welfare, energy use by and emissions from households and firms.
- IntegrCiTy: IntegrCiTy's overall aim is to foster energy networks interoperability either in existing or future urban infrastructures by developing a dedicated decision-support tool, that shall be applied and tested/validated in three Swiss and Swedish cities.
- me2: me2 (mobility + electricity = synergy) is a platform that connects citizens of local communities, helping them to be more aware of their energy consumption, incentivising changes in their individual and collective behaviour and helping them to save electricity costs while being engaged with a local community.
- PARENT: The PARENT project aims to increase engagement of individuals in the responsible management of their own electricity usage, thereby understanding how we can stimulate behavioural change in the area of energy consumption in households.
- Smart Urban Isle: Smart Urban Isle aims to move forward with urban energy savings. Based on a three cornerstones procedure, the project aims at a whole new urban planning that allows cities to grow in a sustainable way.
- SmartCityHospitality: This project develops Smart City Hospitality guidelines and tools for cities that could help them find solutions to these problems and actively involve the public in doing so.
- Smart-Fi: The Smart-FI project main goal is to create a set of facilities to allow citizens and developers to deploy and interoperate services, in an easy and standard way, by exploiting aggregated open data from smart cities in the future internet society.
- SmartGov: The SmartGov project aims to create new support tools that effectively incorporate linked open data and social media into fuzzy cognitive maps (FCMs). FCMs are useful modelling and visualization tools for discussing policy scenarios between citizens and governments. The developed tools will be tested and implemented in four European cities.
- SURECITY: SURECITY's mission is to support smart city level integration of policies and measures towards a low carbon energy system including mobility services keeping in focus the sustainability goals on air quality, sustainable land-use, efficient water use, job creation and improved governance. This is done by a software platform which bridges the different scientific models to perform a holistic and optimal design of local energy and emission abatement strategies in the medium- and longterm for neighborhoods and cities.
- TRANS-FORM: Smart cities and communities rely on efficient, reliable and robust transport systems. This project will contribute to a better understanding of how people move in different levels of the public transport network and to offer new techniques to adjust public transport services to respond to actual demand levels.

SUPPORTING TEAM/PROJECTS

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KEY DELIVERABLES AND OUTPUTS

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Website: https://jpi-urbaneurope.eu/calls/enscc/

8.25 ERA-NET SUF - COFUND SMART URBAN FUTURES

URBAN EUROPE

ABOUT

The overall objective of ERA-Net Cofund Smart Urban Futures (ENSUF), building upon the JPI Urban Europe programme, is to bridge the implementation gap in sustainable urban development. There is a disconnect between the knowledge that exists in the research community and the use of this knowledge in practice. Furthermore, there is a disconnect between the different 'silos' in which both cities and researchers often approach urban problems. The complex urban setting requires a more holistic and systemic approach to achieve sustainable urban development and to investigate ways of understanding and managing this complexity.
Bridging this implementation gap requires co-creative, transdisciplinary, interdisciplinary, and cross-sectorial research and innovation in order to provide new insights on European urban dynamics and the implementation of urban innovations and best practice across Europe. This will be done by testing, analysing and optimising innovative urban ideas and strategies to answer the economic, social, cultural and environmental needs of citizens in a sustainable way.
The following three call topics were defined:

- Concepts and strategies for smart urban transformation, growth and shrinkage;
- New dynamics of public services;
- Inclusive, vibrant and accessible urban communities.

ENSUF is involved in the following segments of the RD&I value chain:

R&I value chain	Actions
DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF R&I TOPICS	• Set-out research topics to stimulate projects within the Smart Urban Futures area.
FINANCING / IMPLEMENTATION OF R&I STRATEGY	• Funding of research projects which follow the topics the ENSUF has defined: A total amount of public funding of maximum 23.8 M€ is provided by national and regional funding agencies from 18 European countries, including support from Horizon 2020
ANALYSIS OF THE IMPLEMENTATION	• Projects were encouraged to use Urban Living Lab or other formats for co-creation and involvement of all stakeholder groups (research, cities, business and societal actors). This shall support validation of concepts and development of solutions that fit different stakeholder needs.
PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES	• Aims to produce replicable results from the funded projects in order to create new standards in the Smart Urban Futures area.
REGULATORY INNOVATIONS	
DISSEMINATION AND KNOWLEDGE SHARING ACTIVITIES	• The impact of the funded projects will create a broad variety of concepts, tools and demonstration activities from city planning to participatory energy management platforms.

COMPOSITION/GOVERNANCE

The ERA-Net SUF gathers national and regional RTD funding agencies from 18 countries: AT; BE, CY, DK, FI, FR, IT, LV, LT, NL, NO, PL, PT, RO, SE, SI, TK, UK. The ENSUF call and projects are embedded into and supported by the JPI Urban Europe programme.

STRUCTURE

It is currently funding 15 ongoing projects, such as:

- BRIGHT FUTURE: Project objective is to develop place-specific strategies for industrial towns in Europe by respecting their strengths, needs and expectations. BRIGHT FUTURE has developed an Atlas of industry and industrial towns in Europe which provides an interactive, user-friendly geographical overview of different dimensions of industry in Europe. brightfuture.zrc-sazu.si
- CAPA.CITY: develops a theoretical and operational framework to support the building of collective capabilities to create smart and robust urban ecosystems. www.capa-city- ERA-Net SUF.eu
- Cities of Making: explores opportunities for strengthening urban based manufacturing in European cities following years of decline and offshoring. www.citiesofmaking.com
- C3Places: aims at increasing the quality of public open spaces (squares, parks, green spaces) as a community's service, reflecting through ICT the needs of different social groups. www.c3places.eu
- LOOPER: The aim of LOOPER is to build a participatory co-creation methodology and platform to demonstrate 'learning loops' i.e. new ways of decision-making that bring together citizens, stakeholders and policy-makers to iteratively learn how to address such urban challenges. The methodology addresses the whole co-creation process. Citizens and stakeholders debate on topical issues, then frame the problem and collect data.
- PLACED: introduces a new type of place- and activity-centric digital library services. Whereas library services typically focus on providing access to a collection of media, PLACED services support activities.
- SoHoLab: The overall aim of this project is to develop an integrated approach towards the renovation of the public and collective spaces of such estates. These approaches will be developed, tested and refined via an evaluation of existing projects in Paris, of an ongoing living lab experience in Milan and in new living lab projects in Brussels and Paris. In these labs we examine how social tenants can be effectively involved in renovation processes, but also how such involvement can be aligned with top-down planning processes.
- 3S RECIPE: 3S RECIPE is a project that offers the best practice and most feasible solutions to the problem of urban shrinkage – a continuous population decline affecting more than 1500 cities all over Europe. By learning from the experience of the cities that once were on the edge of an abyss but have bounced back to life, and sharing the key ingredients of their success across Europe and beyond, this project enables as many shrinking cities as possible to adapt, transform, and thrive in the face of continuously and often dramatically changing circumstances.

SUPPORTING TEAM/PROJECTS

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KEY DELIVERABLES AND OUTPUTS

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ENSUF Projects Catalogue: provides details on all the 15 projects funded by SUGI.

Website: https://jpi-urbaneurope.eu/calls/ensuf-call/

8.26 EIP-SCC - SMART CITIES AND COMMUNITIES

ABOUT

The European Innovation Partnership on Smart Cities and Communities (EIP-SCC) is a major market changing undertaking supported by the European Commission bringing together cities, industries, SMEs, investors, researchers and other smart city actors.
The EIP-SCC Marketplace plays a distinctive and new role compared to other European Commission platforms. Engaging cities, industry and financiers in interest matching activities, leading to project design and delivery shall be the Marketplace's team objective. Building solutions and facilitation are the two main tasks of the Marketplace to help deliver investments.

EIP - SCC is involved in the following segments of the RD&I value chain:

R&I value chain	Actions
DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF R&I TOPICS	• Roadmap to deliver business cases and scale them up.
FINANCING / IMPLEMENTATION OF R&I STRATEGY	• Stimulating investments to unlock market potential.
ANALYSIS OF THE IMPLEMENTATION	• A set of KPIs is proposed to select projects fitting with the Market Place's purposes, measuring their contribution to achieve them and monitor their progress.
PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES	
REGULATORY INNOVATIONS	• Bridging the gap between EIP-SCC's members and policy makers.
DISSEMINATION AND KNOWLEDGE SHARING ACTIVITIES	• Facilitate partnership creation between a variety of actors. • Play the role of a network of networks, establishing connections with all the other EU initiatives fostering investments in a Smart City environment.

COMPOSITION/GOVERNANCE

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STRUCTURE

The EIP-SCC Marketplace is run by a consortium consisting of PwC, Connectivity Alliance, MCI and UrbanDNA. It has a Leadership Team and a Secretariat.
Beyond this, there are six Action Clusters. An Action Cluster is an assembly of partners committing to work on specific issues related to smart cities, by sharing the knowledge and expertise with their peers, giving added-value to their national and local experience and identifying gaps that need to be fulfilled at European level. These Action Clusters are:

- **Citizen Focus:** Believing too little attention is given to citizens, this Action Cluster strongly sees citizens as fundamental actors for the regeneration and development of smart cities.
- **Business Models, Finance and Procurement:** This Action Cluster is a platform where stakeholders work together to establish a dialogue, identify and remove the obstacles for the development of a smart cities market.
- **Integrated Infrastructures and Processes:** Aims to facilitate means to combat the significant and as yet insufficiently tapped value which is offered by integrating the various existing and new infrastructure networks within and across cities.

- **Integrated Planning, Policy and Regulations:** Focuses on Innovative forms of smart city policies and regulations that are needed to enable large scale implementation and roll-out of smart cities.
- **Sustainable Districts and Built Environment:** Aims to reduce energy use, environmental impact and carbon footprint, entail competitive industries for jobs and growth and at the same time ensure societal and social development and the well-being of citizens.
- **Sustainable Urban Mobility:** It brings together cities and regions with companies to show-case innovative mobility solutions and support their replication at scale in key market segments.

SUPPORTING TEAM/PROJECTS

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KEY DELIVERABLES AND OUTPUTS

The Roadmap for the Market Place of the EIP-SCC: The EIP SCC Market Place aspires to be the place where demand can meet supply for city solutions. It will bring together municipal actors and their demand, physically and virtually, with supply from investors, technology providers and financiers, who can meet each other and lay the foundation for actual investments in on the ground solutions.

Website: https://eu-smartcities.eu

8.27 EERA SG - SMART GRIDS

ABOUT

The Joint Programme on Smart Grids was officially launched at the SET-Plan Conference in Madrid (3-4 June 2010). The JP, coordinated by RSE and ENEA from Italy by means of an extended cross-disciplinary cooperation involving many Research and Development (R&D) participants with different and complementary expertise and facilities, aims at addressing in a medium- to long-term research perspective, one of the most critical areas directly relating to the effective acceleration of smart grid development and deployment. On December 2013, the JP programme successfully launched ELECTRA the EC funded (FP7) Integrated Research Programme on Smart Grids technologies.

EERA SMART GRIDS JP is involved in the following segments of the RD&I value chain:

R&I value chain	Actions
DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF R&I TOPICS	• An important goal of the JP SG is to speed up the realization of SET-plan goals by building the programme on SET-plan initiatives and aiming at fulfilling the challenges of the European energy policy: competitiveness, sustainability and security of supply. The Strategic Research Agenda forms the starting point for the discussion on priority areas. • The programme is addressed in medium to long term research perspective and shares the SET-Plan's objective of rearrangement the European energy system in order to foster the reduction of the electricity costs and the increasing of the quality and reliability of supply.
FINANCING / IMPLEMENTATION OF R&I STRATEGY	• National funding agencies are the main sponsors of the research carried out by the participants of the JP. • The funding of the JP research can be through dedicated strategic research programmes or via more general programmes.
ANALYSIS OF THE IMPLEMENTATION	• A strategic leadership in the field of smart grids is achieved through the detailed analysis of research activity results from past and ongoing RD&I national and international projects and gathered information and experiences from demonstration and deployment of smart grids solutions in Europe.
PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES	
REGULATORY INNOVATIONS	• The Programme intends to establish a structured dialogue with government bodies (ministries, funding agencies, and other public research organizations) to communicate findings, activities and future research needs. • EERA SG supports regulators in order to promote a regulatory framework that encourages fair market access and efficient coordination among the different market players.

DISSEMINATION AND KNOWLEDGE SHARING ACTIVITIES	• Mapping and governance of research activities are supported by the exchange of information in workshops, the coordination of the research efforts towards common aims and the design and development of new concepts, control algorithms, and technologies, simulations as well as experimental validations by standard procedures, protocols, and methodologies. • Advising policy makers through expert workshops and other channels (e.g., road mapping exercises).

COMPOSITION/GOVERNANCE

20 full participants, 20 associate participants, from 17 European countries.

STRUCTURE

The JP SG is constituted by five Sub-Programmes (SP), aiming to cover the different aspects of the smart grid field and has also been thought to be in correlation with the ETIP-SNET (www.etip-snet.eu) working groups activity:

- **SP1 – Technologies and tools for management of future power systems**: System simulation and analysis and novel grid control architectures for Smart Grids. In particular the "Web-of-Cells" (WoC) control concept was developed for more distributed control to take advantage of local capability. Control room scenarios based on WoC use cases have been defined and some of them implemented and tested in labs. Technical and economic scenarios have been considered for the active distribution network development, taking into account the most important smart grids features.
- **SP2 – Storage integration:** The SP2 deals with the integration of storage resources and the ancillary services, definition of appropriate data models, as well as economic, market and regulatory issues. An important part is dedicated to the flexibility potential and control requirements of storages and to evaluate how to role the storage for minimizing the disturbances during real-time operation. The control strategies for single or multiple storage systems is highly important in the web of cells implementation scenario
- **SP3 – Distribution Network Flexible operation:** The SP3 focuses on the study of the state-of-the-art of the weather prediction models to extract information about their performance and uncertainty/reliability and to analyse different post-processing algorithms for generations, loads and markets, depending on forecast horizon and geographical localization and size. It also aims to investigate the potential with respect to a WoC-based cooperating systems, in which updated predictions, real-time measurements and a continuous and free exchange of information between cells are guaranteed. A study on how to implement Demand Response as a strong constituent for the balance of energy mix, is also part of the SP3.
- **SP4 - Prosumer activation and engagement through digitalization and ICT**: The SP4 focuses on agreement and development of functions for future real-time voltage and balance control in the related decentralized Web-of-Cells concept. The SP will go on the evaluation and lab-scale validation of voltage and balance control functions carried out in the IRP ELECTRA. It is important to highlight the development of customer engagement concepts and platforms for Smart Grids. It is worth to mention the development of the ELECTRA Assessment Tool for Smart Grid Interface Standards (EAT-SGIS). This tool helps face interoperability barriers
- **SP5 - Flexible transmission network:** The SP5 deals with the modernization of the network. New technologies and materials will be needed as well as the study of new grid architectures, like the WoC, both at transmission and distribution level as a source of flexibility. Reliability and resilience are required to improve defense and restoration plans.

SUPPORTING TEAM/PROJECTS

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KEY DELIVERABLES AND OUTPUTS

- Revision of the scope for the SP and CAs, including interaction with other SPs, based on input received from other active participants
- Smart Asset Management
- Enhanced Ancillary Services
- Webinar (-s) on advanced methods for operation of Transmission Networks (results from R&D projects and similar)
- Market models for new Smart Grids architectures

Website: https://www.eera-set.eu/eera-joint-programmes-jps/list-of-jps/smart-grids/

8.28 EERA E3S - ECONOMIC, ENVIRONMENTAL AND SOCIAL IMPACTS

EERA European Energy Research Alliance

ABOUT

Europe has adopted ambitious energy and climate policy objectives to achieve a low carbon or even carbon neutral society by 2050. The changes in energy policy reflect a re-orientation away from specific technological solutions and markets towards 'system' transformation. This reorientation recognises that technological solutions alone are likely to be insufficient to address the 'grand challenges' in energy and that enhanced policy advice is necessary to understand the complex interaction of a variety of socio-technical elements, such as consumer behaviour and acceptance, markets and technologies. The Joint Programme (JP) on the Economic, Environmental and Social Impacts of Energy Policies and Technologies ("e3s") addresses specifically these issues.

EERA e3s is involved in the following segments of the RD&I value chain:

R&I value chain	Actions
DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF R&I TOPICS	• Exchange of knowledge of policy impact assessments of the EU2030 Climate and Energy Package across EU member states. The objective of the initiative is to learn from each other and thereby improve the analysis methodologies, databases, etc. It is also important to understand what the major critical questions are on a national level, how national policies differ from each other, and what kind of new opportunities the EU 2030 policy framework could create. • Scoping workshops are organized with all partners on different aspects of the energy transition, taking into account the socio-economical dimension. • Analysis and the discussion on 2050 Pathways to reach resilient and carbon neutral societies. Holistic perspectives from Global Policy, to Industry and consumers. Impacts of transition to on all the dimensions of sustainability, including environment, economy and security.
FINANCING / IMPLEMENTATION OF R&I STRATEGY	• Each partner contributes to the Joint Programmewith an annual fee. In addition, the relevant partners organise and take part in the internal workshop(s) and in institutional events with own resources.
ANALYSIS OF THE IMPLEMENTATION	• Several initiatives (workshops) were organised in the last three years. • The partners vote annually the most important H2020 calls for the coming period and each e3s partner is able to send EoIs for the selected calls. Several H2020 projects have received funding, which are prepared and run by e3s partners. • Steering Group meetings are organised twice a year.
PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES	• JP e3s has been represented in the Set-Plan Action 3.1, which also focus on standardisation. However, e3s has mainly focused on formulation of a list of KPIs to monitor consumer readiness level.
REGULATORY INNOVATIONS	

DISSEMINATION AND KNOWLEDGE SHARING ACTIVITIES	• Expert workshops on national energy and climate policy impact assessments in 2016 and 2019 (forthcoming). • Several thematic workshops ("Social Science and Humanities' contribution to the energy transition", "Challenges of the Energy Transition and Idea Creation", "Energy Islands", etc.) • Participation at international conferences and events. • Peer review articles. • Policy briefs (forthcoming).

COMPOSITION/GOVERNANCE

In e3s, like any other EERA Joint Programme (JP), research organisations join other institutions in several European countries to work on shared priority setting and research projects, namely the Economic, Environmental and Social Impacts of Energy Policies and Technologies. Presently, E3S is composed of 34 institutions from 15 different European countries.

STRUCTURE

The JP is organised in five subprogrammes:

- **SP1: Public perception and engagement:** The aim of this sub-programme is to provide a comprehensive and nuanced understanding of public involvement with environmentally friendly energy, including new renewable energy and carbon sequestration and storage. The objective is to suggest effective strategies of dialogue, brokering and collaboration between policy makers, industrial stakeholders and the public.
- **SP2: Market design for energy transition**: : This SP assesses the policies implemented in the EU and its Member States for a transition towards a low carbon economy. We will study how these policies were decided, how they relate to a vision on the energy system and how they are translated into policy instruments. This ex-post assessment will lead to a better understanding of how energy technologies can be diffused more efficiently and effectively in future.
- **SP3: Life Cycle Approach for evaluating the sustainability performance of energy technologies**: The objective of this sub-programme is to further develop and harmonize indicators and methodologies used to evaluate environmental, social and economic impacts of energy technologies, and to provide robust information for the design and implementation of a sustainable energy supply chain, including assessment of critical raw materials.
- **SP4: Energy models for a system assessment of European low-carbon energy futures: markets, environmental and economic impacts:** the SP will improve and develop knowledge and tools to assess the impacts of energy technologies in their systemic context and to implement decarbonisation policies in Europe. The analysis will consider the long-term sustainability in terms of energy, environment and economics, but will be extended to include social and spatial aspects. The approach is pragmatic, seeking to link energy system models with more detailed sectoral and/or environmental and macro-economic models.
- **SP5: Sustainable low-carbon platform:** The sustainable low carbon platform aims at building a transition management framework and an interactive meeting place, which creates and analyses sustainable pathways to low carbon economies and successful green growth strategies for the EU, the Member States and on international level. The platform integrates knowledge derived from other sub-programmes as well as other EERA Joint Programmes.

SUPPORTING TEAM/PROJECTS

The JP is coordinated by Tecnalia (ES) and the SP are led by coordinators from five different institutions and countries.

KEY DELIVERABLES AND OUTPUTS

- Policy Impact Assessment of the EU 2030 Climate & Energy Package: an initiative to enable exchange of policy impact assessments of the EU2030 Climate and Energy Package across EU

member states. The Initiative was led by Maria Rosa Virdis (ENEA – IT) and Tiina Koljonen (VTT – FI). (https://www.eera-set.eu/eera-joint-programmes-jps/economic-environmental-and-social-impacts-jp-e3s/e3s-workshop-assement/).

- Slides and reports of the several workshop organised by the JP are available at https://www.eera-set.eu/category/news-jp-economic-environmental-social-impact/?y=2018.

Website: https://www.eera-set.eu/eera-joint-programmes-jps/economic-environmental-and-social-impacts-jp-e3s/

8.29 EERA ES - ENERGY STORAGE

ABOUT

The JP on Energy Storage strongly fosters the efficient development of new energy storage technologies. It supports the SET-Plan objectives and priorities by "pooling and integrating activities and resources including international partners" on all levels of the value chain. From the collaborations within the JP ES and with other joint programmes, synergies result and a long term, durable integration of European research capacities in energy storage are achieved. Strong links to industrial partners support the transfer of research outcomes to innovation and products in order to establish a strategic European leadership in energy storage.

EERA Energy Storage is involved in the following segments of the RD&I value chain:

R&I value chain	Actions
DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF R&I TOPICS	• Provide recommendations for research, development and demonstration actions on energy storage for the Horizon 2020 and post-Horizon 2020 research frameworks, in line with the European Energy Union goals. • Set up milestones for the development of energy storage technologies over the coming 10-20 year period. • Identify critical needs for each energy storage technology and/or technology gaps that must be filled to meet technology performance and cost targets.
FINANCING / IMPLEMENTATION OF R&I STRATEGY	
ANALYSIS OF THE IMPLEMENTATION	• Identify ways to leverage R&D investments through coordination of research activities.
PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES	
REGULATORY INNOVATIONS	• Advise policy makers by identifying regulatory hurdles and market failures hampering the business case for energy storage.
DISSEMINATION AND KNOWLEDGE SHARING ACTIVITIES	• Results will be disseminated in joint reports and joint workshops (also together with industry)

COMPOSITION/GOVERNANCE

EERA Energy Storage is composed by 33 participants from 15 EC member states.

STRUCTURE

The JP on Energy Storage is structured in six sub-programmes:

- SP1 Electrochemical Energy Storage: Batteries, Supercapacitors
- SP2 Chemical Energy Storage: N and C based fuels
- SP3 Thermal Energy Storage: Sensible Heat Storage, Latent Heat Storage, Thermochemical Heat Storage
- SP4 Mechanical Energy Storage: Flywheels, Liquid Air Energy Storage, Compressed Air Energy Storage, Pumped Hydro Storage
- SP5 Superconducting Magnetic Energy Storage
- SP6 Energy Storage Techno-Economics

SUPPORTING TEAM/PROJECTS

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KEY DELIVERABLES AND OUTPUTS

- EASE/EERA Energy Storage Technology Development Roadmap: The roadmap provides a comprehensive overview of the energy storage technologies developed in Europe and identifies the RD&D needs in the coming decades. On this basis, the roadmap provides recommendations for R&D policies and regulatory changes needed to support the development and large-scale deployment of energy storage technologies. The aim is to inform policymakers on research, innovation and demonstration to further strengthen Europe's research and industrial competitiveness in the energy storage sector.

- Study on Energy Storage to speed up the Energy transition: The overall purpose of the study is to increase understanding on how a technology-driven mission, in this case energy storage, can be designed and how such a mission in the field of energy storage could look like. The methodology used in this study combines literature research with expert knowledge and expert interviews. The study summarizes present EU policy on energy storage, gives examples of missions from various companies and institutions and presents key findings of recent roadmaps on energy storage. Together with expert interviews on mission-oriented R&I this information serves as a background to propose two missions on energy storage. Firstly, a so-called transformer mission is proposed as "Develop an interconnected, carbon-neutral and reliable Pan-European Energy System by 2030". This mission transforms the whole energy system in Europe, while the second proposal accelerates the technical development of Post-Li-Ion batteries. This so-called accelerator mission is proposed as "Develop more powerful and clean European Post-Li-Ion batteries for electro mobility available on the market by 2030". Finally, an evaluation and monitoring scheme for both missions is developed.

Website: https://www.eera-set.eu/eera-joint-programmes-jps/list-of-jps/energy-storage/

8.30 EERA ESI - ENERGY SYSTEMS INTEGRATION

EERA
European Energy Research Alliance

ABOUT

This Joint Programme in Energy Systems Integration seeks to bring together research strengths across Europe to optimize our energy system, in particular by benefiting from the synergies between heating, cooling, electricity, renewable energy and fuel pathways at all scales. The energy elements of the water and transport system are also included as is the enabling data and control network that enables the optimization.
The Joint Programme in Energy Systems Integration is designed to develop the technical and economic framework that government and industries will need to build the future efficient and sustainable European energy system. It is fully aligned with the recently published SET-Plan Integrated Roadmap and potential impact include increased reliability and performance, minimisation of cost and environmental impacts and, in particular, increased penetration of renewable energy sources.

EERA Energy Systems Integration is involved in the following segments of the RD&I value chain:

R&I value chain	Actions
DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF R&I TOPICS	• Provide recommendations for research, development and demonstration actions on the integration of different energy systems and post-Horizon 2020 research frameworks to build the future efficient and sustainable European energy system.
FINANCING / IMPLEMENTATION OF R&I STRATEGY	
ANALYSIS OF THE IMPLEMENTATION	
PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES	• Provide insights on how the optimisation of the EU energy system can help the transition towards a low-carbon system.
REGULATORY INNOVATIONS	• The Programme intends to establish a structured dialogue with government bodies (ministries, funding agencies, and other public research organizations) to communicate findings, activities and future research needs. • EERA Energy Systems Integration supports regulators in order to promote a regulatory framework that encourages fair market access and efficient coordination among the different market players.
DISSEMINATION AND KNOWLEDGE SHARING ACTIVITIES	• Results will be disseminated in joint reports and joint workshops.

COMPOSITION/GOVERNANCE

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STRUCTURE

The Joint Programme is organised in 5 Sub-Programmes (SP) that target different aspects of Energy Systems Integration. Given the nature of Energy Systems Integration, the SPs are strongly interlinked.

- **SP1: Modelling**: To improve understanding of modelling of the interactions between energy sectors at different temporal and geographical scales.

  - Establish fundamental approaches for modelling of integrated energy systems and asses the value of flexibility through the interaction between different energy sectors, infrastructures and emerging technologies;
  - Provide insights on the role of system optimisation to help the transition towards a low-carbon system, by identifying the potential synergies and trade-offs between the evolution of the various components of the system, i.e. its energy carriers (fuel pathways at all scales), technologies (at each step of the value chain), institutions (e.g. the various electricity markets, the gas market);
  - Enhance the understanding of resilience when considering the whole energy system (including links with water and weather), and propose modelling approaches to quantify and enhance future energy systems' resilience;
  - Develop approaches to modelling of local and regional/country level energy systems as well as their interactions and dependences;
  - Providing better tools for analysing issues raised in other EERA JPs
- **SP2: Forecasting, aggregation & control**: To devise appropriate aggregation, forecasting and control paradigms across all levels and the whole geographical extent of the energy system, that will help operate the integrated energy system in an optimal manner, and perform capital planning efficiently.
  - Meteorology for integrated energy systems: develop the necessary customisations of and improvements to meteorological (MET) model and study the conversion of meteorological predictions into directly energy-relevant forecasts, i.e. wind/solar power and demand forecasts;
  - Forecasting: develop methodologies for forecasting in an ESI context with a focus on both probabilistic and multivariate aspects;
  - Aggregation: principles and methods for aggregation (statistical and physical methods) to understand better the link between level of aggregation and the relationship between uncertainty in the individual elements and uncertainty in the aggregated whole; study methods and standards for communication between different elements and levels of the integrated energy system, and will include studies related to physical and commercial aspects of communication systems;
  - Control and optimization: formulate controllers which can be used across a number of technology areas to permit multivariate control based on multivariate forecasting, considering methods for decision support, the relationship between optimisation problems and real time control problems in a hierarchical setting
- **SP3: Technology**: identifying existing gaps as well as specifying the characteristics of important/crucial energy harvesting, conversion and storage technologies relevant and desirable for effective system integration purposes, appreciating that active consumer involvement will be enabled by a multitude of communication technologies. The points addressed are the following:
  - Existing and already deployed technologies must be screened and their characteristics specified, especially those that may hamper or assist system integration.
  - Given the operation of the overall system, what are the characteristics that new technologies should possess for not causing difficulties to system integration?
  - What are possible new technologies one might suggest that have ideal characteristics to smoothen or resolve issues (i.e., that offer real opportunities) concerning system integration.
- **SP4: Consumer**: understand factors promoting active consumer engagement in integrated energy systems, the acceptability of integrated energy solutions, which both are pivotal to enhance the stability, efficiency and sustainability of these systems and the definition of customer-oriented services.
  - Acceptability and understanding consumer behaviour of integrated energy solutions: identify general antecedents that affect a wide range of integrated energy technologies,

such as environmental values and privacy concerns. Identification of key technology characteristics (e.g. level of automation, environmental impact) that affect acceptability, and examine how they interact with individual characteristics in predicting acceptability judgements
    - Practices regarding customer point of access: capture and elicit the state of the art and perspectives from the different communities regarding the way and the solutions customers can use, identification of barriers, challenges, opportunities and development needs;
    - Customer point of access modelling: The aims are to model services and information for different purposes and time scales (energy performance analysis, simulation of responses and scenarios, planning and analysis of investments in the energy system, planning how to develop and use energy market portfolios, forecasting and optimisation of loads and their control responses, verification and settlement of the responses in prosumer consumption and generation, etc.)
    - New concepts and architecture: assess and define the requirements and key characteristics of Customer Point of access (PoA).
- **SP5: Finance & regulation**: development and evaluation of a market design and policy framework which incentivizes optimized system operation with specific emphasis on energy systems integration and investigating new business models that are suited to this new context. Determine a robust policy mix and market design, i.e., effective in the short term (i.e., one that achieves a resource-efficient operation of the integrated energy system) and sustainable in the long term (in the sense that it will achieve the long-term policy goals without requiring fundamental adjustments).

KEY DELIVERABLES AND OUTPUTS

Description of Work for the Joint Programme on Energy System Integration (ESI): Lays out the scope and organisation of the initiative.

Website: https://www.eera-set.eu/eera-joint-programmes-jps/list-of-jps/energy-systems-integration-2/

8.31 EERA SC - SMART CITIES

ABOUT

Within the Joint Programme on Smart Cities, the highly complex structure of a future smart energy system should be investigated on an urban level by applying innovative solutions in an interdisciplinary manner based on a clear long-term research strategy. The fundamental research motivation is reflected in the strong need for a new approach for the planning, design, operation and optimization of urban energy systems on the basis of renewable energy sources, which can only be achieved by the development of radically new scientific methodologies.
In this context, the interfaces between energy grids, buildings and supply technologies play a crucial role, which cannot be captured yet by current scientific techniques. Among many others, innovative information and communication technologies are important instruments of the research team in order to tackle the current barriers in combination with advanced experimental testing facilities and sophisticated simulation frameworks as to be developed by the involved research partners.

EERA Smart Cities Integration is involved in the following segments of the RD&I value chain:

R&I value chain	Actions
DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF R&I TOPICS	• Organisations involved in research and technology development must anticipate trends at an early stage in order to be able to develop future-proof solutions. The clear long-term research strategy of the Joint Programme is designed to guarantee the future leadership of European R&D in urban energy technologies and will enable European cities to act as role models for others to emulate.
FINANCING / IMPLEMENTATION OF R&I STRATEGY	
ANALYSIS OF THE IMPLEMENTATION	
PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES	• The research partners involved in the Joint Programme will develop essential new scientific methodologies for the integration of energy and urban planning.
REGULATORY INNOVATIONS	
DISSEMINATION AND KNOWLEDGE SHARING ACTIVITIES	• Many European countries have initiated research activities to make their cities more sustainable and energy-efficient and have gained valuable expertise in this field. The Joint Programme will leverage this knowledge by facilitating the use of common research infrastructure, intensifying exchange between high-level research players and by coordinating research activities and strategies at a European level.

COMPOSITION/GOVERNANCE

The Management Board consists of the EERA Smart Cities Integration's Coordinator and the coordinators of the four sub-programmes. It is responsible for overall management and communication with the EERA and other relevant stakeholders and for steering and monitoring research progress.

STRUCTURE

The four sub-programmes are:

- **SP1 Energy in cities**: The main objective of the sub-programme Energy in Cities is the development of scientific but yet customer-oriented tools that support the transition process

towards a CO2 neutral energy system of an entire urban area. The transition process consists of several elements: global system analysis, envisioning, exploring pathways, experimenting, assessing and translating. For each of these components relevant support tools will be developed. More in particular:

- The development of examples of visions for smart cities that can be used as a basis for tailor made solutions and roadmaps for each individual city.
- The design of integrated database structures that can allow cities to plan a smart city and then monitor the performance of the city during and after the transition process on the basis of well-defined Key Performance Indicators (KPI´s). Proposing output interfaces to these databases (e.g. GIS layers) to assist in the choice of the measures that will form the energy concept is of crucial importance in this context.
- The development of new simulations tools (static and/or dynamic) that, once an energy concept has been chosen, will help produce a more detailed design of those measures and their implementation (sizing of technical components, business models) in particular in the case of pilot projects.
- The set-up of a template for the implementation of the living lab concept into practice.

- **SP2 Urban energy networks**: the general objective of this sub-programme is to develop the approaches, methodologies, technologies and pilot cases in order to optimize energy metabolism of cities toward low impact urban districts integrating all accessible sources of renewable energy and providing flexible balancing potentials, by means of an energy conscious operation & management fed by data networks spread at urban level. The research activities will mainly focus on three main tasks:
  - Smart Energy Districts: it aims at developing suitable models for optimal management of low impact "Smart Energy Districts" (a settlement of different utilities such as private and public residential buildings, private and public office buildings, schools, hospitals, shopping centres, organized as a single user); solutions for a smart coupling of energy (both electrical and thermal) production, storage and consumption will be investigated and developed; mobility at district level will be also analysed in terms of energy consumption patterns.
  - Urban network integration: it aims at studying and developing opportunities related to the implementation of data acquisition systems at urban level (multi-information sensors networks), connected to data transmission, storage, elaboration and analysis; this structure will be synthesized through an integrated ICT multifunctional platform for network integration; this platform will feed an integrated management system to optimize the balance between energy offer and demand, taking also into account end user expectations and behaviour.
  - Human factors: the citizen-city interaction: it aims at deepening the knowledge about human factors influencing energy uses and at: developing "human oriented technologies" based on citizen needs and expectation for the improvement the quality of life oriented to low energy impacts.
- **SP3 Energy-efficient interactive buildings**: aims to analyse the role and added value of energy-efficient interactive buildings for Smart Cities, and develop a knowledge platform for Key Performance Indicators, methods, solutions and cases that contribute to their large-scale penetration. Five work packages have been defined to contribute towards achieving these goals:
  - Optimised Building Design: Optimising interactivity with real-time energy demands, climate, people, cultural heritage and urban networks to procure locally-adapted, high-quality energy-efficient buildings
  - Envelope solutions: Developing and validating materials and technologies that can provide the optimal interface between buildings and their surrounding site and climate

  - Energy management and grid interactions: Developing and validating the energy interface between buildings and urban infrastructure, to ensure optimal energy efficiency in a larger societal perspective
  - User Interaction: Understanding energy consumption patterns in buildings
  - Support Strategies: Close co-operation with industry, public government, media and users to help identify and improve critical success factors in business models, education and policy, which can create a multiplier effect with in the broader stakeholder community and contribute to a green European economy
- **SP4 Urban city -related supply technologies**: The overall aim of the SP is to create an integrated analytic framework that identifies tailored pathways to smart, sustainable cities from the perspective of energy supply technologies and associated sub-systems. The main objectives of this sub-programme are:
  - Within the context of the 'energy performance gap', evaluate the fitness-for purpose of current sub-system models, and where appropriate develop improved approaches.
  - Given the needs of key end users, create an integrated adaptive 'whole system' approach that is capable of incorporating holistic factors (both technical and non-technical) related to supply sub-systems, and is interoperable with approaches taken in other SPs/JPs.
  - Develop the 'state-of-the-art' in terms of system performance measurement, testing, QA/risk management, benchmarking and control within the context of existing and emerging EU standards.
  - Test and validate the new framework by application to large-scale case studies in conjunction with other SPs/JPs

SUPPORTING TEAM/PROJECTS

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KEY DELIVERABLES AND OUTPUTS

Description of Work for the Joint Programme on Smart Cities: Lays out the scope and organisation of the initiative.
Description of Work for the Sub-programme 1: Lays out the scope and organisation for Energy in cities.
Description of Work for the Sub-programme 2: Lays out the scope and organisation for Urban Energy Networks.
Description of Work for the Sub-programme 3: Lays out the scope and organisation for Energy-efficient Interactive Buildings.
Description of Work for the Sub-programme 4: Lays out the scope and organisation for Urban City-related Supply Technologies.

Website: https://www.eera-set.eu/eera-joint-programmes-jps/list-of-jps/smart-cities/

8.32 PPP 5G

5G PPP
The 5G Infrastructure Public Private Partnership

ABOUT

The 5G PPP brings together a broad range of stakeholders from the communications technology sector and from its extended value chain including the user industries or actors from the microelectronics and IT sectors. Together they have created a shared vision for the next generation of communications infrastructure beyond 2020, a multiannual strategic roadmap for research & innovation which will be updated yearly until 2020. Its objectives include actions for leveraging 5G research to improve competitiveness and innovation with the ultimate aim of stimulating economic growth and more job creation in other industrial sectors.
The 5G PPP brings a long-term commitment from both the private and the public actors to invest in achieving these objectives. The PPP plays a key role in formulating the research and innovation priorities to be supported in Horizon 2020.

PPP 5G is involved in the following segments of the RD&I value chain:

R&I value chain	Actions
DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF R&I TOPICS	• Shared vision for the next generation of communications infrastructure beyond 2020, • Multiannual strategic roadmap for research & innovation to be updated yearly until 2020: its objectives include actions for leveraging 5G research to improve competitiveness and innovation with the ultimate aim of stimulating economic growth and more job creation in other industrial sectors.
FINANCING / IMPLEMENTATION OF R&I STRATEGY	• Large technological and business validation trials, which take into account all barriers and issues, including regulatory ones and those related to security of critical communications infrastructures.
ANALYSIS OF THE IMPLEMENTATION	
PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES	• A competitive portfolio of technologies and solutions meeting the anticipated changes, based on global standards and generating a significant amount of intellectual property. It should also foster the new skills required to compete in the 21st century. • The introduction of innovative business models based on more powerful and open networks.
REGULATORY INNOVATIONS	• Large technological and business validation trials, which take into account all barriers and issues, including regulatory ones and those related to security of critical communications infrastructures.
DISSEMINATION AND KNOWLEDGE SHARING ACTIVITIES	• Present in several specialised events and workshops, updating those in the area about progresses in their different projects.

COMPOSITION/GOVERNANCE

In the 5G PPP, the 5G Infrastructure Association (5G IA) represents the private side and the European Commission the public side.
The Board of the 5G IA is composed by 11 members, elected from the membership, who, in turn, elect the Chair of the Association. Membership is open. The Board is supported by the 5G IA Office. The Secretary General is in charge of the overall visibility and management of the 5G IA and is the

spokesperson of the Association. The Head of Office ensures the operational well-functioning of the 5G IA.
The 5G IA is committed to the advancement of 5G in Europe and to building global consensus on 5G. To this aim, the Association brings together a global industry community of telecoms & digital actors, such as operators, manufacturers, research institutes, universities, verticals and SMEs. The 5G IA carries out a wide range of activities in strategic areas including standardization, frequency spectrum, R&D projects, technology skills, collaboration with key vertical industry sectors, notably for the development of trials, and international cooperation.

STRUCTURE

Within the 5G-PPP there are a number of cross-project work groups where the work of multiple projects can be converged into identifying the shared issues and developing supported programme level position on technical and strategic items.
The currently active work groups have their origins in both 5G-Infrastructure Association activities and from decisions on needs by the 5G-PPP projects themselves.

- Pre-Standardization WG
- Spectrum WG
- 5G Architecture WG
- Software Networks WG
- Network Management & QoS WG
- Vision and Societal Challenges WG
- Security WG
- SME WG
- Trials WG
- 5G Automotive WG
- IMT-2020 Evaluation Group

SUPPORTING TEAM/PROJECTS

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KEY DELIVERABLES AND OUTPUTS

- 5g Pan-European Trials Roadmap Version 2.0: This document addresses the high-level 5G Pan-European Trials Roadmap and the related actions towards implementation.
- European Annual Journal 2018: Europe is entering into a critical phase in the global race to 5G and so is the 5G PPP. In that respect, this third edition aims to present how 5G PPP Phase II master 5G technologies and look into their application with relevant users in particular vertical industries.

Website: https://5g-ppp.eu/

8.33 PPP BDVA - BIG DATA VALUE

ABOUT

Effectively combining in a consortium Large Enterprises, SMEs and Academia the Big Data Value eCosystem Project (BDVe) provides coordination and support for the current and future H2020 projects within the Big Data Value Public-Private Partnership.
BDVe directly interfaces with numerous stakeholders, both from inside and outside the PPP to foster a true vibrant community around Big Data in Europe and facilitating the common bodies to discover and exploit synergies at project management level, to jointly contribute to generate a complete Big Data Value Reference Model at technical level and multiply impact into the different targets at communication level.
To articulate these, BDVe is producing several outcomes in different categories:

- Big Data Landscape;
- Big Data Marketplace;
- People and Talent;
- Big Data Value Association.

Finally, BDVe is putting its marketing capabilities at the service of the whole Community to produce the European Big Data Value Forum, the Big Data flagship event of this and the coming years.

PPP BDV is involved in the following segments of the RD&I value chain:

R&I value chain	Actions
DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF R&I TOPICS	• Developing and implementing a strategic roadmap for research, technological development and innovation in the Big Data Value and other ICT domains. • Developing strategic goals of European Big Data Value research and innovation and supporting their implementation.
FINANCING / IMPLEMENTATION OF R&I STRATEGY	• Improving industrial competitiveness of Europe through innovative Big Data Value technologies, applications, services, solution.
ANALYSIS OF THE IMPLEMENTATION	• Strengthening competitiveness and ensuring industrial leadership of providers and end users of Big Data Value technology-based systems and services. • Promoting the widest and best uptake of Big Data Value technologies and services for professional and private use.
PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES	
REGULATORY INNOVATIONS	• Contributing to policy development, education and technology ramification in the widest possible sense and addressing ethical, legal and societal issues.
DISSEMINATION AND KNOWLEDGE SHARING ACTIVITIES	• Present in several specialised events and workshops, updating those in the area about progresses in their different projects. • Strengthening networking activities of the European Big Data Value community. • Networking and partnering with industrial and research partners in the European Data Value Chain,

	for setting-up collaborative research and innovation activities.

COMPOSITION/GOVERNANCE

In the PPP BDV, the General Assembly (GA) is confirmed by all the BDVA members (only Full members have voting rights). BDVA GA approves the general policy of the Association on the basis of proposals of the Board of Directors and gives recommendations to the Board of Directors for its application. The Board of Directors (BoD) is selected by the General Assembly (2-year mandate). The Board of Directors is in charge of reaching the objectives of the Association. It follows the resolutions, instructions and recommendations adopted by the General Assembly. The GA also elects the President, Vice President(s) and Treasurer. The Partnership Board (PB) is the monitoring body of the cPPP composed by a group of selected directors of the Board, and representatives of the European Commission. The Secretary General (SG) is responsible for the day-to-day administrative management of the Association with the support of the Deputy Secretary General and BDVA Secretariat.

STRUCTURE

Task Forces (TFs) are the main instrument to develop BDVA activities and are established to take care of specific matters within the 'Objectives' of the Association under the authority of the BoD. TFs may focus on sector-specific or cross- disciplinary issues related to BDV:

- TF1 Programme: Contributing to the H2020 Programme content of the BDV PPP
- TF2 Impact: Maintain the various KPIs defining the expected Impact of BDV PPP
- TF3 Community: Big data community engagement and participation
- TF4 Communication: Communication plan for creating awareness around the BDVA activities
- TF5 Policy and Societal: Bridge Big Data technology with legal, societal and policy matters
- TF6 Technical: Identifying and refining the technical challenges of the programme – e.g. Data Management
- TF7 Application: Domain usage group which can influence other task forces – e.g. Telecoms
- TF8 Business: Examining the business and economic influences and business areas such as Web Entrepreneurs and SMEs
- TF9 Skills and Education: What skills are needed for the next general of knowledge workers

SUPPORTING TEAM/PROJECTS

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KEY DELIVERABLES AND OUTPUTS

- European Big Data Value - Strategic Research and Innovation Agenda: This Strategic Research and Innovation Agenda (SRIA) defines the overall goals, main technical and non-technical priorities, and a research and innovation roadmap for the European Public Private Partnership (PPP) on Big Data Value.
- Big Data Value cPPP - Monitoring Report 2017

Website: http://www.bdva.eu/PPP

8.34 PPP CYBS - CYBERSECURITY

ABOUT

As part of the EU cybersecurity strategy, the European Commission and the European Cyber Security Organisation (ECSO) signed a cPPP on 5 July 2016. The aim of the partnership is to foster cooperation between public and private actors at early stages of the research and innovation process to allow people in Europe to access innovative and trustworthy European solutions in the fields of ICT products, services and software. These solutions take into consideration fundamental rights, such as the right for privacy. It also aims to stimulate cybersecurity industry, by helping align the demand and supply sectors to allow industry to elicit future requirements from end-users, as well as sectors that are important customers of cybersecurity solutions (e.g. energy, health, transport, finance).
The cPPP is instrumental in structuring and coordinating digital security industrial resources in Europe. It includes a wide range of actors, from innovative SMEs to producers of components and equipment, critical infrastructure operators and research institutes, brought together under the umbrella of ECSO.

PPP Cybersecurity is involved in the following segments of the RD&I value chain:

R&I value chain	Actions
DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF R&I TOPICS	• Propose a Strategic Research and Innovation Agenda (SRIA) and a Multiannual Roadmap with its regular updates. • Focusing on innovation and following a jointly-agreed strategic research and innovation roadmap.
FINANCING / IMPLEMENTATION OF R&I STRATEGY	• Leveraging funding from Horizon2020 and maximising the impact of available industry funds through better coordination and better focus on a few technical priorities.
ANALYSIS OF THE IMPLEMENTATION	• Foster competitiveness and growth of the cybersecurity industry in Europe (large companies and SME) as well as end users / operators through innovative cybersecurity technologies, applications, services, solutions.
PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES	
REGULATORY INNOVATIONS	• Bringing together industrial and public resources to improve Europe's industrial policy on cybersecurity.
DISSEMINATION AND KNOWLEDGE SHARING ACTIVITIES	• Present in several specialised events and workshops, updating those in the area about progresses in their different projects. • Providing visibility for European R&I excellence in cybersecurity and digital privacy.

COMPOSITION/GOVERNANCE

In the PPP Cybersecurity, the Partnership Board is the formal communication channel between the European Commission and the ECSO Association to discuss the Horizon 2020 Cybersecurity cPPP Work Programme, the implementation of the overall R&I programme related topics and the monitoring of the cPPP commitments (Key Progress Indicators). It allows for an open dialogue between the members to reach the objectives foreseen by the contractual arrangement between the European Commission and ECSO. It provides oversight such as monitoring, advising, community support etc. The Partnership Board is composed by representative from the European Commission and ECSO Members (with exclusion of representatives from public administrations).

STRUCTURE
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SUPPORTING TEAM/PROJECTS
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KEY DELIVERABLES AND OUTPUTS

- Strengthening Europe's Cyber Resilience System and Fostering a Competitive and Innovative Cybersecurity Industry:

Website: https://ec.europa.eu/digital-single-market/en/cybersecurity-industry

8.35 PPP EGVI - EUROPEAN GREEN VEHICLES INITIATIVE

EGVI European Green Vehicles Initiative

ABOUT

The European Green Vehicles Initiative is a contractual Public Private Partnership (cPPP) dedicated to delivering green vehicles and mobility system solutions of the future which match the major societal, environmental and economic challenges. Launched in 2013, as part of the "Smart, Green and Integrated Transport" challenge of Horizon 2020, as a follow-up of the previous Green Cars Initiative, EGVI brings together stakeholders from three different European Technology Platforms (ERTRAC, EPoSS and Smart Grids) gathered into the European Green Vehicles Initiative Association (EGVIA) and the involved European Commission services (DGs RTD, MOVE and Connect). EGVI is following a system approach to tackle the challenge of decarbonisation of road transport, and contribute to the transition to greener road transport, while boosting the innovative strength and competitiveness of the European economy.
EGVI cPPP is covering all types of vehicles, from passenger cars, trucks and buses to two-wheelers and new vehicles concepts. It focuses on the development and integration of technologies enabling the improvement of the energy efficiency of vehicles using alternative powertrains. EGVI is following an integrated approach to cover the entire process chain from resource application up to demonstration and creation of services, with the aim to extend research and development to innovation.

EGVI PPP is involved in the following segments of the RD&I value chain:

R&I value chain	Actions
DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF R&I TOPICS	• Developing and implementing a strategic roadmap for research, technological development and innovation which takes into account the roadmaps and Strategic Research Agendas from the three European Technology Platforms involved – ERTRAC, EPoSS, SmartGrids. • Calls recommendations are discussed with the European Commission services based on the cPPP multiannual roadmap and inputs from EGVIA members.
FINANCING / IMPLEMENTATION OF R&I STRATEGY	• Three rounds of biennial calls for proposals have been launched within EGVI in the period 2014-2020, with a total expected budget of € 750 million.
ANALYSIS OF THE IMPLEMENTATION	• PPP EGVI aims at accelerating research, development and demonstration of technologies allowing the efficient use of energy in road transport. • 52 projects have been funded from 2014 to 2017 (165 since 2009) coering various technological areas. Please refer to the project portfolio for detailed information: https://egvi.eu/wp-content/uploads/2018/09/egvia-project-portfolio-2018.pdf • Outlook of the achievements of the EGVI PPP: https://egvi.eu/mediaroom/egvi-project-monitoring-report-2017/
PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES	
REGULATORY INNOVATIONS	
DISSEMINATION AND KNOWLEDGE SHARING ACTIVITIES	• Present in several specialised and general events and workshops, updating those in the area about progresses in their different projects.

COMPOSITION/GOVERNANCE

The Partnership Board is the governing body of the EGVI cPPP. It is the main mechanism for dialogue between the public and the private side of the partnership. Within this body, both sides exchange on the recommendations and priorities to be included in the Work Programme EGVI.
EGVIA is represented via the Industry Delegation while the European Commission is involving different services active in the partnership (DG RTD, DG MOVE, DG Connect). All members active in the Partnership Board commit to provide advice in their relevant fields of expertise to the best of their ability and in the best interest of the EU research.
The Industry Delegation is composed of a maximum of 25 members elected by the General Assembly to represent the association in the Partnership Board of the European Green Vehicles Initiative cPPP. They are elected for a 2 years mandate, which can be renewed. The Industry Delegation is chaired by EGVIA Chairman (currently Stephan Neugebauer, also chairman of the technology Platform ERTRAC) and is reporting on its activities to the General Assembly on a regular basis.
Gathering all EGVIA members, the General Assembly is the supreme body of the Association. Its role is to approve the general policy on the basis of proposals from the Executive Board and give recommendations for its implementation. The General Assembly meets at least once a year.
The Executive Board is responsible legally for the Association. It defines the strategy of the association and is responsible in front of the General Assembly. It manages the work of the Association and its financial management, achieving its objectives, and its representation towards third parties.

STRUCTURE

The update of the Electrification roadmap for road transport, jointly drafted by the three supporting Technology Platforms has been updated in 2017 and includes the following aspects:

- Scenarios for Electrification in Road Transport
- Benefits, Challenges and Technology Potentials of Electrification
- Milestones:
  - Electrified passenger cars
  - Electrified L-Category Vehicles
  - Electrified commercial vehicles
  - Deployment of electrified passenger car
- Big Initiatives
  - “Operation system dependent EVs in the urban environment”
  - “User-friendly affordable EV passenger car + infrastructure”
  - “Non-compromise electric urban bus system”
  - “Sustainable electrified long-distance trucks and coaches”

Taking into account the user perspective (with a particular attention paid to the range, cost and charging procedure of vehicles) as a central pillar, the roadmap sets the scene, give clear objectives, and list the milestones that require funding or policy action at European level. The four big initiatives identified in the document should drive research and innovation in the upcoming years.
The 3rd edition of the document is extending the outlook until 2030, such that identified research recommendations can serve as an input for the strategic discussions about the next FP.

SUPPORT TEAM/PROJECTS

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KEY DELIVERABLES AND OUTPUTS

- EGVI cPPP Project Portfolio Calls 2014-2017: The 2018 edition of EGVI cPPP Project Portfolio captures the full list of projects launched in the framework of European Green Vehicles Initiative (2014 – 2017).
- European Roadmap Electrification of Road Transport, 3rd version, June 2017

Website: https://egvi.eu/

8.36 FCH JU FUEL CELLS AND HYDROGEN

ABOUT

The Fuel Cells and Hydrogen Joint Undertaking (FCH JU) is a unique public private partnership supporting research, technological development and demonstration (RTD) activities in fuel cell and hydrogen energy technologies in Europe. Its aim is to accelerate the market introduction of these technologies, realising their potential as an instrument in achieving a carbon-clean energy system.
Fuel cells, as an efficient conversion technology, and hydrogen, as a clean energy carrier, have a great potential to help fight carbon dioxide emissions, to reduce dependence on hydrocarbons and to contribute to economic growth. The objective of the FCH JU is to bring these benefits to Europeans through a concentrated effort from all sectors.
The three members of the FCH JU are the European Commission, fuel cell and hydrogen industries represented by Hydrogen Europe and the research community represented by Hydrogen Europe Research.

JU FCH is involved in the following segments of the RD&I value chain:

R&I value chain	Actions
DEFINITION OF R&D STRATEGY THROUGH IDENTIFICATION AND PRIORITIZATION OF R&I TOPICS	• The FCH 2 JU programme of research and innovation is structured around two research and innovation Pillars dedicated to Transportation and Energy Systems. Overarching projects integrating both transport and energy technologies and a cluster of Cross-cutting research activities complement these two Pillars.
FINANCING / IMPLEMENTATION OF R&I STRATEGY	• Cross-cutting research and development projects will support and enable the Transportation and Energy Pillars and facilitate the transition to market for FCH technologies. • With the aim of accelerating the market introduction and deployment of the technologies stemming from the projects FCH JU supports, funding/financial engineering activities have been integrated recently into the Programme Office.
ANALYSIS OF THE IMPLEMENTATION	
PRE-STANDARDISATION AND STANDARDISATION ACTIVITIES	
REGULATORY INNOVATIONS	
DISSEMINATION AND KNOWLEDGE SHARING ACTIVITIES	• Publication of annual Programme Review Reports as well as annual Stakeholder Forums to discuss the role of fuel cells and hydrogen in the energy and transport sectors and beyond.

COMPOSITION/GOVERNANCE

The Fuel Cells and Hydrogen Joint Undertaking is a public-private partnership with three members: the European Union, represented by the European Commission, the Industry Grouping "Hydrogen Europe" and the Research Grouping "Hydrogen Europe Research".
For coordinating the inputs of all the members and managing the activities, the Joint Undertaking's governance structure comprises two executive bodies:

- the Governing Board

- the Executive Director, assisted by the Programme Office

Three advisory bodies:

- The Scientific Committee
- The States Representatives Group
- The Stakeholder Forum

STRUCTURE

The FCH 2 JU programme of research and innovation is structured around two research and innovation Pillars dedicated to Transportation and Energy Systems. Overarching projects integrating both transport and energy technologies and a cluster of Cross-cutting research activities complement these two Pillars. The Transportation Pillar encompasses all aspects of hydrogen utilisation in transportation including FCEVs as well as non-road, train, maritime and aviation applications, in addition to the required Hydrogen Refuelling Station infrastructure for refuelling these vehicles and systems.
The Energy Pillar will support projects in four areas:

- Hydrogen production for energy storage and grid balancing from renewable electricity – including large 'green' hydrogen production, storage and re-electrification systems. The initial focus will be on the role hydrogen can play in the integration of renewable energy sources in the grid.
- Hydrogen production with a low carbon footprint from other resources – whereby different hydrogen pathways will be developed and if appropriate demonstrated.
- Fuel cell systems for CHP and Power only – covering the technical developments necessary to reduce costs, increase lifetime and improve performance.
- Hydrogen storage, handling and distribution – to allow storage of hydrogen at central production plant and distribution to the customer base.

SUPPORT TEAM/PROJECTS

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KEY DELIVERABLES AND OUTPUTS

- Fuel Cells and Hydrogen For Green Energy In European Cities And Regions: The new study provides a detailed insight into the FCH investment plans of the participating regions and cities and points out next steps to be taken for realising a European FCH roadmap with a view to commercialising the technology.
- Programme Review Report 2016: The Fuel Cell and Hydrogen 2 Joint Undertaking (FCH 2 JU) organised the sixth edition of its Programme Review Days (PRD). 100 projects allocated in 6 panels covering cross-cutting, energy and transport in research and demonstration activities have been the basis of the FCH JU's annual review of its research and innovation programme.

Website: https://www.fch.europa.eu/

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