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Towards an Integrated Strategic Energy Technology (SET) Plan: Accelerating the European Energy System Transformation

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1. THE INTEGRATED SET PLAN IN THE CONTEXT OF THE ENERGY UNION

The Energy Union[1] strategy adopted by the European Commission is built on the ambition to achieve in a cost-effective way a fundamental transformation of Europe's energy system. This will be achieved by moving to smarter, more flexible, more decentralised, more integrated, more sustainable, secure and competitive ways of delivering energy to consumers.

More than anything else, meeting this ambition will require that energy producers and suppliers innovate in terms of how they produce energy, how they transport it, how they deliver it to customers and what services they offer. The innovations to be developed in Europe as part of our energy transformation will place European consumers in the centre-stage and support the competitiveness of European industry. These innovations will also help meet the energy needs of other parts of the world – both creating a potentially very important export sector which can support jobs and growth, and facilitating technology transfer as part of the development agenda after the Paris Climate Change Conference.

1.1. Innovation as key to the Energy Union

Europe is well placed to deliver this innovation. The EU energy system is stable and well-managed. Market and technical expertise is considerable. The EU energy sector is highly innovative – Europe is a leader in many technologies and energy systems, and has the potential to be a testing ground for many more innovations. Specialisation at regional level shows major interest in the energy sector as a driver of innovation-led growth.

This is why research and innovation cuts across all elements of the Energy Union strategy. For example, the new electricity market design being developed[2] will allow innovative companies with new business models to emerge and compete on the market. Heating and cooling in homes and workplaces[3] as well as transport – both private and public - will benefit from innovation just as much as electricity markets. New technologies and innovation entering quickly into the market through new business models are key to achieve the transformation of EU energy system.

1.2. A vibrant innovation ecosystem

However, creating a vibrant innovation ecosystem goes beyond enabling market access. Public action, by supporting researchers and companies at key stages in the development of new products and processes, can enable them to realise their full potential. It can also allow challenges to be addressed in an integrated way, benefiting from synergies across different parts of the energy system. This is why in the Energy Union strategy Research and Innovation is explicitly linked with competitiveness and encompasses the transport sector, industry and the energy sector. The aim is to avoid working in silos. The

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1 COM(2015)080, A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy

2 As outlined in: COM(2015) 340 final, Communication on launching the public consultation process on a new energy market design

3 Share of final energy consumption: heating and cooling = 46%; transport = 33% and power =21%

Roadmap for the Energy Union[4] annexed to the Energy Union Communication establishes the Integrated Strategic Energy Technology Plan (SET Plan) and the Strategic Transport Research and Innovation Agenda as key actions to extend our technological frontier. These will be accompanied by the Global Technology and Innovation Leadership Initiative. These three strands will then be brought together to give new impetus to the Energy Union technology and innovation agenda.

1.3. Towards a new Integrated SET Plan

This Communication takes stock of the Strategic Energy Technology Plan and outlines areas for future consultation and work. Since 2007, the SET Plan has been at the forefront of European energy technology policy. In that time it has had success on several fronts. It has created a vibrant open innovation ecosystem which capitalises on the results of research. And it has contributed to open science by making many of its results accessible to all. While maintaining these building blocks of success, it now needs to be upgraded and adapted to the Energy Union's main objectives and core priorities.

The new integrated SET Plan must identify those strategic priorities and actions needed to accelerate this EU energy system transformation in a cost-effective way. It needs greater prioritisation, integration, coordination and ownership. It needs to better identify gaps, duplication and synergies at EU and national level. It also needs to take advantage of opportunities to blend the digital and physical worlds in the energy domain. At the same time, it has to be open to the world by addressing international cooperation for global challenges. To achieve the above, promoting new investments at all stages of the innovation chain is vital. This is why the financing and market-uptake measures must be well-linked and focussed on delivering the key actions, and thereby succeed at accelerating the implementation of an integrated SET Plan agenda.

2. STRENGTHS AND WEAKNESSES OF THE SET PLAN IN THE CONTEXT OF EU ENERGY RESEARCH AND INNOVATION PRIORITIES

The political priorities for research and innovation set out in the Energy Union strategy need to be translated into effective policy action. This means building synergies between European and national research and innovation programmes. It also requires assessment of where we stand in relation to:

– EU strengths and weaknesses in each of the Energy Union research and innovation priorities,

– the experience gained from the implementation of the SET Plan to date in these areas.

2.1. Assessment of the SET Plan

Since its inception the SET Plan[5] has helped direct EU, Member States and countries part of the SET Plan[6], industrial and research actors towards the development of key low-

[4] COM(2015) 80 final, Annex, Roadmap for the Energy Union

[5] http://ec.europa.eu/energy/en/topics/technology-and-innovation/strategic-energy-technology-plan

carbon energy technologies. It has contributed to reducing the cost of these technologies and facilitating large-scale deployment by structuring national and EU programmes around shared objectives which has triggered substantial investment. For example, annual total Research & Development (R&D) investment in the SET Plan priority technologies has more than doubled in the EU in the period 2007 to 2011, from EUR 2.8 billion to EUR 7.1 billion, with ⅔ coming from industry[7]. In addition, it has also addressed educational, training and socio-economic challenges.

The Commission regularly assesses research and innovation investments[8] and technology developments[9] to measure the impact of the work under the SET Plan.

In 2013 the Commission adopted a Communication on Energy Technologies and Innovation[10]. The Communication found that although Member States do share common industrial and research objectives, their commitment to the SET Plan is currently suboptimal. To leverage private sector investments we need to foster coordinated and joint investments between Member States and between Member States and the EU.

The public consultation conducted in support of the Energy Technologies and Innovation Communication indicated a widespread call for an energy system approach instead of a sectorial approach and for an integration of the activities along the innovation chain. Stakeholders supported the SET Plan structures as useful elements for knowledge sharing and long term programming of research and innovation but required stronger involvement from industry and Member States and a greater focus on the implementation of concrete actions.

The review of the SET Plan implementation system[11] assessed its appropriateness, effectiveness and impact. It concluded its value in prioritizing and planning of actions and driving energy research and innovation, but also indicated the need to:

– reinforce the implementation of actions beyond EU-funded projects,

– strengthen the financial commitment from Member States and the private sector,

– broaden the participation of stakeholders along the innovation chain in the various structures,

– improve the reporting from Member States on national research and innovation priorities and investments.

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6 Norway, Switzerland, Iceland and Turkey. Throughout this document, when referring to Member States in the framework of the SET Plan Steering Group, also these countries are meant.

7 JRC 2015 Capacity Mapping: R&D investment in SET-Plan technologies and JRC 2009 R&D Investment in the Priority Technologies of the European Strategic Energy Technology Plan

8 https://setis.ec.europa.eu/setis-output/capacity-mapping; JRC Industrial R&D Investment Scoreboard: http://iri.jrc.ec.europa.eu/scoreboard.html

9 Technology Maps for the various energy technologies (https://setis.ec.europa.eu/setis-output/technology-mapping)

10 COM(2013) 253 final

11 https://setis.ec.europa.eu/system/files/SET-Plan_%20Review%20of%20Implementation%202010-12.pdf

The subsequent work on the Integrated Roadmap, that assessed the European Energy research and innovation investment needs, leads to the conclusion that increased funding efforts and more cooperation between industry, research institutions and among Member States (based on a better overview of who does what) are needed to accelerate the energy system transformation.

Additional internal evaluations showed that the European Energy Research Alliance (EERA) and the European Industrial Initiatives (EII) are not delivering to the level required to move the SET Plan forward. The need to substantially reform this framework has already been discussed with Member States and stakeholders.

2.2. Strengths and weaknesses in the Energy Union research and innovation priorities

2.2.1. Renewable technologies at the heart of the new energy system

Driven by climate and energy targets, the share of renewable energy in the EU has increased from 8.5% in 2005 to 15.3% in 2014[12] (26% in electricity). This has enabled Europe to lead the global development and large-scale installation of renewable energy technologies. But this has not always translated into the creation of lasting jobs and profitable business activities.

Between 2010 and 2014, the cost of photovoltaic (PV) systems has fallen, globally, by 50% but EU PV cell production has decreased from 3GW in 2010 to below 1.3 GW in 2013. Similarly, while Europe leads in biotechnology and biomass conversion technologies[13] the overall share of bioenergy patents fell from 2000 to 2010, and industrial investments in Europe have been put on hold. Finally, European companies currently lead in resources specific technologies such as ocean and geothermal energy and concentrated solar power (CSP).

2.2.2. A smarter energy system, empowering the consumer

The Commission's vision for the electricity market design[14] aims to deliver a new deal for consumers[15], smart homes and network, data management and protection. Communities and individual citizens are eager to manage energy consumption and actively participate in the production of energy[16]. Increased use of information and

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12 Renewable energy progress report, COM(2015) 293 final

13 ICF International, Study on the competitiveness of the EU renewable energy industry (both products and services), 2014

14 COM(2015) 340 final, Communication on launching the public consultation process on a new energy market design

15 COM(2015) 339 final, Communication on delivering a new deal for energy consumers

16 "Changing the future of energy: civil society as a main player in renewable energy generation", EESC study on the role of civil society in the implementation of the EU Renewable Energy Directive, Jan 2015

communication technology for the management, amongst others, of large volumes of data will be required to optimise and manage in real time the flows of energy[17].

While meeting the challenge of integrating renewables, the European electricity grid continues to be world class with continuity of supply at 99.99%. Europe leads in patents of power components that contribute to network stability. However, Europe does not have an equivalent position when it comes to smart consumer services. This is a risk because the technology leaders set the standards for the digital transformation in the energy field.

Europe is pioneering ways to store excess electricity in other energy vectors – district heating, heat pumps (largely supplied by EU companies) and using the thermal inertia of buildings. Battery costs are dropping rapidly, however USA, Japan and Korea are currently leaders in this sector and they are expanding their manufacturing capacity.

2.2.3. Energy efficiency

Driven by a strong regulatory framework and by the uptake of innovative solutions, energy efficiency in the EU has improved by 15.5%[18]. Alongside lower future demand for energy in the heating and cooling sector[19], there will be a shift to increased demand for electricity due to household electrical appliances, and electrification in heating and transport[20].

Energy Efficiency has become a business opportunity, especially in construction[21]. European companies are developing promising solutions such as phase-change materials, dynamic glazing and adaptive facade systems, with a threefold increase of related patents over a decade[22]. Despite this progress, the uptake is still slow: only 1.4% of all buildings

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17 There are close to 45 million smart meters for electricity already installed in three Member States (Finland, Italy and Sweden), in line with the 200 million foreseen by 2020 (Source: Benchmarking smart metering deployment in the EU-27 with a focus on electricity, COM(2014) 356 final.)

18 Primary energy consumption of EU 28 in 2013 (Eurostat data) compared to the projected primary energy consumption in 2020 as defined in the Energy Efficiency Directive. For example, thanks to the ecodesign requirements and energy labelling legislation, appliances have become more and more energy efficient: washing machines have increased their efficiency by 32% from 1998 to 2010

19 As a result of the EPBD (2010/31/EU) requirements, future new single family houses in the south of Europe will typically require less than 15kWh/m²/y for heating, less than 10kW/m²/y for cooling, photovoltaic and solar thermal being present in 20% of the cases (Source: Ecofys, Towards nearly zero-energy buildings - Definition of common principles under the EPBD-)

20 While energy consumption in Europe has remained relatively stable since the 1990s, electricity consumption at the level of households in the EU-27 grew by 39.58% between 1990 and 2010 (Source: JRC Energy Efficiency Status Report)

21 COM(2014) 520 final, Communication on Energy Efficiency and its contribution to energy security and the 2030 Framework for climate and energy policy

22 EU patent office, Building the future: Four innovation trends that are shaping green construction: http://www.epo.org/news-issues/technology/sustainable-technologies/green-construction.html

are renovated each year, 64% of space heaters are still inefficient[23] and 44% of windows are still single glazed[24].

The EU is leading research in the area of heat pumps, condensing boilers and cooling supply technologies, but further research and innovation is needed for new construction materials and methods with a potential for energy savings of between 13% and 22% of the energy consumption of buildings in the next two decades[25]. European industry is constantly improving its energy efficiency, reducing its energy intensity by 19% between 2001 and 2011[26]. In order to maintain the competitiveness of our industry and strengthen our technological leadership in energy efficiency solutions, research and innovation is needed to increase even more the efficiency of appliances (e.g. pumps, boilers or furnaces), processes and systems (e.g. better control and energy management) exploiting advances in information and communication technology and improved heat recovery.

2.2.4. Other low-carbon technologies

Carbon Capture and Storage (CCS) reduces greenhouse gas emissions from the energy sector and carbon intensive industries. Currently, four large-scale demonstration projects in the EU are expected to be operational around 2020, but none has taken the final investment decision as the business case for CCS in Europe has not yet been established. The first CCS power plant in the world started operation in Canada.

50 years of experience underpin Europe's technological leadership in nuclear energy, notably on combining safety, security and efficiency. In response to the 2011 Fukushima nuclear accident, the EU further strengthened its already very high standards for nuclear safety. The EU leads in the adaptability of reactors to variation in demand and is constructing the world's first geological repositories for high-level and heat generating long-lived radioactive waste[27]. The closure of nuclear power stations in the EU will increase focus on decommissioning and associated radioactive waste management, which could also constitute a global business opportunity.

3. MAKING THE SET PLAN FIT FOR THE NEW CHALLENGES

A new impetus to the partnership through a more integrated and better targeted SET Plan

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[23] COM(2014) 520 final, Communication on Energy Efficiency and its contribution to energy security and the 2030 Framework for climate and energy policy

[24] Preparatory study under the Ecodesign Directive, VHK, draft results

[25] Waide et al., The scope for energy and CO2 savings in the EU through the use of building automation technology, June 2014

[26] COM(2014) 520 final, Communication on Energy Efficiency and its contribution to energy security and the 2030 Framework for climate and energy policy

[27] Finland, POSIVA, http://www.posiva.fi/en/final_disposal/general_time_schedule_for_final_disposal ; Sweden, SKB, Forsmark http://193.235.25.3/Templates/Standard____28848.aspx

In order to make the new SET Plan fit for the new challenges determined by the ongoing transformation of the EU energy system, adaptations are needed along the following main lines of action:

- **A more targeted focus:** as underlined in the Research and Innovation and Competitiveness dimension of the Energy Union, actions should be grouped around 4 core priorities - renewables, consumer, energy efficiency, transport - on top of which 2 research priorities - CCS and nuclear – could be added for those Member States interested in those technologies.

- A more integrated approach: moving away from a vertical and technology-specific focus, to embrace a more horizontally integrated approach, identifying the new opportunities made possible by research and innovation, such as increased flexibility and resilience in the system.

- A new SET Plan management: to ensure an increased transparency, accountability and monitoring of the progress achieved, as well as result-oriented approach.

Achieving these objectives requires the following changes:

a) *SET Plan management firmly rooted in the Energy Union*

The implementation of the SET Plan management needs to be tied into the Energy Union and 2030 framework providing a tight cooperation mechanism for the EU and all Member States to achieve our objectives. A new integrated SET Plan management, the SET Plan Steering Group and related Member States committees, with dedicated stakeholder fora for each of the four common priorities (renewables, consumer, energy efficiency, transport) and two additional research ones (CCS and nuclear) should be effectively linked to the wider Energy Union governance.

b) *Strengthened cooperation: opening and widening to new actors*

Achieving the ambitions in the Energy Union framework requires a more effective coordination of research and innovation activities to avoid unnecessary duplication of funding and efforts. This means that the European research and innovation needs to bring together all relevant stakeholders and initiatives, including relevant Public Private Partnerships (PPPs) and Joint Technology Initiatives, and needs to move beyond silos. In particular, it needs to link with the information and communication technology and transport sectors, stakeholders involved in Key Enabling Technologies[28], and in funding instruments under the emissions trading scheme.

International research and innovation cooperation with partnerships with common interest and mutual benefits should be developed for the proposed ten actions. The 2015 Paris Climate Change Conference as well as the technology facilitation mechanism to be

[28] Advanced manufacturing, advanced materials, industrial biotechnology, nanotechnology, photonics and micro-/nanoelectronics

launched at the UN summit for the adoption of the post-2015 development agenda[29] offer opportunities to encourage key countries including developing countries to engage with the EU on climate and energy agenda through technologies and innovation.

c) *More joint actions*

The SET Plan Steering Group should coordinate joint actions involving Member States with or without EU funds. The ERA-Net co-fund instrument in Horizon 2020 can launch transnational calls on demonstration activities involving industry and leveraging private funds. A new type of Public-Public Partnership, based on the European Strategic Forum for Research Infrastructure (ESFRI), could be used to build large scale demonstration facilities of European interest. Such facilities can test the appropriateness of the current regulatory frameworks and identify bottlenecks to the deployment of new innovative energy technologies.

d) *Transparency, indicators and periodic reporting*

Better cooperation and coordination at EU level depends on improved transparency and exchange of information to avoid unnecessary duplication of efforts. Measuring concrete results and achievements will be crucial to improve transparency and evaluate the contribution of the SET Plan to the objectives of the Energy Union in a quantifiable way, as part of the reporting on the State of the Energy Union.

Annually, Key Performance Indicators (KPI) need to be monitored, notably the level of investment in research and innovation (both private and public sector), trends in patents, and the number of researchers active in the energy sector. Further key indicators are being developed in parallel for the Energy Union governance and their consistency will be ensured. Every two years, progress should be measured by assessing, in particular, respective technology developments, cost reductions, and systemic integration of new technologies.

e) *Monitoring and knowledge sharing*

The Commission will further strengthen the existing SET Plan Information System (SETIS)[30] to ensure a more diligent and intelligent use of available information, data and reporting practices by stakeholders and the Member States. Reflecting the necessity of full engagement of Member States and stakeholders in the success of the SET Plan and the Energy Union, where data are not publicly available, all will be invited to support SETIS by pooling and making accessible their data, analyses and intelligence, in order to facilitate partnerships and collaboration across Europe.

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[29] Outcome document of the Third International Conference on Financing for Development: Addis Ababa Action Agenda, 15 July 2015.

[30] https://setis.ec.europa.eu/

4. TEN ACTIONS TO ACCELERATE THE ENERGY SYSTEM TRANSFORMATION AND CREATE JOBS AND GROWTH

Following the 2013 Communication on Energy and Innovation the evolution of the SET Plan began with the development of the Integrated Roadmap[31] presenting the key research and innovation actions needed to transform the entire energy system. On the basis of the Integrated Roadmap developed with stakeholders and Member States during the last two years and in line with the new political priorities defined in the Energy Union, ten priority actions for the Integrated SET Plan have been identified which could serve to develop and integrate the innovative technologies and system solutions.

These ten points should facilitate coordinated or joint investments by individual Member States, between Member States and with the EU. They could then help accelerate the energy system transformation and the realisation of the EU's aim to become the global leader in the deployment and use of renewable energy.

In the months to come, and in the context of the development of the overall Energy Union approach to research and innovation, these 10 priorities should serve as a starting point for discussions with Member States and stakeholders in the development of new research and innovation programmes and activities at European and national level.

Number 1 in renewable energy

1. Sustain technological leadership by developing highly performant renewable technologies and their integration in the EU's energy system:

The EU has the opportunity to build on promising projects in Member States, regions, leading research institutions, industries and at European level. In order to revitalise strategies and regain global leadership, the EU can restore and scale-up to competitive manufacturing the next generation of highly performing PV, including the technologies to integrate PV into the built environment. The recently launched InnovFin Energy Demonstration Projects and the European Fund for Strategic Investment (EFSI) could support these investments.

Where the EU is currently world leader, such as in offshore wind, lignocellulosic biofuels or ocean energy, leadership should be maintained. Therefore, the Commission considers that it makes sense to continue to support the development of the next generation of renewables technologies and the improvement of their performance, from basic research all through the innovation chain to demonstration projects. This applies in particular to offshore wind, ocean energy, bioenergy, geothermal technologies, solar thermal, and technologies that convert power into chemicals and fuels.

[31] https://setis.ec.europa.eu/set-plan-process/integrated-roadmap-and-action-plan

2. Reduce the cost of key technologies:

A large and stable market, combined with coordinated research and innovation and scaled up manufacturing, can achieve cost reduction of key renewable technologies. Regional cooperation where there is common renewable energy potential can help achieve further cost reductions, in particular:

- in the Northern and Baltic Seas for offshore wind energy systems, including deployment and maintenance technologies and techniques, and develop the associated grid systems,
- on the Atlantic sea board for ocean energy,
- in Southern Europe for photovoltaic and solar thermal systems, algae and biomass residues,
- in Northern, Central, and Eastern Europe for bio-energy and bio-fuels.

The future smart EU energy system, with the consumer at the centre

3. Create technologies and services for smart homes that provide smart solutions to energy consumers:

European research and innovation is in a position to develop innovative solutions that can contribute considerably to give consumers in homes, companies and public administration control to optimise their energy consumption (and production), and to cities the opportunity to optimise the use of energy in their infrastructures, through a more interactive/smarter system, relying on smart grid services. The new SET Plan should bring together energy and information and communication technology researchers and companies to support the development of innovative solutions and, over time, encourage the integration of these services into smart homes with other digitally delivered services, such as environmental control, electro mobility and e-health via the Internet of Things.

It is essential that socio-economic impacts of the energy system transformation and the factors that determine people's interaction with the energy system are better understood. European research coordinated through the SET Plan should examine how to best involve citizens, including consumers, social partners and civil society, in the energy system transformation, related to both technology and infrastructure projects.

4. Increase the resilience, security and smartness of the energy system:

With the next generation of smart energy-system solutions, the EU needs to develop and demonstrate innovative power electronics, flexible thermal generation, demand response and storage, as well as efficient heating and cooling technologies (such as heat pumps and combined heat and power) to use synergies between energy vectors, new transmission technologies, new techniques for physical and cybersecurity of networks, and demand analysis including exploitation of Big Data.

Connecting the different networks in an integrated energy system, will be particularly important for ensuring the stability and security of the electricity system, as well as the

protection and privacy of consumer data. This requires the development of new methodologies for optimisation across networks and for protocols of data exchange, including testing and demonstration. This will require a collaborative effort between the Commission and Member States as well as the energy, transport, and information and communication technology sectors and regulators.

Develop and strengthen energy-efficient systems

5. Develop new materials and technologies for, and the market uptake of, energy efficiency solutions for buildings:

The development of advanced materials and industrialised construction processes to reduce costs requires cross-technology innovative and cooperative efforts with Member States, the construction sector, leading institutes in materials and industry.

At the European level the European Fund for Strategic Investments (EFSI) and its guarantee mechanism and the European Structural and Investment Funds (ESIF) can help unlock investments and support the further deployment of innovative technologies and to accelerate the large-scale market uptake of Nearly Zero Energy Buildings (see Chapter 5). The Heating and Cooling strategy planned for end 2015 and the Smart Finance for Smart Buildings Initiative foreseen for the end of 2016 will present opportunities for additional action at European level.

6. Continue efforts to make EU industry less energy intensive and more competitive:

Building on EU and national initiatives (such as SPIRE - Sustainable Process Industry through Resource and Energy Efficiency)[32], we should mobilise EU-wide research and innovation cooperation to continue to improve the performance and cost effectiveness of industry and to enhance the wider use of renewables. Potential technologies include on-site PV, Combined Heat and Power (CHP), heat and cold recovery solutions, intelligent control and energy management systems. Research and innovation for development and deployment of less energy and carbon intensive technologies in energy intensive industries will be very important.

Diversify and strengthen energy options for sustainable transport[33]

7. Become competitive in the global battery sector to drive e-mobility forward:

Energy storage solutions will require batteries that have higher performance (e.g. energy density), extended life, reduced costs, larger capacity and can be scaled-up to competitive manufacturing. This will require work by major European industrial innovators and researchers from the private and public sector. It will require bringing together key elements from the initiatives on the SET Plan, the Strategic Transport Research and

[32] www.spire2030.eu

[33] Work under these two actions will be coordinated with the development of the Strategic Transport Research and Innovation Agenda

Innovation Agenda and the Global Energy Technology and Innovation Leadership Initiative.

8. Strengthen market take-up of renewable fuels needed for sustainable transport solutions:

Market uptake of renewable fuels requires cooperation with national authorities, advanced biofuel producers and potential users at a European scale[34]. This should be closely coordinated with the Strategic Transport Research and Innovation Agenda and should focus on transport modes lacking readily available sustainable fuels alternatives such as aviation, as started in Flight-path[35]. For hydrogen the focus needs to be on the production of renewables-based hydrogen and on reducing the cost of fuel cells for transport.

Actions such as these, together with the appropriate legal framework, should support the creation of the necessary demand to enable the commercialisation of bio-based fuels and chemicals. They should also trigger investment in industrial-scale advanced generation sustainable bio-fuel demonstration facilities while guaranteeing the sustainable production and use of biomass of all uses.

Driving ambition in carbon capture storage and use deployment

9. Step up research and innovation activities on the application of carbon capture and storage (CCS) and the commercial viability of carbon capture and use (CCU):

Enhanced efforts by Member States, in the implementation of large-scale integrated chain CCS demonstration projects in both power and industrial sectors, are necessary to gain experience, bring down costs and demonstrate safe and reliable underground storage of CO_2.

At the EU level, apart from the support planned under Horizon 2020, future CCS projects may be able to benefit from the proposed Innovation Fund to support highly innovative, low-carbon first-of-a-kind projects; and the Modernisation Fund, to support modernisation of energy systems in 10 lower-income Member States.

Research and innovation should support carbon and energy intensive industries to explore the feasibility of CCS, focusing primarily on sectors with high-purity sources of CO_2 to minimise capture costs. CCU options, such as transforming CO_2 into fuels, chemicals and material, could further improve the economic case for CCS.

Increase safety in the use of nuclear energy

[34] Bio-Based Industries Joint Undertaking supports flagship bio-refineries, Fuel Cells and Hydrogen Joint Undertaking aims to reduce the costs of production of renewables-based hydrogen

[35] https://ec.europa.eu/energy/en/topics/biofuels/biofuels-aviation

10. Maintaining a high level of safety of nuclear reactors and associated fuel cycles during operation and decommissioning, while improving their efficiency:

In the short-term, cooperation in research and innovation between the Commission and the interested Member States should focus on maintaining a high level of safety through the most advanced technologies, while being cost-competitive, as well as in the overall management of radioactive waste, from operation to decommissioning and final disposal.

Long-term research and innovation in the EU focuses on the development of nuclear fusion. The roadmap of the EUROfusion Joint Programme is mainly built around the construction and operation of ITER[36]. The EU's large share in the project can also support development of advanced and key enabling technologies in other sectors (e.g. aerospace).

5. BRINGING INNOVATIONS TO THE MARKET – A SHOWCASE FOR OPEN INNOVATION

5.1. Commercialising innovation

A major problem for investors in new technologies in the EU is overcoming the 'valley of death' between the demonstration and commercialisation phase. This requires greater access to risk-financing and a better articulation of coordinated funding sources between EU and national programmes for energy research and innovation.

As part of the response to the need for better financing, the Commission and EIB launched the InnovFin Energy Demonstration Projects (EDP) in June 2015. This new facility provides loans and loan guarantees for first-of-a-kind, commercial-scale industrial demonstration projects in renewables, such as ocean energy and fuel cells [37]. The facility will complement existing grant-based programmes, in particular the NER300 programme and its successor, the Innovation Fund, which will draw on an endowment of 400 million emission allowances, an increased co-funding and a scope enlarged also to low carbon innovation in industrial sectors, including for small-scale projects.

In addition, EFSI can spur energy sector investments that are difficult to finance through the market alone. The Commission should coordinate with Member States so that EFSI promotes close-to-market energy projects such as large-scale industrial demonstrators and building renovation or investment in smart grids.

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[36] ITER is a large-scale scientific experiment that aims to demonstrate the technological and scientific feasibility of fusion energy that is being built in Saint Paul-lez-Durance in France, in an international collaborative effort of the EU, China, India, Japan, Korea, Russia and the USA.

[37] A strategic market study (Study on "Innovative Financial Instruments for first-of-a-kind demonstration projects in the field of Energy" [PP-02022-2014]) will provide further information and analysis regarding the envisaged approach. On this basis, and in light of the expected strong interest in the EDP pilot facility in 2015 and 2016, the future direction and modalities of the EDP pilot will be determined by the Commission services and the EIB.

Further down the innovation chain, support can come from the European Structural and Investment Funds (ESIF). In particular, from the Cohesion Policy funds[38] for the 2014-2020 period EUR 38 billion are allocated to investments supporting the shift towards a low-carbon economy[39], EUR 40 billion for research and innovation, and EUR 33 billion for enhancing the competitiveness of SMEs[40]. The Commission recently launched a platform to assist Member States and regions in the uptake of the Cohesion Policy funds for sustainable energy, including for energy research and innovation[41], one of the most widely chosen priorities in regional Smart Specialisation Strategies. Examples could be the development and equipment of research and innovation infrastructures, and the transfer of knowledge and technologies resulting from Horizon 2020 projects to companies that can develop them further through ESIF funding.

The state aid guidelines for environmental protection and energy as well as the state aid guidelines on research, demonstration and innovation, as well as Important Projects of Common European Interest (IPCEIs)[42], already give guidance on how to give Member State support to the key actions. The future SET Plan will strengthen its collaboration with the Knowledge and Innovation Community (KIC) InnoEnergy of the European Institute of Innovation & Technology (EIT) to identify innovative projects and bring them to the attention of investors or companies that can turn these innovations into successful businesses.

Grant-based financing continues to be important for supporting energy-related research. At least 35% of the Horizon 2020 budget, some EUR 30 billion, is expected to be invested in supporting low-carbon technologies and services. Horizon 2020 will continue to support Public-Private Partnerships (PPPs) with industry in key sectors[43] that are expected to realise investments of almost EUR 12 billion over 2014-2020, half coming from Horizon 2020 funds and half from industry. The Commission will also increasingly use inducement prizes[44] to generate breakthroughs and boost innovation in low-carbon energy technologies and solutions.

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38 Cohesion Policy funds include the ERDF, CF and ESF

39 The investments priority 'shift towards a low-carbon economy' includes areas such as energy efficiency, renewables, cogeneration, smart grids, sustainable multimodal urban transport, and the research and innovation in these areas. European Commission's Directorate-General for Regional and Urban Policy (DG REGIO), How EU Cohesion Policy is helping to tackle the challenges of climate change and energy security, September 2014

40 DG REGIO, Sixth report on economic, social and territorial cohesion, July 2014, cited at: http://ec.europa.eu/regional_policy/sources/docoffic/official/reports/cohesion6/6cr_en.pdf

41 Enabling synergies between European Structural and Investment Funds, Horizon 2020 and other research, innovation and competitiveness-related Union programmes - Guidance for policy-makers and implementing bodies

42 COM (2014/C 188/02), Criteria for the analysis of the compatibility with the internal market of State aid to promote the execution of important projects of common European interest

43 Such as the PPPs on Efficient Buildings, Sustainable Process Industry (SPIRE), Photonics, Bio-based Industries, Fuel Cells and Hydrogen, Clean Sky, Shift2Rail and Green Vehicles

44 https://ec.europa.eu/research/horizonprize/index.cfm

5.2. Adding market 'pull' to technology 'push'

In addition to sophisticated use of financial support, regulatory measures are essential to encourage market uptake at large scale and drive cost reduction. An improved market design (including a new deal for consumers)[45], the reformed ETS, new standards and new legislation on renewables and energy efficiency will reinforce the creation of a flexible energy system that is fit for renewables and of a market that will create economies of scale and growing demand for more innovative products and services. The Commission will ensure that promoting innovation is a key component of its legislative proposals in the coming years.

Additional enabling conditions such as standards, public procurement, market access and skills (crucial in fast-evolving sectors like construction, renewable energy, thermal energy storage or home energy management and essential for nuclear safety) will be addressed in the forthcoming Communication on EU global technology and innovation leadership foreseen for 2016.

6. NEXT STEPS

6.1. Delivering on the Integrated SET Plan priority actions

The ten key actions to address the Energy Union research and innovation priorities proposed here can give new impetus given to the Integrated SET Plan agenda.

The Commission should work closely through the SET Plan Steering Group with stakeholders, including new actors, and with Member States to develop and deliver these priority actions. The SET Plan management should engage with all actors and be effective and integrated with the wider Energy Union governance.

For each of the ten priority actions the Commission should define with the Member States (a) the level of ambition (in terms of priorities and funding), (b) the modalities for the implementation and (c) the timing for achieving results and adopting expected deliverables.

6.2. Strategic Transport Research and Innovation Agenda and the Global Technology and Innovation Leadership Initiative

In line with the Energy Union roadmap, the integrated SET Plan will be supplemented by the Strategic Transport Research and Innovation Agenda and the Global Technology and Innovation Leadership Initiative. The priorities and actions thus identified will also be discussed with Member States, the research community and industry, as their ownership is key to building the Energy Union research and innovation strategy.

[45] COM(2015) 339 final, Communication on delivering a new deal for energy consumers

6.3. An overarching research, innovation and competitiveness strategy

The outcome of discussions on these three interconnected strands – low-carbon cost efficient energy technologies (SET Plan), transport innovation and industrial strategy for jobs and growth – should then feed into an integrated and comprehensive Energy Union research and innovation and competitiveness strategy, to be presented as part of the 2016 State of the Energy Union.