European Commission

Integrated SET Plan
Progress in 2016

Energy

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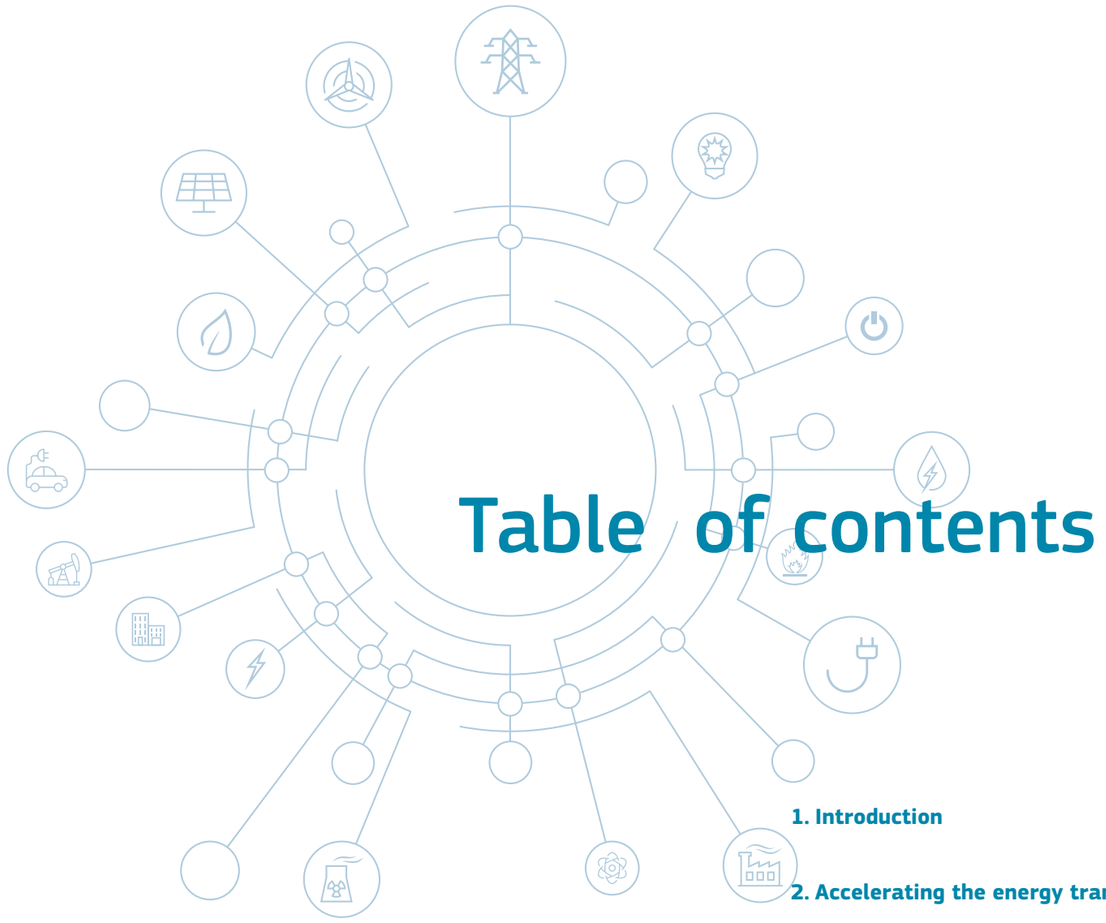
Integrated Strategic Energy Technology (SET) Plan
Progress in 2016

Publication prepared jointly by European Commission's Directorates-General for Energy, Research & Innovation and Joint Research Centre



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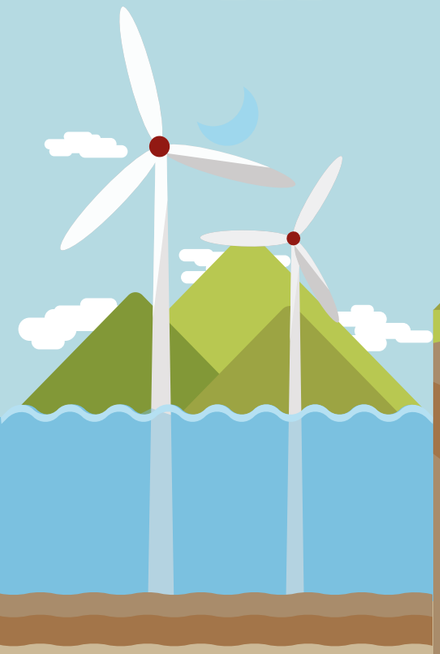
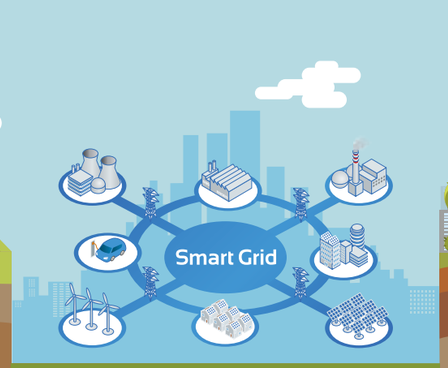


Nº 1 in Renewables

70 €/MWh or less for the cost of offshore wind energy by 2030

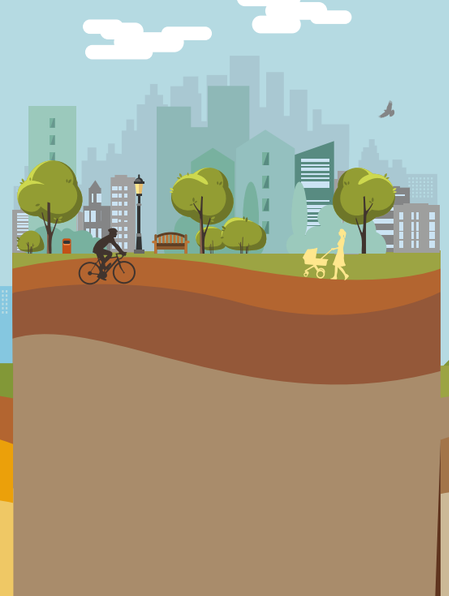
Energy efficiency in buildings

60 % savings of buildings' energy consumption by 2025*



Flexible energy system

25 % peak load reduction from demand-response by 2030*



Consumers & smart cities

100 positive energy districts by 2025* and 80 % of electricity consumption to be managed by consumers in 4 out of 5 households

Energy efficiency for industry

20 % reduction of energy consumption for chemical, pharmaceutical and steel industries by 2025*

Sustainable mobility

70 % cost reduction for Li-ion batteries by 2030*

*baseline 2015

1.

Introduction

The Energy Union Strategy is built on the ambition to achieve, in a cost-effective way, a fundamental transformation of Europe's energy system, moving to more sustainable, secure and competitive ways of delivering energy affordably to consumers. Research and Innovation (R&I) constitute a crucial pillar to fulfil this objective.

Since 2007[1], Europe has taken a strategic approach to innovation and identified priorities that have been delivered through the Strategic Energy Technology Plan (SET Plan), with the aim to speed up the energy transition. In September 2015, the SET Plan Communication[2], tackling the energy system in Europe as a whole and going beyond a 'technology silos' concept, translated the Energy Union Research, Innovation and Competitiveness priorities[3] into 10 Actions. Since then, through a widely participatory process, national governments[4], industry and research actors, involving 154 umbrella organisations that represent 16 700 entities, have set ambitious R&I targets in each of the 10 priorities. The aim of these targets is to accelerate the decarbonisation of the energy systems, by making technologies cost-effective and better-performing.

Reaching the targets will place Europe at the forefront of the next generation of low-carbon energy technologies and of energy efficiency, creating economic growth, jobs and increased competitiveness. It will also positively impact on the well-being of European citizens.

SET Plan facts and figures (2014)[5]

- The funding from the European Union framework programme for research and innovation (Horizon 2020), for low carbon technologies, reached EUR 1.1 billion in 2014. In the same year, public investment from national research and development (R&D) programmes accounted for nearly EUR 4.2 billion.
- In 2014, total EU-28 investments[6] in Energy Union's R&I priorities reached EUR 27 billion. Private sector investment represented almost 85 % of the total investment this year.
- For public funding, the focus of national programmes has shifted towards topics related to smart integrated energy systems – this is the only Energy Union R&I priority where public investment has increased.

[1] COM(2007) 1 An Energy Policy for Europe.

[2] Building on the Integrated Roadmap (2014) – https://setis.ec.europa.eu/set-plan-process/integrated-roadmap-and-action-plan

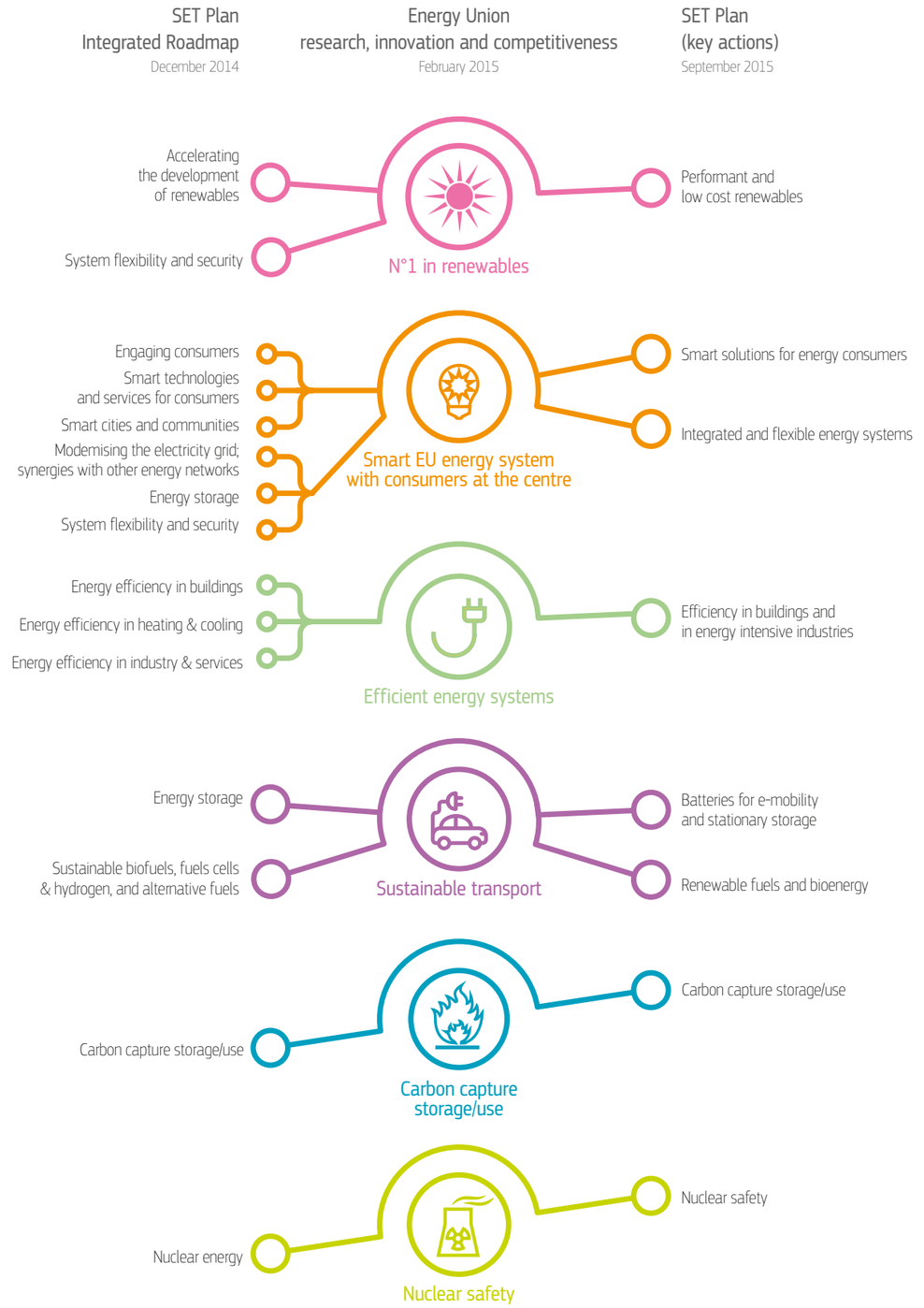
[3] The Research, Innovation and Competitiveness pillar, the 5th pillar of the Energy Union Strategy, identifies 4+2 priority areas for focusing its R&I – see Figure 1, next page.

[4] From all the EU Member States plus Iceland, Norway, Switzerland and Turkey.

[5] Joint Research Centre (JRC) Science for Policy Report, EU innovation and R&I financing in energy – 2016 edition (forthcoming reference).

[6] This figure does not include the funding from the European Union framework programme for research and innovation (Horizon 2020).

Figure 1 – Integrated SET Plan structure[7]



[7] The figure above represents links between the SET Plan Integrated Roadmap, the Energy Union R&I and Competitiveness priorities and the 10 SET Plan key actions. The SET Plan Integrated Roadmap (2014) presented for a first time R&I challenges of the European energy system in a holistic way.

2.

Accelerating the energy transition: ambitious targets to deliver on the priorities

The SET Plan focuses on those low-carbon technologies that have the highest innovation potential for delivering cost reductions and improvement of performance quickly, and which can contribute in this way to the decarbonisation of the European energy system. This will help the EU to achieve its ambitious 2020 and 2030 energy and climate goals that have been set. The SET Plan also addresses the technologies that will facilitate the integration of low-carbon technologies into the European energy system. All the R&I actions will contribute towards maintaining or regaining the EU's global industrial leadership and expanding export opportunities in low-carbon technologies and energy efficiency, by strengthening partnerships among national governments, industry and research actors.

A. Number 1 in renewable energy: SET Plan actions 1 & 2

Europe has the ambition to be the world number one in renewable energy. To fulfil this objective it must lead the development of the next generation of renewable technologies, and to integrate into the energy system, efficiently and cost-effectively, the energy produced from renewable sources. To attain these goals, ambitious R&I targets have been set for five renewable technologies with great potential for cost-reductions, performance improvements and large-scale deployment worldwide – off shore wind, the next generation of photovoltaics, concentrated solar power, deep geothermal and ocean.

OFF-SHORE WIND, currently in growing commercialisation stage, can afford a swift contribution to the penetration of renewable energy in Europe. The targets focus on strong cost reductions and better performance to ensure that the current EU technological leadership translates into real market opportunities in the near future.

Regarding **PHOTOVOLTAICS** (PV), the targets aim at accelerating the development and market introduction of the next generation of innovative PV technologies through cost-reductions, advanced manufacturing and their integration in the built environment.

CONCENTRATED SOLAR POWER (CSP) and **DEEP GEOTHERMAL** are still at an early stage of deployment. They both provide dispatchable electricity (although embedded storage capability is needed in the case of CSP) and heat generation on demand. In this context, targets focus on innovation to allow for drastic cost reductions as well as delivery of the next generation of these technologies through increased performance and, in the specific case of CSP, improved thermal storage capacity.

Finally, **OCEAN** technologies represent an emerging sector of potential interest in numerous parts of the world with a host of applications in the marine environment (e.g. wave, tidal energy). A nascent European industry is in the lead and its strength needs to be maintained during the demonstration phase, so these technologies can convincingly reach the early deployment phase.

B. Future EU energy system, smart cities and placing consumers at the centre: SET Plan actions 3 & 4

Europe puts at centre stage those R&I developments necessary to enable an increasing number of citizens to actively participate in a new, evolving energy market, improve their quality of life and transform their cities' living environment. Starting from the needs of citizens, passing through the requirements of their buildings and cities and rounding it all up with a performable energy system, R&I is needed to address all these new challenges. Within this innovative sphere, energy consumers will be better empowered, engage more actively and end up being key enablers of a decentralised and highly digitalised energy system. And such a commitment will help the EU to further exploit its energy-efficiency potential but also better manage energy generation, especially with regards to variable renewable energy (wind, solar). The energy system needs to adapt to this new reality and allow for the penetration of more renewable energy, while remaining at the same time safe and well-functioning. Through the R&I objectives under these 2 actions and their respective strands, the aim is to create opportunities for citizens to actively participate in different areas, such as demand response, energy savings, energy management of buildings and renewable energy sources (RES) integration at local level.

ENERGY CONSUMERS

The R&I objectives under this strand aim at creating a more comfortable and healthier living environment at a lower energy cost for energy consumers. This requires the use of R&I solutions to promote the uptake of new interoperable energy services, based on intelligent and connected devices, and developing the business models associated to these services. The control and performance of such devices need to be improved and optimised through sensors and controllers that are easy to install, easy to use and easy to maintain.

SMART CITIES AND COMMUNITIES

One of the key challenges for urban areas is to identify and provide them with solutions that will significantly increase their overall energy and resource efficiency. In this sense, actions are needed to address the needs of the building stock, the energy systems and urban mobility, all in one coherent way. Therefore, the sole target set in this respect aspires to being a global role model/market leader in technology integration for and the deployment of net zero-energy/emission districts with positive energy blocks of various sizes as a central boundary-pushing element. A goal has been set to showcase, by 2025, successful examples of synergistic connections to these types of energy system districts throughout Europe. This will lead to a competitive advantage for the European providers of such technologies and services on international markets.

INTEGRATED AND FLEXIBLE ENERGY SYSTEMS

The R&I actions in this area target both a flexible European power grid and optimised integrated local energy systems.

Regarding the power grid, targets have been set to develop technologies, systems and services to increase the system flexibility as a response to the increasing share of production from variable renewables. This calls for high levels of observability and controllability of the grid, increased storage capabilities, stronger interactions with other energy networks (e.g. via power-to-heat, power-to-gas/fuel, electric vehicles) and an optimised integration of consumers and prosumers via innovative and attractive demand-response schemes. The integration of variable renewable sources in the grid must also be rethought (e.g. better accuracy of forecasting of RES plant power production) and the flexibility and sustainability of backup and generation capabilities must be improved.

Scaling down to the local energy systems, the focus shifts to better integrating different sources of temperature and unused energy for local heating and cooling systems. These targets will encourage active participation at local level and will enable a higher penetration of renewable energy.

C. Energy efficiency first: SET Plan actions 5 & 6

There is a need to encourage result-oriented research both at the level of citizens, at the micro scale of a building, and at the level of European industry. Innovation achievements would bring an added value in accelerating refurbishment rates of buildings and in encouraging more actors to mobilise in this area, which is extremely promising in terms of new business opportunities, the creation of jobs and growth. Increased deployment of energy-efficiency solutions across the building sector and also for European industries will eventually enhance the competitiveness of the European export industry.

EFFICIENCY IN BUILDINGS: NEW MATERIALS AND TECHNOLOGIES

The targets that were set in this area will accelerate innovation, thus leading to a more efficient and energy-neutral building stock, fully integrated into the energy system. The targets aim at the reduction of the average primary energy use and at the reduction of the total cost of ownership, construction and maintenance costs. In addition, the goal is to achieve a shorter duration of energy-related construction works and to reduce the difference between the predicted and the measured energy performance of a building.

HEATING AND COOLING IN BUILDINGS

As heating and cooling applications for buildings are an important factor towards the decarbonisation of the European energy system, targets have also been set for cross-cutting technologies that can enhance the thermal energy output of RES, allowing for a greater fraction of this output to be used by the system. Such technologies encompass heat pumps, district heating and cooling, micro combined heat and power (CHP) and thermal energy storage solutions.

STRIVING TO MAKE THE EU INDUSTRY MORE COMPETITIVE AND LESS ENERGY INTENSIVE

Europe must maintain the competitiveness of its energy intensive industry and strengthen its technological leadership in industrial energy-efficiency solutions. What needs to be urgently done is to further increase the energy efficiency of industrial components, processes and systems, further

exploit the opportunities provided by advances in information and communication technology, and further improve the levels of heat recovery during industrial processes.

The relevant R&I priorities that have been set in this area are both sectorial – Iron & Steel and Chemical & Pharmaceutical – and cross-cutting. In such a way, all industrial sectors could benefit from them. The objectives that have been put forward aim at increasing the cost-effectiveness of proven technologies, increasing the energy savings potential and reducing the payback time and duration of the investments in their deployment.

Another objective is to reduce the energy consumption of industries and to recover the industrial excess heat/cold for industrial process or district networks in a cost-efficient manner, by developing and demonstrating efficient components and solutions that can lead to better system integration and intelligent operation.

D. Sustainable transport: SET Plan actions 7 & 8

One of the core priorities of the Energy Union Strategy is to speed up the energy efficiency and decarbonisation of transport through R&I in e-mobility and in renewable fuels. Electric vehicles (EVs) will play a major role in meeting Europe's need for clean and efficient mobility. In addition, the goals for the decarbonisation of transport will also require significant volumes of advanced second-generation biofuels from sustainable sources.

BATTERIES FOR E-MOBILITY AND STATIONARY STORAGE

The development of less costly, durable EV traction batteries, with improved energy storage, power performance and charging capabilities, is essential for the successful transition towards e-mobility. Accordingly, it is important to identify a number of cost reduction and performance improvement targets for traction batteries but also on recycling, second use and cell manufacturing, to reverse the foreign dominance of the battery cell manufacturing industry.

The development of batteries for stationary applications can benefit from automotive sector achievements. Exploiting battery R&I synergies between both applications will improve performance and safety, decrease production costs and at the same time avoid duplication of efforts, thereby leveraging competitiveness. Lower-cost batteries can support self-consumption for the benefit of consumers and give a more stable electricity grid that can integrate a larger share of renewables.

RENEWABLE FUELS FOR TRANSPORT AND BIOENERGY

The SET Plan constituency has identified the need for bioenergy R&I in seven related sustainable value chains. This will create a new market for European-produced advanced renewable fuels.

In the same vein, concerted efforts are required for an efficient management of biomass resources and the upgrading of fuel quality, with particular emphasis on agricultural, municipal and industrial residues, along with waste streams and energy crops grown on degraded land. Innovative system integration via bio-refineries could maximise the use of sustainable resources. The overall focus of the targets is on cost reduction, improvement of conversion efficiency and on meeting sustainability goals.

E. Driving ambition in carbon capture, storage and use: SET Plan action 9

Carbon capture and storage (CCS) and carbon capture and use (CCU) are important technologies for the global decarbonisation in the power generation and energy intensive industries in a cost-effective manner. The targets set relate in particular to enabling whole-chain CCS demonstration projects, including in carbon-intensive industries, to developing CO_2 transport and storage infrastructure, and to researching options for w utilisation through industrial symbiosis.

F. Increase safety in the use of nuclear energy: SET Plan action 10

The EU is at the forefront of R&I in nuclear safety. The agreed targets focus first and foremost on ensuring a high level of safety, particularly in existing and advanced power reactors and associated fuel cycles, including waste management and decommissioning. For those countries wishing to use nuclear energy as part of their low-carbon energy mix in the longer term, targets are also included for increasing efficiency and competitiveness, in particular through innovative designs.

▲ The relevant R&I actions to be carried out in order to reach the targets are expected to be supported primarily through national programmes of those interested Member States and by industry.

It should be recalled that financial support (if any) via the Euratom Research and Training Programme will continue to be restricted to research addressing safety, waste management, radiation protection as well as education and training, in accordance with the underlying legal framework[8].

[8] Council Regulation (EURATOM) No 1314/2013 of 16 December 2013 on the Research and Training Programme of the European Atomic Energy Community (2014-2018) complementing the Horizon 2020 Framework Programme for Research and Innovation, OJ L347, 20/12/2013, p.948.

3.

Progress on governance, implementation and the way forward

A. The SET Plan Steering Group

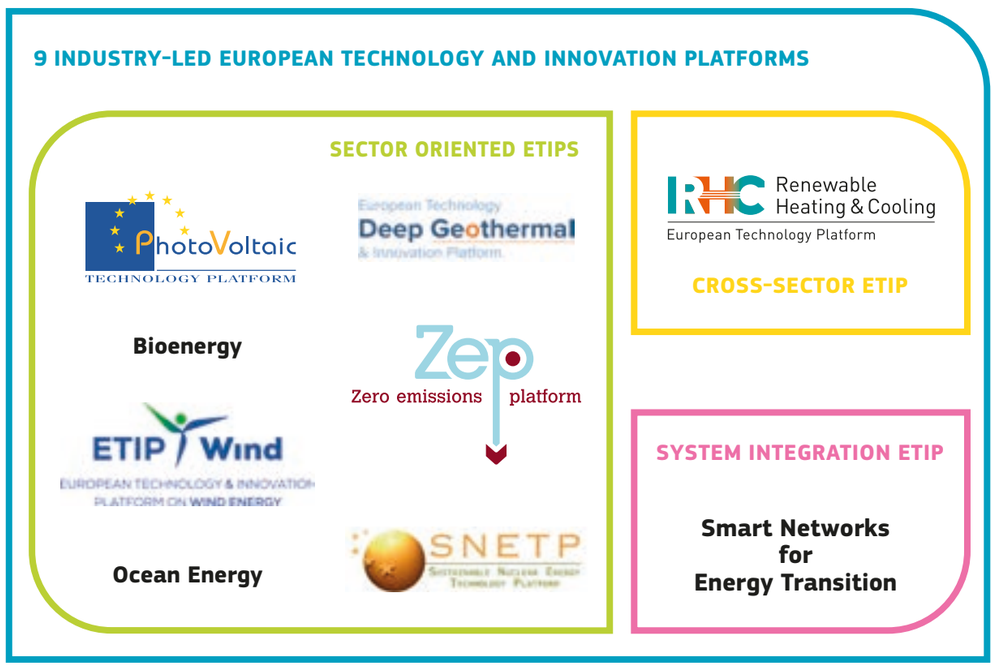
The Steering Group is the SET Plan decision-making body. It gathers representatives from the European Commission and representatives from the 28 EU Member States and four other countries -Iceland, Norway, Switzerland and Turkey. Its main responsibility is to ensure an increased alignment between their respective R&I programmes (i.e. at EU and national level) and the SET Plan priorities, as well as an increased cooperation between national programmes, in order to avoid duplication wherever appropriate and thus to increase the impact of public investment.

Acting in partnership with stakeholders (industry and research) the Steering Group has been instrumental to deliver all SET Plan achievements in the last three years: (1) the SET Plan Integrated Roadmap in 2014; (2) the R&I core and additional priorities of the Energy Union strategy and the 10 key related actions of the SET Plan in 2015; (3) and ambitious targets to accelerate the energy system transformation and place Europe at the forefront of the next generation of low-carbon energy technologies in 2016. Ownership of the countries has been demonstrated by their engagement in an increased number of coordination activities among them (Figure 4), their active participation this year to the establishment of the targets and their willingness to lead the implementation phase where R&I actions will be selected to reach the targets (Figure 5).

B. Streamlining industry-led stakeholders' structures – ETIPs

The industrial platforms of the initial SET Plan governance structure were simplified in 2016. The 6 European Industrial Initiatives have been merged with the 8 European Technology Platforms to form 9 distinct entities called the European Technology and Innovation Platforms (ETIPs). These ETIPs are recognised as key industry-led communities for the implementation of SET Plan priorities along the innovation chain. They have been directly involved in the 2016 target setting process.

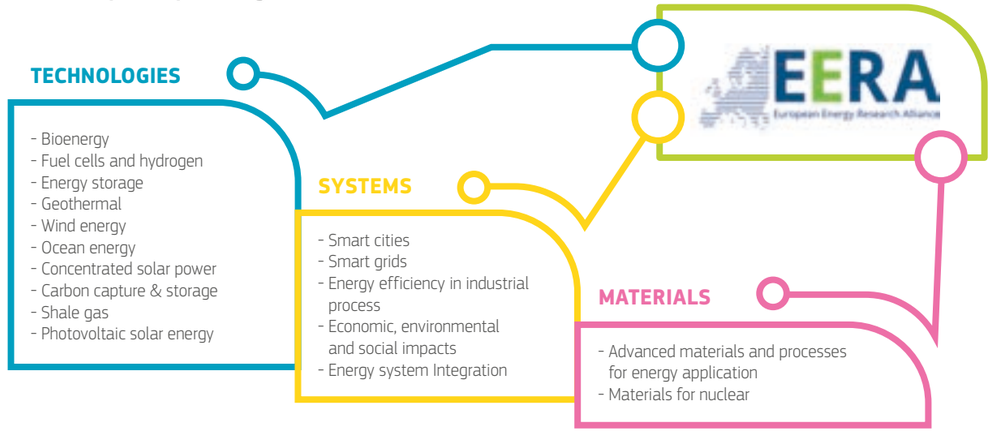
Figure 2 – European Technology and Innovation Platforms (ETIPs)



C. A strategic partnership with the research community – EERA

The European Energy Research Alliance (EERA) brings together more than 175 research organisations from 27 SET Plan countries that are involved in 17 joint programmes. It plays an important role in promoting coordination among energy researchers along the SET Plan objectives and in the technology transfer to the industry. In addition, it has been directly involved in the 2016 SET Plan target-setting process. It delivered a new strategy plan for the Alliance up to 2020, where its contribution to the SET Plan is clarified and where cross-actions between the 17 joint programmes will be fostered, in an attempt to better address the challenges of an integrated energy system.

Figure 3 – EERA Joint Programme Technology Portfolio – European research coordination & shared priority setting

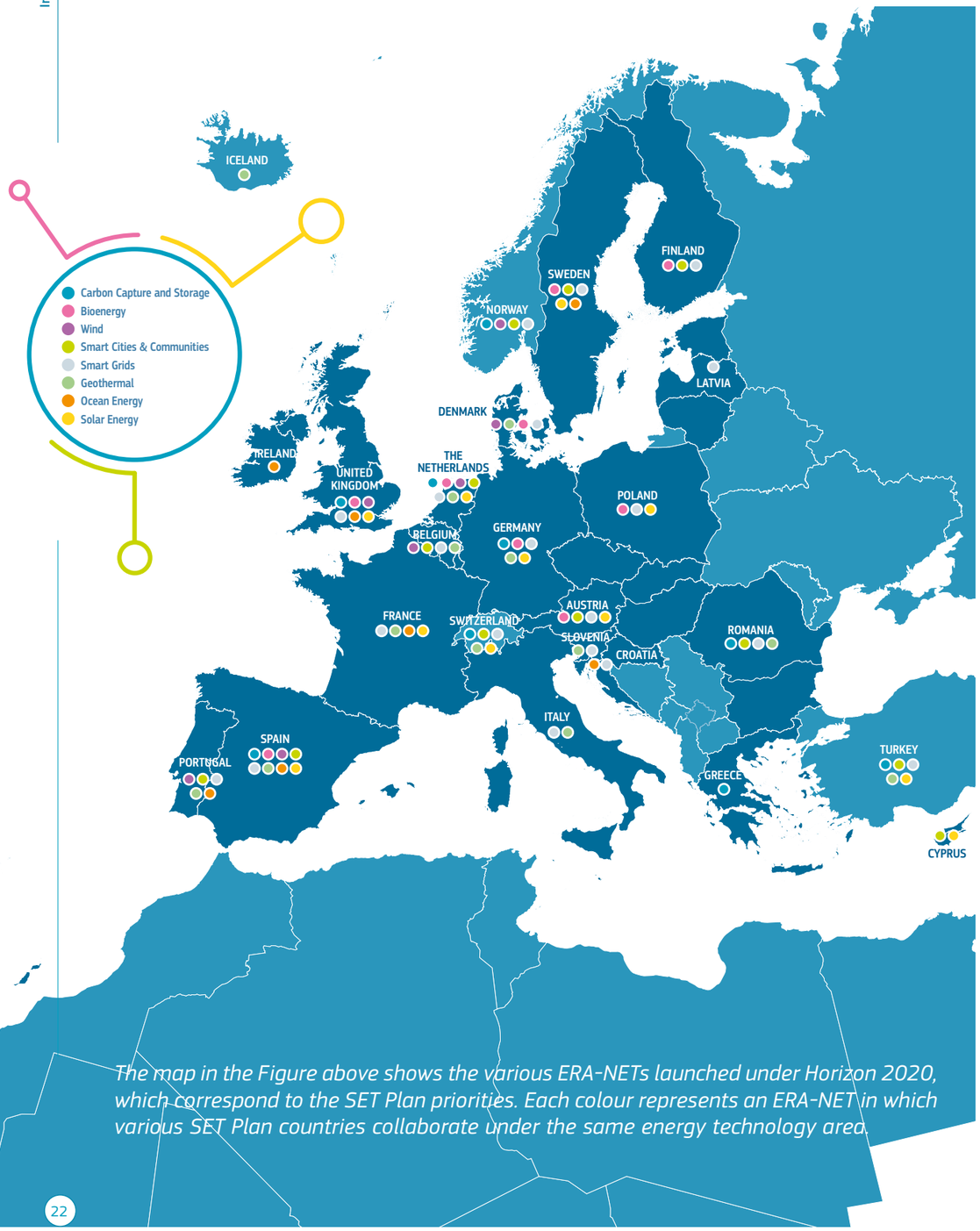


D. Increased coordination between SET Plan countries and the European industry

One of the core SET Plan objectives is to increase coordination among SET Plan countries, leading to an improved alignment of their national programmes wherever appropriate. A key instrument for achieving this objective is the ERA-NET Co-fund, under the EU programme Horizon 2020. It is designed to support public-public partnerships, including joint programming initiatives between Member States. It is also a topping-up device of relevant transnational calls for proposals. By the end of 2016, nine energy ERA-NET Co-fund networks (including two in the wind sector) will have been launched representing eight out of the 10 SET Plan priorities, involving 21 EU Member States plus Iceland, Norway, Switzerland and Turkey. The participating SET Plan countries will launch 16 joint calls for proposals for these nine ERA-NETs. This way, the reach of EU and national research funding programmes is extended, transnational collaboration is stimulated and the duplication of efforts is better avoided.

These Co-fund networks represent, so far, over EUR 217 million in public funding commitments for the period 2015-2021, of which EUR 149 million comes from SET Plan countries and EUR 68 million from the EU's Horizon 2020 programme. In addition, and because of their focus on demonstration activities, the ERA-NETs have mobilised significant private funding for energy R&I: almost EUR 80 million for the joint calls concluded so far, which exceeds by 10% the respective public funding contribution (national plus EU). Also, the ERA-NETs create a collaborative environment for national and regional research programmes.

Figure 4 – Cooperation of SET Plan countries in priority areas



The map in the Figure above shows the various ERA-NETs launched under Horizon 2020, which correspond to the SET Plan priorities. Each colour represents an ERA-NET in which various SET Plan countries collaborate under the same energy technology area.

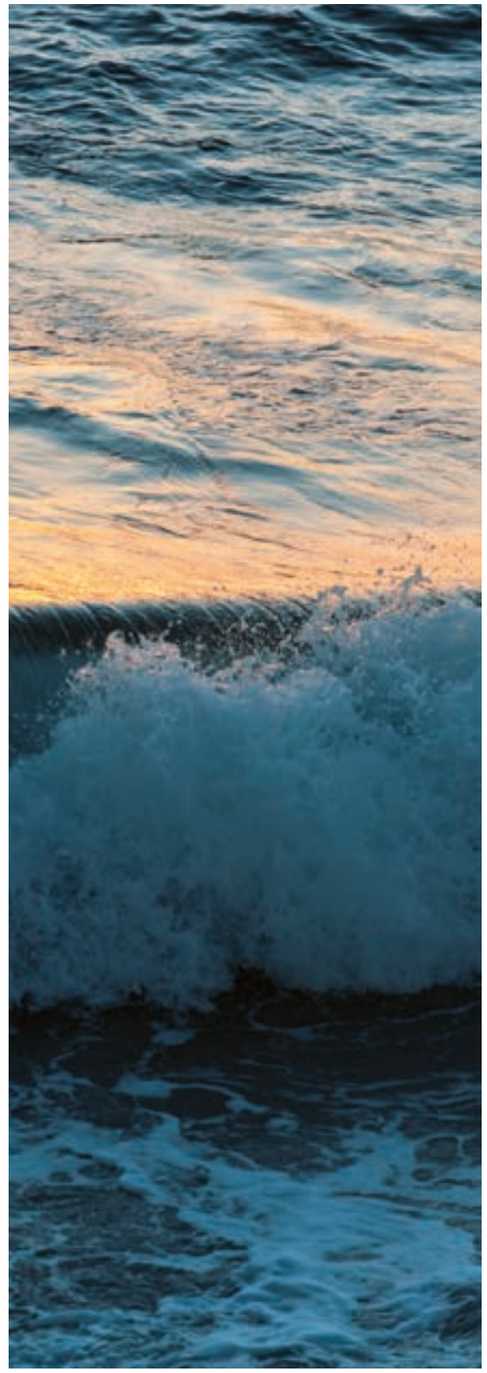
E. New financial instrument to bridge the 'valley of death', from demonstration to the market

Public intervention is needed to overcome the crucial bottleneck that energy technologies face when moving from demonstration to market introduction, in other words to bridge the so-called 'valley of death'. This led the European Commission to roll out in June 2015 the InnovFin Energy Demo Projects (InnovFin EDP) pilot financial facility – implemented by the European Investment Bank (EIB). This risk finance instrument is tailored to the next generation of renewable technologies, addressing the specific challenges of first-of-a-kind, commercial-scale demonstration projects through debt financing support (loans and loan guarantees), which can cover up to 50% of their total costs.

After one year of operation, InnovFin EDP has already managed to spark a significant interest from project developers, with over 90 applications for funding, largely oversubscribing the facility resources. The first EDP project, Wave Energy Device, was signed in July 2016.

- The Wave Energy Device, a commercial-scale demonstrator near Peniche (Portugal), is based on a 1993 invention by a professional diver. It took 10 years for a Finnish company (set up by the inventor with support from the Finnish Technology Fund) to perform thorough tests and enable it to reach the prototype stage. Then, in 2012, the European Commission co-funded prototype demonstrators of this technology in an operational environment as part of the SURGE project under the Seventh Framework Programme (FP7) – the predecessor of Horizon 2020. Given the encouraging outcome, the company decided to go ahead with a commercial-scale demonstration and applied with success for InnovFin EDP support.

  This example proves that financing R&I is crucial even if the results may take years to be fully exploitable by the industry. InnovFin EDP, by extending the public support to the later stages of the R&I cycle, is paramount to the EU goal of being a technology leader worldwide.



F. Taking forward R&I activities to achieve the targets

Following the completion of the target-setting for each action, implementation plans for achieving these targets will be drafted. These will be prepared by SET Plan temporary working groups[9], each led by one or more SET Plan countries and co-led by industrial stakeholders. The work of the groups will focus on the selection of the R&I actions necessary to reach the targets and on establishing the methodology for their monitoring by the Information System of the SET Plan (SETIS[10]). Most of these actions will be implemented at national level. Only those where the EU added value is justified will be potentially considered eligible for funding at European level. In other words, the implementation plans will need to describe the work required in order to achieve the strategic targets set, using which tools, by whom and by when, and how to monitor progress along the way.

G. Enablers for SET Plan implementation

With respect to the innovative, low-carbon technologies necessary to accelerate the decarbonisation of the European energy system, the SET Plan should not be considered in isolation from existing or upcoming initiatives, instruments and tools. There are policy areas and initiatives that, if linked to the innovation strategy[11], could significantly accelerate the impact and cost-effectiveness of the Energy Union goals.

One such example is the Smart Specialisation Strategy. The Smart Specialisation Strategy[12] aims at facilitating partnerships between EU regions in different sectors. The EU regions that have identified renewable energy technologies and innovative energy solutions as one of their smart specialisation priorities seek to match the local strengths in R&I to the local business needs, aiming at avoiding duplication and fragmentation of efforts[13]. A Smart Specialisation Platform on Energy (S3PEnergy[14]) has been created in May 2015 to facilitate the uptake of the cohesion policy funds for innovation in energy and the creation of partnerships in order to better align R&I activities at national, regional and local levels that support the EU energy policy priorities in the most cost-effective way. So far, four energy priorities have been identified: bioenergy, sustainable construction, marine renewable energy and smart grids where partnerships for interregional cooperation are fostered.

Another such example is the use of public procurement. By applying public procurement requirements that promote energy efficient solutions, especially regarding energy products, devices and buildings, Member States and regions can spearhead innovation, thus creating new markets for low-carbon energy technologies.

[9] These groups are formed by countries interested in a particular action, stakeholders and the European Commission.

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

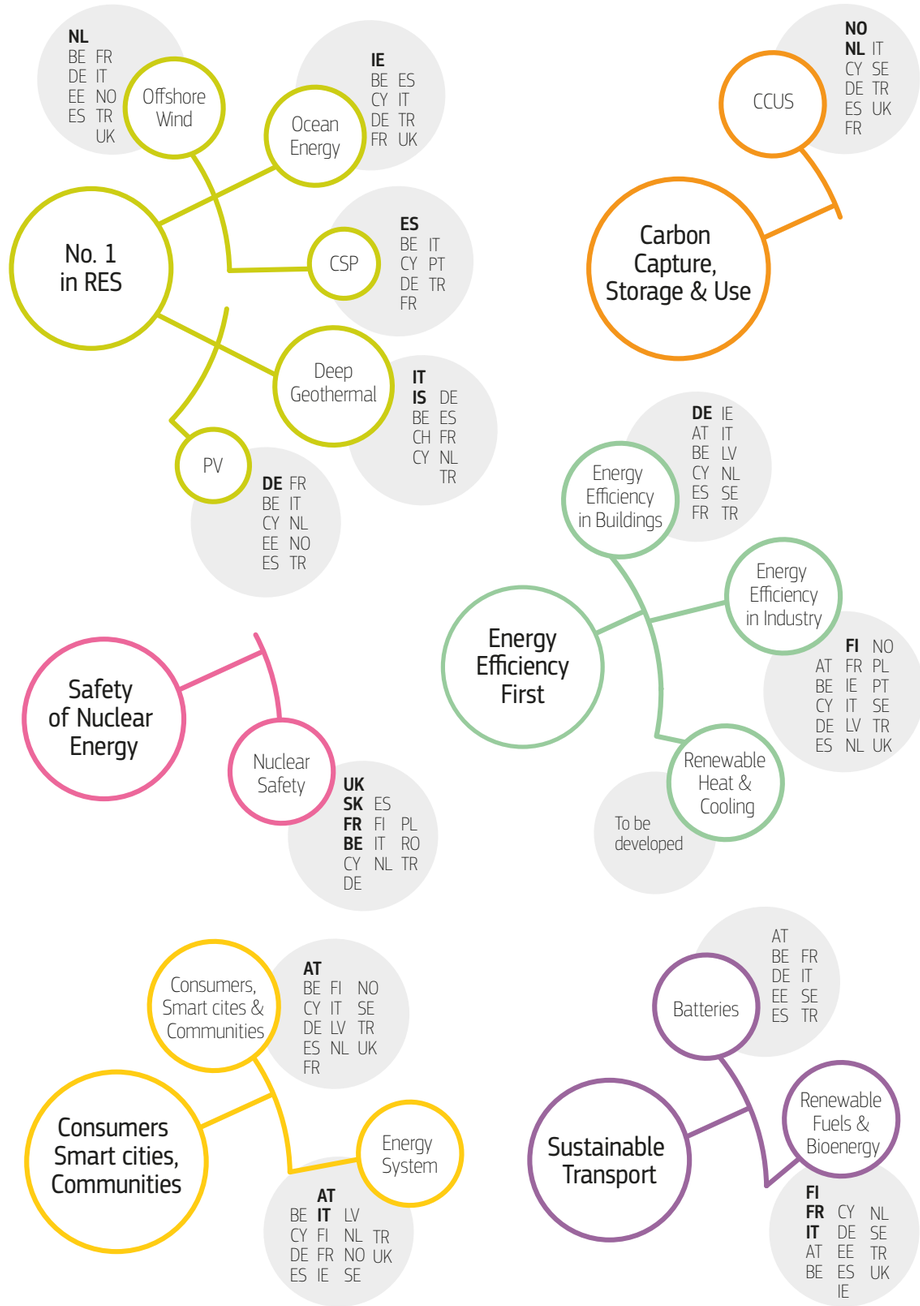
[11] COM(2012) 497 final.

[12] COM(2010) 553 final.

[13] Joint Research Centre (JRC) Science for Policy Report, Mapping regional energy interests for S3P-Energy – https://setis.ec.europa.eu/related-jrc-activities/jrc-setis-reports/mapping-regional-energy-interests-s3p-energy

[14] http://s3platform.jrc.ec.europa.eu/s3p-energy

Figure 5 – SET Plan countries are taking the lead of the Implementation[15]



[15] The above figure shows the four core R&I priorities of the Energy Union and the two additional R&I priorities (Nuclear and CCUS). It lists the SET Plan countries having committed to join each working group in charge of selecting the R&I actions to reach the targets – which will mainly be implemented at national level. The country(ies) that will take the lead for each working group are indicated in bold. The list is expected to evolve as the process is ongoing.

Insert

SET Plan delivering on 10 actions:
Agreed targets and stakeholders consulted

The targets that are presented below have been agreed between representatives of the European Commission services, representatives of the EU Member States, Iceland, Norway, Switzerland and Turkey (i.e. the SET Plan Steering Group), and representatives from research and industry. This is the first big step towards the implementation of the 10 R&I actions on low carbon technologies as identified in the 2015 SET Plan Communication[1].

Under each priority, the stakeholders agreed to set highly ambitious targets in an endeavour to cost-effectively decarbonise the European energy system and to maintain global leadership in the sector by putting forward their best efforts in a coordinated way between public and private sectors. It should be noted, however, that the actual achievement of some of these targets may depend not only on successful R&I activities, but also on the evolution of the energy system, market conditions or the possibility to deploy the technologies in question at large scale, parameters on which the SET Plan has little influence.

Being the world leader in developing the next generation of renewable energy technologies: SET Plan actions 1 & 2

KEY ACTIONS 1 & 2: SOLAR PHOTOVOLTAICS (PV)

Scope

The goal is to relaunch photovoltaic (PV) cell and module manufacturing in the EU, develop reliable, high-performance PV technologies, and accelerate deployment by significantly reducing costs and through the development of building-integrated PV.

Agreed strategic targets

https://setis.ec.europa.eu/system/files/integrated_set-plan/declaration_of_intent_pv.pdf

1. Major advances in the efficiency of established technologies (crystalline silicon and thin films – c-Si and TFs) and new concepts: (a) Increase PV module efficiency by at least 20% by 2020 compared to 2015 levels; (b) Increase PV module efficiency by at least 35% by 2030 compared to 2015, including the introduction of novel PV technologies.
2. Reduction of the cost of key technologies: (a) Reduce turn-key system costs by at least 20% by 2020 as compared to 2015; (b) Reduce turn-key system costs by at least 50% by 2030 compared to 2015 with the introduction of novel, potentially very high-efficiency PV technologies manufactured on a large scale.
3. Further enhancement of lifetime quality and sustainability: (a) Increase module lifetime to a guaranteed power output time (at 80% of initial power) to 30 years by 2020 and 35 years by 2025; (b) Minimise lifecycle environmental impact along the whole value chain of PV electricity generation and increase recyclability of module components.
4. Enable mass realisation of '(near) zero-energy buildings' by building-integrated PV (BIPV) through the establishment of structural collaborative innovation efforts between the PV sector and key sectors from the building industry: Develop BIPV elements, which at least include thermal insulation and water protection, to entirely replace roofs or facades and reduce their additional cost by 50% by 2020, and by 75% by 2030 compared to 2015 levels, and include flexibility in the production process.
5. Major advances in manufacturing and installation: (a) Increase large-scale manufacturing concepts and capabilities by demonstrating PV production capabilities of at least 20 m^2 per minute by 2020; (b) Develop PV module and system design concepts that enable a fast and highly automated installation and reduce the installation costs of both ground-mounted arrays and PV building renovation solutions by 2020.

Stakeholders consulted

European Technology and Innovation Platform (ETIP) on Photovoltaics, European Energy Research Alliance (EERA) Joint Programme on Photovoltaics, European Construction Technology Platform, Iberdrola, European Platform of Universities in Energy Research & Education (EUA-EPUE), SolarWorld AG, Energy Research Centre of the Netherlands (ECN), Association of the European Renewable Energy Research Centres (EUREC), European Photovoltaic Industry Association (EPIA), Helmholtz-Zentrum Berlin and Fraunhofer Institute for Solar Energy Systems.

KEY ACTIONS 1 & 2: CONCENTRATING SOLAR POWER / SOLAR THERMAL ELECTRICITY (CSP/STE)

Scope

In order to maintain the global leadership of the European industry in Concentrating Solar Power/Solar Thermal Electricity (CSP/STE), the goal is to achieve significant cost reductions of existing technologies (in the short term), and to work towards the development of the next generation of technologies (in the longer term).

Agreed strategic targets

https://setis.ec.europa.eu/system/files/integrated_set-plan/declaration_of_intent__csp.pdf

1. Short term: > 40% cost reduction by 2020 (from 2013) translating into a supply price[2] of < 10 ct€/kWh for a radiation of 2050 kWh/m^2/year (conditions in Southern Europe).
2. Longer term: develop the next generation of CSP/STE technology. New cycles (including supercritical ones) with a first demonstrator by 2020, with the aim of achieving additional cost reductions and opening new business opportunities.

Stakeholders consulted

European Energy Research Alliance (EERA) Joint Programme on CSP/STE, European Solar Thermal Electricity Association (ESTELA), European Association of Gas and Steam Turbine Manufacturers (EUTurbines), Iberdrola and European Platform of Universities in Energy Research & Education (EUA-EPUE).

KEY ACTIONS 1 & 2: OFFSHORE WIND ENERGY

Scope

The focus is on maintaining EU leadership and increase the competitiveness of the offshore wind industry via R&I leading to augmented performance and reliability, cost reductions and wider deployment. Simultaneously, the EU will seek a technological edge by developing the next generation of offshore wind technology for deeper waters (i.e. floating substructures or integrated floating wind energy systems that can be used in a variety of marine conditions).

[1] Towards an Integrated Strategic Energy Technology (SET) Plan: Accelerating the European Energy System Transformation" (C(2015)6317).

[2] The supply price is meant to be the targeted price within Power Purchase Agreements (PPA) with a duration of 25 years.

Agreed strategic targets

https://setis.ec.europa.eu/system/files/integrated_set-plan/declaration_of_intent_wind.pdf

1. Reduce the levelised cost of energy (LCoE[3]) at final investment decision for fixed offshore wind by improving the performances of the entire value chain to (a) less than 10 ct€/kWh by 2020, and to (b) less than 7 ct€/kWh by 2030.
2. Develop cost-competitive integrated wind energy systems including substructures that can be used in deeper waters (> 50m) at a maximum distance of 50 km from shore with a LCoE of (a) less than 12 ct€/kWh by 2025 and to (b) less than 9 ct€/kWh by 2030.

Stakeholders consulted

European Technology and Innovation Platform (ETIP) on Wind Energy, ETIP on Smart Networks for the Energy Transition, Waterborne Technology Platform, European Technology Platform-Alice (ETP-Alice), European Energy Research Alliance (EERA) Joint Programme on Wind, WindEurope, Iberdrola, Eleon AS, European Platform of Universities in Energy Research & Education (EUA-EPUE), European Ships & Maritime Association (SEA Europe), Community of European Shipyards Association (CESA), EURELECTRIC and GAMESA.

KEY ACTIONS 1 & 2: DEEP GEOTHERMAL ENERGY

Scope

The EU's industrial and scientific leadership in deep geothermal energy are recognised worldwide. In order to exploit these opportunities and stimulate the market uptake of geothermal technologies, it is necessary to reduce costs, improve performance and develop cost-efficient technologies that harness unconventional resources. These include enhanced geothermal systems (EGS) as well as hybrid solutions that couple geothermal with other renewable energy sources.

Agreed strategic targets

https://setis.ec.europa.eu/system/files/integrated_set-plan/declaration_of_intent_geoth_0.pdf

1. Increase reservoir performance[4] resulting in power demand of reservoir pumps to below 10% of gross energy generation and in sustainable yield predicted for at least 30 years by 2030.
2. Improve the overall conversion efficiency, including bottoming cycle, of geothermal installations at different thermodynamic conditions by 10% in 2030 and 20% in 2050.
3. Reduce production costs of geothermal energy (including from unconventional resources, EGS, and/or from hybrid solutions that couple geothermal with other renewable energy sources) below 10 €ct/kWh$_e$ for electricity and 5 €ct/kWh$_{th}$ for heat by 2025[5].
4. Reduce the exploration costs by 25% in 2025, and by 50% in 2050 compared to 2015.
5. Reduce the unit cost of drilling (€/MWh) by 15% in 2020, 30% in 2030 and by 50% in 2050 compared to 2015.
6. Demonstrate the technical and economic feasibility of responding to commands from a grid operator, at any time, to increase or decrease output ramp up and down from 60% to 110% of nominal power.

[3] The costs for delivering the electricity to onshore substations are taken into account within the LCoE.

[4] Reservoir performance includes underground heat storage.

[5] Costs have to be confirmed, establishing at least 5 plants in different geological situations, of which at least one with large capacity (20 MW$_e$ or, if for direct use only, 40 MW$_{th}$).

Stakeholders consulted

European Technology and Innovation Platform (ETIP) on Deep Geothermal, Geothermal Panel of the ETIP Renewable Heating and Cooling, Euroheat DHC+ Technology Platform, European Energy Research Alliance (EERA) Joint Programme on Geothermal Energy, European Geothermal Energy Council (EGEC), Geothermal ERA-Net, European Platform of Universities in Energy Research & Education (EUA-EPUE) and Ross Offshore.

KEY ACTIONS 1 & 2: OCEAN ENERGY

Scope

The objective is to maintain EU global leadership in ocean energy. The overarching targets aim at bringing ocean energy to commercial deployment and at driving down its costs. Ocean energy technologies need to demonstrate their reliability and capacity to survive in aggressive sea conditions.

In order to speed up the time towards market uptake of ocean energy technologies, it is important to prioritise and concentrate efforts on a limited number of technology areas. Priority will be given to tidal stream and wave energy, which have a high market potential in Europe and sufficient scale at the European level.

Agreed strategic targets

https://setis.ec.europa.eu/system/files/integrated_set-plan/declaration_of_intent_ocean_0.pdf

Development of cost-competitive ocean energy technologies with high market potential for Europe.

1. Reduce the LCoE[6] for tidal stream energy to at least 15 ct€/kWh in 2025 and 10 ct€/kWh in 2030.
2. Wave energy technology should follow the same pathway and reach at least the same cost targets a maximum of 5 years later than tidal energy: 20 ct€/kWh in 2025, 15 ct€/kWh in 2030 and 10 ct€/kWh in 2035.

Stakeholders consulted

European Technology and Innovation Platform (ETIP) on Ocean Energy, European Energy Research Alliance (EERA) Joint Programme on Ocean Energy, Ocean ERA-NET, European Platform of Universities in Energy Research & Education (EUA-EPUE), FloWave (University of Edinburgh), Atlantis Resources, Ocean Energy Europe and Scotland Europa.

Consumers, smart cities and energy systems: SET Plan actions 3 & 4

KEY ACTION 3: SMART SOLUTIONS FOR ENERGY CONSUMERS

Scope

The aim is to facilitate consumers' participation in a new, interactive energy system. The focus is on developing easy-to-install, easy-to-use and easy-to-maintain energy management and demand-response tools that create the conditions for a more comfortable and convenient living environment. In order to accelerate

[6] The costs for delivering the electricity to onshore substations are taken into account within the LCoE.

the development and roll-out of novel energy services and business models, interoperability along the whole value chain should be ensured.

Agreed strategic targets

https://setis.ec.europa.eu/system/files/integrated_set-plan/action3_1_consumers_declaration_of_intent.pdf

1. Demonstrate and apply an interoperable reference architecture and a set of open interface standards as soon as possible so they become the default architecture and standards used by new services by 2020.
2. Improve the performance of the tools for forecasting the electricity consumption of the smart home so that it is within 80% of the real consumption 1 hour in advance.
3. Make available to the market five user-friendly interfaces/tools for energy management (including applications) in every Member State developed by start-ups and innovative service providers as part of a smart home service bundle.
4. Make available an agreed methodology (key performance indicators and protocols) to measure the consumer benefits and the success of tools and appliances that are deployed in the market.
5. The additional cost of sensors, controllers and actuators, their installation and maintenance should have a pay-back period maximum of three years.
6. Increase the penetration of advanced energy sensors and controllers so that at least 80% of the electricity consumption and at least 80% of the total energy consumption is controllable through ICT[7] in 80% of homes in Europe by 2030[8].

Stakeholders consulted

European and Technology Innovation Platform (ETIP) on Smart Networks for the Energy Transition, European Energy Research Alliance (EERA), European Consumers Organisation (BEUC), European Heating Industry Association (EHI), European Heat Pump Association (EHPA), European Committee of Domestic Equipment Manufacturers (CEDED), European Partnership for Energy and Environment (EPEE), European association of Smart Energy Solutions providers (ESMIG), Solar Power Europe, European University Association (EUA), European Platform of Universities engaged in Energy Research (EUA-EPUE), European association for Building Automation and Controls (EU-BAC), European Committee of Air Handling and Refrigeration Equipment manufacturers, Smart Energy Demand Coalition (SEDC), European consumer voice in standardisation (ANEC), Alliance for Internet of Things Innovation (AIOTI), Energy Cities – European Association of local authorities in energy transition, European Innovation Partnership on Smart Cities and Communities, KNX Association / European Committee for Standardization – European Committee for Electrotechnical Standardization (CEN-CENELEC), Covenant of Mayors (CoM), Schneider Electric, European Photovoltaic Industry Association (EPIA), Eurovent.

KEY ACTION 3: SMART CITIES AND COMMUNITIES

Scope

The focus is on demonstrating the integration of smart and low-carbon innovative technologies in buildings and zero-energy districts by 2025.

Agreed strategic targets

https://setis.ec.europa.eu/system/files/integrated_set-plan/action3_2_scc_declaration_of_intent.pdf

[7] That uses the reference architecture and the open standards as stated in the target under 1.

[8] The reference to 80 % of the total energy and the total electricity consumption in a house is set so as to ensure that the main electricity-consuming appliances beyond those used for heating and cooling are included.

To be the global role model/market leader in technology integration for and deployment of net zero-energy/emission districts (ZEED) with positive energy blocks (PEB). The aim is to have by 2025 at least 100 successful examples synergistically-connected to the energy system in Europe and a strong export of related technologies.

Stakeholders consulted

European University Association (EUA), European Platform of Universities engaged in Energy Research (EUA-EPUE), European Energy Research Alliance Joint Programme on Economic, Environmental and Social impacts (EERA E3s), ERA-NET for Smart Cities and Communities, European Innovation Partnership on Smart Cities & Communities, Scheider Electric, ERA-NET Smart Grids+, AkzoNobel SCC, Energy Efficient Buildings (ECTP), Covenant of Mayors (CoM), Bouygues Europe, UrbanDNA, Casaliguria, European Committee for Standardization – European Committee for Electrotechnical Standardization (CEN-CENELEC), The Urban Institute, Eurocities European Centre for Women in technology (ECWT), Advancing Public Transport (UITP) and Centre Scientifique et Technique du Bâtiment (CSTB).

KEY ACTION 4: ENERGY SYSTEMS

Scope

The focus is on developing technologies, systems and services to increase system flexibility and improve grid capabilities. This involves improved energy management via demand response, storage, optimised integration of 'prosumers' and synergies with other energy networks (e.g. local heating and cooling systems).

Agreed strategic targets

https://setis.ec.europa.eu/system/files/integrated_set-plan/declaration_action4_energy_systems.pdf

Flexibility of the system

1. Technologies for grid observability and controllability: the percentage of substations equipped with remotely accessible monitoring and control devices should be 80% or higher for high voltage (HV) and medium voltage (MV) and around 25% for low voltage by 2030. Values will vary between Member States.
2. Tools for managing the variability and uncertainty of operational conditions should enable the peak load to be reduced by 25% due to demand response by 2030.
3. Develop technologies to increase the flexibility of centralised and decentralised thermal power generation enabling, by 2030, 50% of all thermal power plants (new as well as retrofitted) to meet the flexibility requirements demanded by variable renewable energy sources (vRESs). This requires: (a) doubling the average ramping rates (the speed at which output can be increased or decreased); (b) halving efficiency losses for part-load operations; and (c) reducing the minimum load by 30% compared to today's average (avoiding plant switch-off).
4. Increasing the capability of RESs to provide services to the energy system by: (a) improving the accuracy of forecasting models for aggregated RES plant power production by 10%, and (b) developing technologies, tools & services and interfaces enabling a full and effective integration of RES in the grid (balancing services, dispatch, contribution to the stability, 'smart' connection with the grid).

Economic efficiency

5. The main indicator for the technological development that will be used focuses on the cost reduction of energy storage by 2030, ranging from 50% to 70% depending on the specific technologies for the same storage function. In this context, storage has a broad meaning – i.e. it includes batteries, pumped hydro, the interaction of heat and electricity networks, power-to-heat and power-to-gas/fuel concepts, interaction of gas, and heat and electricity networks.

Integrated Local and Regional Energy System[9]

6. Heating and cooling systems: local integration from different sources of different temperature levels, including unused surplus energy.
7. Develop innovative mix solutions (i.e. wind+storage or PV+storage) that will reduce the uncertainties.
8. Smart services: establish innovation environments for the development of smart services.

Stakeholders consulted

European and Technology Innovation Platform (ETIP) on Smart Networks for the Energy Transition, European Energy Research Alliance (EERA) Joint Programme on Smart Grids, European Association for the promotion of Cogeneration (COGEN), European Power Plant Suppliers Association (EPPSA), European Association of Gas & Steam Turbines Manufacturers (EU Turbines), European Turbine Network (ETN), European Engine Power Plants Association (EUGINE), European distribution system operators for SMART GRIDS, European Network of Transmission System Operators for Electricity (ENTSO-E), European Association for Storage of Energy (EASE), European Platform of the Universities in Energy Research and Education (EUA-EPUE), European Geothermal Energy Council (EGEC) and Energy Materials Industrial Initiative (EMIRI).

Energy efficiency first: SET Plan actions 5 & 6

KEY ACTION 5: ENERGY EFFICIENCY IN BUILDINGS: NEW MATERIALS AND TECHNOLOGIES

Scope

The objective is to develop new materials and innovative technologies that have the potential to accelerate the improvement of energy efficiency in existing and new buildings.

Agreed strategic targets

https://setis.ec.europa.eu/system/files/integrated_set-plan/declaration_action5_ee_building.pdf

1. By 2025, R&I will lead to the development and demonstration of highly replicable, standardised and holistic refurbishment packages, tailored to the main building typologies in Europe (including historical buildings). The objective is to reduce on average the primary energy of buildings by 60% while reducing total cost of ownership and limiting the payback time to 10 years.
2. By 2025, develop and demonstrate market-ready solutions to reduce the construction and maintenance costs of nearly zero-energy buildings (NZEB) or positive energy buildings by at least 10% compared to their costs in 2015, with a view to reach a cost reduction of 15%. While reducing cost, these energy-related solutions should lead to an optimal holistic system design and control, and they should respond to consumers' and societal needs.
3. By 2025, develop and demonstrate market-ready solutions to reduce the average duration of energy-related construction works by more than 20% for renovation and for new buildings compared to current national standard practices. Activities could include solutions capable of being adapted to the final conditions with a lower execution time (e.g. offsite construction) or other solutions to increase the effectiveness of construction processes.
4. By 2025, R&I will develop and demonstrate market-ready solutions to reduce the difference between the predicted and the measured energy performance to a maximum of 15% after the commissioning period with the ambition to reach 10%. These solutions should, for instance, result in more accurate energy performance predictions for new and refurbished buildings (e.g. better baseline, better understanding of occupants' behaviour), optimised control systems or solutions to increase the quality of workmanship.

Stakeholders consulted

European Technology and Innovation Platform (ETIPs) on Renewable Heating & Cooling, ETIP on Photovoltaics, European Energy Research Alliance (EERA), European Construction Technology Platform – Energy Efficient Buildings Association, Buildings Performance Institute Europe (BPIE), European Alliance for Companies for Energy Efficiency in Buildings (EuroAce), European Heat Pump Association (EHPA), Architects' Council of Europe (ACE), Federation of European Heating, Ventilation, and Air Conditioning Association (REHVA), European Association for the Promotion of Cogeneration (COGEN Europe), Energy Materials Industrial Research Initiative (EMIRI), Construction Product Europe (CPE), European Alliance to Save Energy (EU-ASE), European Partnership for Energy and the Environment (EPEE), Euroheat & Power, Association of the European Heating Industry (EHI), European Insulation Manufacturers Association (EURIMA), PU Europe, European Polyurethane Insulation Industry, Eurowindoor, European Committee of Air Handling & Refrigeration Equipment Manufacturers (Eurovent), European Solar Thermal Industry Federation (ESTIF), Working Group Building Integrated Photovoltaics (BIPV), European Platform of Universities in Energy Research and Education (EUA-EPUE), Joint Programming Initiative on Cultural Heritage, European Building Automation and Controls Association (eu.bac), European Builders Confederation (EBC), Glass for Europe, KIC InnoEnergy and European Geothermal Energy Council (EGEC).

KEY ACTION 5: CROSS-CUTTING HEATING AND COOLING TECHNOLOGIES FOR BUILDINGS*

Scope

The aim is to decarbonise the heating and cooling sector in European buildings through increased renewable technology penetration and improved energy efficiency of the targeted cross-cutting technology areas. This contributes to the core objectives of EU energy policy.

Agreed strategic targets*

https://setis.ec.europa.eu/system/files/integrated_set-plan/declaration_action5_2_hc_buildings.pdf

Targets by 2025

Heat Pumps systems

1. Reduction by 50% of the global cost (equipment, sensors and installation) of the next generation for small and large size heat pumps compared to 2015 market prices.
2. Development of prefabricated, fully integrated cost-effective 'plug in and play' hybrid/multisource heat pump systems and integrated compact heating/cooling plants based on modular heat pumps.

District heating and cooling

1. Increase by 25% the amount of renewable heat or heat recovered from industrial installations in district heating and cooling (DHC) networks, in a cost effective way, without jeopardising the quality of the service provided to the consumers.
2. Decrease of the DHC substations reference cost for residential buildings by 20% compared to the 2015 prices.

[9] Under adoption at the time of publication, subject to modifications. One of the first missions of the Working Group dealing with the 'Integrated Local and Regional Energy System' targets will be to refine and quantify them.

* Under adoption at the time of publication, subject to modifications.

Micro CHP/CCHP

1. Reduction by 50% of the equipment and installation costs compared to the 2015 market prices.
2. Increase of the energy efficiency of Micro CHP/CCHP by 20% compared to the 2015 levels by:
   - increasing operational electrical efficiency close to nominal;
   - maintaining thermal efficiency of the entire operating range of micro and small scale CHP/CCHP.

Thermal energy storage

1. Improvement of 25% of performance (energy efficiency, system lifetime, O&M) above ground and underground energy storage compared to 2015 levels.
2. Increase of 200% of storage density at the system level (including pumps, valves, pipes, short term buffer) from the current state-of-art of 60 kWh/m^3.

Stakeholders consulted

European Technology and Innovation Platform on Renewable Heating & Cooling, European Energy Research Alliance (EERA), Energy-efficient Buildings association (European Construction Technology Platform) – ECTP, Buildings Performance Institute Europe (BPIE), The European Alliance for Companies for Energy Efficiency in Buildings (EuroAce), European Heat Pump Association (EHPA), Federation of European Heating, Ventilation, and Air Conditioning Association (REHVA), The European Association for the Promotion of Cogeneration (COGEN Europe), Construction Product Europe (CPE), Renewable Heating & Cooling Technology Platform (TPRHC), Euroheat & Power, Association of the European Heating Industry (EHI), European Insulation Manufacturers Association (EURIMA), PU Europe, European Polyurethane Insulation Industry, Eurovent (European Committee of Air Handling & Refrigeration Equipment Manufacturers), European Solar Thermal Industry Federation (ESTIF), European Platform of Universities in Energy Research and Education (EUA-EPUE), European Builders Confederation (EBC), European Geothermal Energy Council (EGEC) and European Turbine Network (ETN), Joint Programming Initiative (JPI) Cultural heritage, European Biomass Association (AEBIOM).

KEY ACTION 6: ENERGY EFFICIENCY IN INDUSTRY

Scope

Priority is given to those industrial sectors offering the greatest potential for energy savings and enhanced competitiveness via improved and innovative technologies – a crucial factor when energy costs represent a high share of the value added. As such, the three following sectors were identified: Iron & Steel, Chemicals & Pharmaceuticals, and Petroleum refineries.

Agreed strategic targets

https://setis.ec.europa.eu/system/files/integrated_set-plan/declaration_action6_ee_industry_0_0.pdf

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

Sector-specific: Iron & Steel and Chemicals & Pharmaceuticals

1. By 2030, at least one third of the technical potential energy savings related to technologies identified for the Iron & Steel and Chemical & Pharmaceutical sectors become economically viable (payback <= 3 years).
2. By 2030, one third of the currently promising emerging technologies in the Iron & Steel and Chemical & Pharmaceutical sectors will be successfully demonstrated on a large scale (TRL [10] >=8).

[10] Technology Readiness Level.

Cross-cutting technologies

3. By 2025, develop and demonstrate cost-effective (to TRL 8) excess heat/cold recovery solutions for industry (e.g. heat exchangers, upgrade to higher temperature, storage, distribution, heat-to-power, heat-to-cold, power-to-heat).
4. By 2025, develop and demonstrate (to TRL 8) improved industrial components whose losses are reduced by 15% (e.g. boilers, dryers, pumps, compressors, fans, conveyors, etc. – systems which typically contain motors and drives).
5. By 2025, develop and demonstrate solutions enabling small and large industries to reduce their energy consumption by 20% while striving to reduce GHG emissions proportionally.

Stakeholders consulted

European Energy Research Alliance (EERA), Sustainable Process Industry through Resource and Energy Efficiency Association (A.SPIRE), European Chemical Industry Council (CEFIC), European Committee of Manufacturers of Electrical Machines and Power Electronics (CEMEP), European Association for the Promotion of Cogeneration (COGEN Europe), European Petroleum Refiners Association (CONCAWE), Energy Efficiency in Industrial Processes (EEIP), European University Association (EUA-EPUE), European Confederation of Iron and Steel Industries (EUROFER), District Heating & Cooling and Combined Heat & Power Association (Euroheat DHC+ Technology Platform), Mechanical, Electrical & Electronic, Metalworking & Metal articles industries (Orgalime), Birmingham Energy Institute, BUSINESSEUROPE, European Cement Association (CEMBUREAU), European Geothermal Energy Council (EGEC), European Power Plant Suppliers Association (EPPSA), EU Turbines, European Turbine Network (ETN), FoodDrinkEurope, KIC InnoEnergy, Ultra-Low CO_2 Steelmaking Consortium (ULCOS) and Fuel Cells and Hydrogen Joint Undertaking (FCH JU).

Sustainable transport Systems: SET Plan actions 7 & 8

KEY ACTION 7: BATTERIES FOR E-MOBILITY AND STATIONARY STORAGE

Scope

The aim is to develop competitive technologies and manufacturing processes for high performance, safe and cost-effective battery systems in order to accelerate the transition to e-mobility, which is crucial to achieve climate targets. This will also increase the use of batteries for stationary energy storage, thereby facilitating the integration of a larger share of renewables in the energy mix and setting the conditions for a more stable electricity grid. Other important goals are the establishment of a manufacturing base in Europe and the recycling of batteries.

Agreed strategic targets

https://setis.ec.europa.eu/system/files/integrated_set-plan/action7_declaration_of_intent_0.pdf

Performance targets (automotive applications unless otherwise indicated)

	Current (2014/2015)	2020	2030 [11]
Gravimetric energy density [Wh/kg]			
Pack level	85-135	235	> 250
Cell level	90-235	350	> 400
Volumetric energy density [Wh/l]			
Pack level	95-220	500	> 500
Cell level	200-630	750	> 750
Gravimetric power density [W/kg]			
Pack level	330-400	470	> 470
Cell level		700	> 700
Volumetric power density [W/l]			
Pack level	350-550	1000	> 1000
Cell level [12]		1500	> 1500
Fast recharge time [min] (70-80 % ΔSOC)	30	22	12
Battery lifetime (at normal ambient temperature)			
Cycle life for BEV [13] to 80 % DOD [cycles]		1000	2000
Cycle life for Stationary to 80 % DOD [cycles]	1000-3000	3000-5000	10 000
Calendar life [years]	8-10	15	20
Cost targets			
Battery pack cost for automotive applications [€/kWh]	180-285	90	75
Cost for stationary applications [€/kWh/cycle]		0.1	0.05

[11] Post-Lithium ion technologies are assumed relevant in this time frame.

[12] May also be relevant to stationary applications.

[13] Cycle life for PHEV must be bigger.

	Current (2014/2015)	2020	2030
Manufacturing targets			
Automotive (Li-ion and next-generation post-lithium) battery cell production in EU [GWh/year] (% supporting EU PHEV+BEV production)	0.15-0.20	5 (50 % of the 0.5 M EVs with 20 kWh)	50 (50 % of the 2 M EVs with 50 kWh)
Utility storage [14] (Li-ion and next-generation post-lithium) battery cell production in EU [GWh/year]	0.07-0.10	2.2	10
Recycling			
Battery collection/take-back rate	45 % [15]	70 %	85 %
Recycling efficiency (by average weight)	50 %	50 %	50 %
Economy of recycling	Not economically viable	Breakeven	Economically viable
Second Life	Not developed	Developed	Fully established

Stakeholders consulted

European Technology and Innovation Platform (ETIP) on Networks for the Energy Transition, European Energy Research Alliance (EERA), European Association for Storage of Energy (EASE), Energy Materials Industrial Research Initiative (EMIRI), E-Mobility Platform, European Green Vehicles Initiative Association (EGVIA), Association of European Automotive and Industrial Battery Manufacturers (EUROBAT), European Association for Advanced Rechargeable Batteries (RECHARGE), VITO Energy and ENEL Green Power.

KEY ACTION 8: RENEWABLE FUELS AND BIOENERGY*

Scope

The aim is to prioritise the production of advanced biofuels (based on non-food biomass feedstocks, residues and wastes) and to also address the sustainable production of solid, liquid and gaseous fuels based primarily but not exclusively on biomass. Targets on improving greenhouse gas (GHG) savings and fostering market penetration of advanced and renewable fuels remain a central activity. The production of intermediary energy carriers, such as hydrogen from biomass and other renewable sources is also taken into account.

Agreed strategic targets

https://setis.ec.europa.eu/system/files/integrated_set-plan/declaration_action8_renewablefuels_bioenergy.pdf

[14] The energy storage capacity in GWh depends strongly on the implementation rate of intermittent renewable electricity sources and market models behind those.

[15] September 2016.

* Under development at the time of publication, subject to modifications.

Intermediate Bioenergy Carriers

1. Improve performance and reduce GHG emissions by increasing efficiency:

Obtain net efficiency of biomass conversion to intermediate bioenergy carriers[16] of at least 75% by 2030 with GHG emissions reduction of 60% from use of all types of bioenergy intermediate carrier products resulting to a contribution to at least 4% reduction of the EU GHG emissions from the 1990 levels.

Renewable Fuels for Sustainable Transport

1. Improve production performance

1.1. Advanced biofuels
- By 2030, improve net process efficiency of conversion to end biofuel products of at least 30% compared to present levels, while simultaneously reducing the conversion process costs.
- By 2020, obtain total production of 25 TWh (2.15 Mtoe) advanced biofuels[17].

1.2. Other renewable liquid and gaseous fuels
- By 2030, improve net process efficiency of various production pathways of advanced renewable liquid and gaseous fuels[18] of at least 30% compared to present levels.
- By 2030, for renewable hydrogen production by electrolysis improve net process efficiency to reach 70%[19].

2. Improve GHG savings

Total GHG savings through the use of advanced biofuels and renewable fuels will be at least that required in the Directive (EU) 2015/1513 where Article 7b (amended) states that greenhouse gas emissions saving from the use of advanced renewable fuels shall be at least 60%. The greenhouse gas emission saving from the use of biofuels shall be calculated in accordance with Article 7d(1) of the same Directive and should be at least 60% of the 40% target in 2030.

3. Reduce Costs *(excluding taxes and feedstock cost)*

In conclusion, the target price in 2020 and 2030 for advanced biofuels and renewable fuels should be within a reasonable margin from parity with the fossil based fuels. Nevertheless, when policy incentives for CO_2 reduction are taken into account, they should aim to be in parity with fossil fuel prices in 2030. This will require in particular improvements in process efficiency and energy balance through the application of innovative practices[20].

3.1. Reduce cost for end biofuel products
- Liquid or gaseous advanced biofuels by thermochemical or biochemical processing: <50 €/MWh in 2020 and <35 €/MWh in 2030 e.g. at least by 30% from 2020 levels.
- Algae based advanced biofuels <70 €/MWh in 2020 and <35 €/MWh in 2030 e.g. at least by 50% from 2020 levels.

3.2. Reduce cost for renewable liquid and gaseous fuels
- Other renewable liquid and gaseous fuels excluding renewable hydrogen: at least by 50% from 2020 levels (<50 €/MWh).
- Renewable hydrogen: <7 €/kg.by 2020 <4 €/kg.by 2030 (electrolysis, reforming, etc.).

[16] In the context of this document intermediate bioenergy carriers are on one hand primary carriers such as wood pellets, wood briquettes, torrefied biomass/biochar and sugars, on the other secondary carriers such as biogas/biomethane, biohydrogen, bioethanol, biodiesel, pyrolysis oils, BTL, etc.

[17] This corresponds to the non-binding target of 0.6% of the approximately 4100 TWh (350 Mtoe in 2014) total transport fuel consumption and to 3 GW installed production capacity.

[18] For example, using renewable electricity to produce gaseous or liquid fuels, including the capture and reuse of CO_2, as well as synthetic fuels made by other innovative processes.

[19] 50-47kWh/kg H_2.

[20] To determine the price margin, input from stakeholders and Member States will be needed for developing the Implementation Plan.

Bioenergy

1. ***Reduce cost*** *(excluding taxes and feedstock cost)*[21] ***for intermediate bioenergy carriers*** *(before further processing to final bioenergy products).*
- Liquid and gaseous intermediate bioenergy carriers by thermochemical or biochemical processing: <20 €/MWh in 2020 and <10 €/MWh in 2030 for e.g. pyrolysis oil; <40 €/MWh in 2020 and <30 €/MWh in 2030 for higher quality, e.g. microbial oils.
- Solid intermediate bioenergy carriers by thermochemical or biochemical processing (e.g., bio-char, torrefied biomass, lignin pellets): <10 €/MWh in 2020 and <5 €/MWh in 2030.

2. ***Reduce conversion system costs*** for high efficiency (>70% based on net calorific value of which >30% electrical) large-scale biomass cogeneration of heat and power by 20% in 2020 and by 60% in 2030 compared to present levels.

Stakeholders consulted

European Technology Innovation Platforms (ETIP) on Bioenergy, ETIP on Renewable Heating and Cooling, European Energy Research Alliance (EERA) Joint Programme on Bioenergy, EERA Joint Programme on Fuel Cells and Hydrogen, KIC InnoEnergy, Leaders of Sustainable Biofuels, Methanol Institute, Energy Materials Industrial Research Initiative (EMIRI), E Mobility Platform, Fuel Cells and Hydrogen Joint Undertaking, Hydrogen Europe, ProcessNet Expert Group, Swedish Energy Agency, The Research Council of Norway, European Biomass Association (AEBIOM), European Environment Bureau, Leaders of Sustainable Biofuels, Euroheat DHC+ Technology Platform, European Platform of Universities in Energy Research & Education (EUA-EPUE), Confederation of European Waste-to-Energy Plants (CEWEP), COGEN Europe, CONCAWE, European Algae Biomass Association (EABA), European Producers Union of Renewable Ethanol (ePURE), European Biomass Industry Association (EUBIA), European Gas Research Group (EUROGAS/GERG), Euroheat&Power, European Biodiesel Board (EBB), European Biogas Association, European Suppliers of Waste to Energy Technology (ESWET), Fuels Europe, Hydrogen Europe, International Air Transport Association (IATA), Climate Action Network Europe (CAN Europe), Transport & Environment (T&I) European Power Plant Suppliers Association (EPPSA), New Research Grouping for Hydrogen and Fuels Cells (N.ERGHY) and European Road Transport Research Advisory Council (ERTRAC Technology Platform).

Driving ambition in carbon capture, storage and use: SET Plan action 9

KEY ACTION 9: CARBON CAPTURE AND STORAGE (CCS) AND CARBON CAPTURE AND USE (CCU)

Scope:

The key objectives for carbon capture and storage/use (CCS/U), both in the short and longer term, are to deliver the commercial scale demonstration of the full CCS/U value chain, and to reduce the costs of CO_2 capture through R&I.

Agreed strategic targets

https://setis.ec.europa.eu/system/files/integrated_set-plan/setplan_doi_ccus-final.pdf

[21] The purpose of this target is to give a rating for different technologies concerning their cost competitiveness. Hence this includes production plus profit margin and relevant costs to point-of-sale to a customer where applicable, and excludes product-related taxes applied (e.g. VAT) and feedstock costs.

The following targets are those reached between research and industry stakeholders and the SET Plan countries BE, DE, ES, FI, FR, IT, NL, NO, RO, UK who chose to take part in their definition.

Targets by 2020

1. At least one commercial-scale[22], whole chain CCS project operating in the power sector;
2. At least one commercial-scale CCS project linked to an industrial CO_2 source having completed a FEED study;
3. SET Plan countries having completed, if appropriate in regional cooperation with other Member States, feasibility studies on applying CCS to a set of clusters of major industrial and other CO_2 sources by 2025-2030, if applicable involving cooperation across borders for transporting and storing CO_2 (at least five clusters in different regions of the EU);
4. At least one active Project of Common European Interest for CO_2 transport infrastructure, for example related to storage in the North Sea;
5. An up-to-date and detailed inventory of the most suitable and cost-effective geological storage capacity (based on an agreed methodology), identified and accepted by various national authorities in Europe;
6. At least three pilots on promising new capture technologies, and at least one to test the potential of sustainable Bio-CCS at TRL 6-7;
7. At least three new CO_2 storage pilots in preparation or operating in different settings;
8. At least three new pilots on promising new technologies for the production of fuels, value added chemicals and/or other products from captured CO_2;
9. Set up of one Important Project of Common European Interest (IPCEI) for demonstration of different aspects of industrial CCU, possibly in the form of Industrial Symbiosis.
10. By 2020, Member States having delivered on their 2030 nationally determined contributions to the COP21 agreement, and having identified the needs to modernise their energy system including, if applicable, the need to apply CCS to fossil fuel power plants and/or energy and carbon intensive industries in order to make their energy system compatible with the 2050 long-term emission targets.

Stakeholders consulted

European Technology and Innovation Platform 'Zero Emissions Platform' (ETIP ZEP), European Technology Platform on Sustainable Chemistry, European Energy Research Alliance (EERA) Joint Programme on CCS, EERA Joint Programme on Advanced Materials and Processes for Energy Application, European Cement Association, European Steel Technology Platform, European Steel Association, EUTurbines, European Power Plant Suppliers Association, European Turbine Network, EURELECTRIC, Sustainable Process Industry through Resource and Energy Efficiency Association (A.SPIRE), European Chemical Industry Council (CEFIC), Energy Materials Industrial Research Initiative (EMIRI), EURACOAL, International Association of Oil and Gas Producers, European Cement Research Academy, ENeRG, CO_2GeoNet, Research Council of Norway, British Research Council, British Geological Survey, European Platform of Universities in Energy Research and Education, Lodz University of Technology, CO_2Chem Network, UK Centre for Carbon Dioxide Utilisation, SCOT Project and Global CCS Institute.

[22] Commercial-scale projects: projects involving the capture, transport, and storage of CO_2 at a scale of at least 800 000 tonnes of CO_2 annually for a coal-based power plant, or at least 400 000 tonnes of CO_2 annually for natural gas-based power generation and emissions-intensive industrial facilities (definition by GCCSI).

Increase safety in the use of nuclear energy: SET Plan action 10

KEY ACTION 10: NUCLEAR ENERGY

Disclaimer

'R&I actions to be carried out, in order to reach the fission-related targets, are expected to be supported primarily through national programmes of interested Member States and by industry.' It should be recalled that financial support (if any) via the Euratom Research and Training Programme will continue to be restricted to research addressing safety, waste management, radiation protection as well as education and training, in accordance with the underlying legal framework[23].

Scope

The agreed targets focus first and foremost on ensuring a high level of safety, in particular in existing and advanced power reactors and associated fuel cycles, including waste management and decommissioning.

Agreed strategic targets

https://setis.ec.europa.eu/system/files/integrated_set-plan/setplan_doi_nuclear-final.pdf

The following targets are those reached between research and industry stakeholders and the SET Plan countries BE, CZ, ES, FI, FR, IT, NL, SK, PL & UK who chose to take part in their definition.

Safety

1. By August 2017, transposition by Member States of the Nuclear Safety Directive, followed by the timely realisation of the new Nuclear Safety Objective through a clear schedule for implementation.
2. By 2020, implementation by Member States of relevant actions to improve nuclear safety as a follow-up to the stress tests[24]; e.g. agreement on how to manage equipment obsolescence in older plants; validation of safety approach and feasibility of storage solutions for irradiated nuclear fuel.
3. By 2025, availability of robust research findings on (1) ageing of structures, materials and components (in particular the long-term operation of nuclear power plants), and (2) more robust and accident-resistant designs (e.g. passive systems, accident-tolerant fuels, improved containment designs, etc.).

Radioactive waste management and decommissioning

4. By 2025, the operation of the world's first deep geological repositories in Europe for spent nuclear fuel and/or heat-generating high-level radioactive waste.
5. By 2030, the development of a world-leading decommissioning sector, including, through R&D, the characterisation and conditioning of waste, building on the EU's safety culture and know-how in waste management.

[23] Council Regulation (EURATOM) No 1314/2013 of 16 December 2013 on the Research and Training Programme of the European Atomic Energy Community (2014-2018) complementing the Horizon 2020 Framework Programme for Research and Innovation, OJ L347, 20/12/2013, p.948.

[24] ENSREG, 2012. Compilation of recommendations and suggestions: peer review of stress tests performed on European nuclear power plants (available at http://www.ensreg.eu/sites/default/files/Compilation%20of%20RecommendationsI_0.pdf).

Efficiency and competitiveness aspects (of interest only to countries wishing to maintain nuclear in their low-carbon energy mix over the longer term, thereby allowing innovation in safety systems).

a) Current technology[25].

b) Innovative emerging technologies – concerning increased efficiency and competitiveness, and enhanced safety through design.

6. By 2025, licensed small modular rectors and/or co-generation very-high or high temperature reactors design(s) available in the EU, with operating demonstrator(s) by 2030.
7. By 2030, at least one Generation-IV demonstrator fast reactor in Europe, including associated fuel cycle facilities.

Fusion (the 'implementation plan' is already largely in place in view of ITER and the fusion roadmap)

8. ITER construction and operation in line with the new baseline.
9. Demo design and construction, and progress towards eventual fusion power plants, in line with the fusion roadmap.

Stakeholders consulted

Sustainable Nuclear Energy Technology Platform (SNETP), European Energy Research Alliance (EERA) Joint Programme on Nuclear Materials, European Economic and Social Committee, European Human Resources Observatory-Nuclear, European Nuclear Education Network, European Nuclear Security Regulators Association, European Nuclear Safety Regulators Group (ENSREG), European Safeguards Research & Development Association, European Technical Safety Organisation Network, European University Association, Euratom Scientific and Technical Committee, European Industry Nuclear Forum (FORATOM), Implementing Geological Disposal of Radioactive Waste Technology Platform, Multidisciplinary European Low Dose Initiative (MELODI), Western European Nuclear Regulators Association (WENRA) and EUROELECTRIC.

[25] For recent information on the cost of nuclear electricity, from new-build Gen-III / III+ and LTO Gen-II, refer to, for example, (i) William D. D'Haeseleer, 2013. Synthesis on the Economics of Nuclear Energy (study for the European Commission, DG Energy) (available at https://www.mech.kuleuven.be/en/tme/research/energy_environment/Pdf/wpen2013-14.pdf); and (ii) Energy Technology Reference Indicator projections for 2010-2050 (available at https://setis.ec.europa.eu/publications/jrc-setis-reports/etri-2014).

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