EUROPEAN COMMISSION
RTD - Energy
ENER - Renewables, R&I, Energy Efficiency
JRC – Institute for Energy and Transport
SET Plan Secretariat

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

Purpose of this document

This document[1] is intended to record the agreement reached between representatives of the European Commission services, representatives of the EU Member States, Iceland, Norway, Turkey and Switzerland, and representatives from the SET-Plan stakeholders most directly involved in energy systems activities, on the implementation of the actions contained in the SET-Plan Communication[2], and specifically the strategic targets for the priority "Number 4 – Increase the resilience, security, smartness of the energy system".

This agreement follows input from EERA Joint Programme Smart Grids, the European Association for the promotion of Cogeneration (COGEN), European Power Plant Suppliers Association (EPPSA), European Association of Gas & Steam Turbines Manufacturers (EU Turbines), European Turbine Network (ETN), European Engine Power Plants Association (EUGINE), EDSO for SMART GRIDS, ENTSO-E, European Association for Storage of Energy (EASE), European Platform of the Universities in Energy Research and Education (EUA-EPUE), European Geothermal Energy Council (EGEC), Energy Materials Industrial Initiative (EMIRI). Note that a number of these stakeholders are also part of the European Technology and Innovation Platform (ETIP) on Smart Networks for the Energy Transition (SNET) who held their first General Assembly in June 2016. This agreement also integrates input from a public consultation via the SETIS website[3] on an issues paper prepared by the Commission services[4]. It takes into consideration the responding input papers and public comments available on SETIS and discussions from the SET-Plan Steering Group on 20 January 2016 with the participation of the SET-Plan stakeholders most directly involved in the topic.

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

Brussels, 19th October 2016

---

1 This document has no legally binding character, and does not prejudge the process or final form of any future decisions by the European Commission.

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

3 Strategic Energy Technology Information System website https://setis.ec.europa.eu/

4 https://setis.ec.europa.eu/system/files/issues_paper-action4_energysystem.pdf

4.1) An optimised European power grid

Introduction

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

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

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

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

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

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

1) Flexibility

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

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

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

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

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

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

2) Economic efficiency

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

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

Overarching goals

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

Strategic Targets

- **Flexibility of the system, by 2030**

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

Tools for managing the variability and uncertainty of operational conditions should enable the **peak load to be reduced by 25% due to demand response by 2030**[5]**.**

Technologies for flexibilisation of centralised and decentralised thermal power generation **enabling 50% of all thermal power plants (new as well as retrofitted) should meet the flexibility requirements demanded by vRES.** This requires:
- Doubling of average ramping-rates (the speed at which output can be increased or decreased)
- Halving efficiency losses for part-load operations
- Reducing minimum load by 30% compared to the average of today (avoiding plant switch-off)

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

Economic efficiency

The main indicator for the technological development that will be used focuses on the **cost reduction by 2030** of energy storage ranging from **50% to 70%** depending on the specific technologies **for the same storage function**[6]. Here storage is meant broadly, including batteries, pumped hydro, the interaction of heat and electricity networks, power-to-heat and power-to-gas/fuel concepts, interaction of gas, heat and electricity networks.

[5] In ENTSO-E TYNDP 2016, under the scenario 'European Green Revolution', demand-response potential is fully used to shift the daily load in response to the available supply resulting in a reduction of peak load of 20%; therefore 25% is considered as an ambitious goals that R&I could enable

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

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

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

Monitoring of the targets

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

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

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

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

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

The capabilities **to assess safety, stability and security** will rely on ENTSO-E's new adequacy methodology[7] and partly on the network codes. This should enable us to define additional indicators with grid operators who bear the responsibility for these matters. Reference values should then be established based on historical data and the evolution of the situation predicted. These are nonetheless non-trivial issues, requiring studies as well as the inclusion of data security aspects (cybersecurity).

Next steps

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

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

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

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

[7] Midterm Adequacy Forecast (ENTSO-E) 2016

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

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

4.2) Integrated local and regional energy systems

Introduction

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

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

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

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

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

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

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

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

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

Overarching goals

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

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

Strategic targets

- **Heating and cooling systems: local integration from different sources of different temperature levels, including unused recoverable energy.**
  Develop and implement local heating and cooling systems, including district heating, that are integrating heat pumps and heat storage technologies, rely on local energy sources (e.g. bio energy, solar thermal and geothermal energy, natural cooling sources, flexible CHP production) and recover heat from other processes (e.g. industry, data centres, cogeneration with cooling and waste water facilities, excess of energy from wind and solar electricity production).
  These systems shall be able to cope with high levels of decentralised energy supply and to interact with future low-energy buildings, leveraging synergies and economic energy-efficient solutions. Furthermore they shall deliver differentiated thermal services (heat, steam, cold, etc.) with optimised primary energy efficiency and significantly contribute to the decarbonisation of the heating and cooling sector which represents more than 50% of the EU final energy consumption.

- **Develop innovative mix solutions (e.g. wind, solar, renewable heat production combined with energy storage) that will reduce variability.**
  In this respect, tools and methodologies used to produce the Ten Years Network Development Plans (TYNDP) for electricity and gas will be particularly useful; enhanced and more complete modelling of the new renewables capacities to fully understand the energy system evolution and its new necessities are needed. This includes the development of regional and local forecasting models for renewables.

- **Smart Services: establish innovation environments for the development of smart services**
  The integration of users and participants in the energy systems is - according to the exponential growth in number - a key competence to design the future energy systems. In order to cope with international developments, European innovation ecosystems should be created around the regional and local energy systems that will enable the potential buyers, developers and providers to work together in co-creation processes, to develop attractive services serving the requirements of the different participants and of the overall system. This includes
    - Data accessibility for pilot initiatives in cooperation with ICT infrastructure providers,
    - Initiation of developer platforms for digital business processes,
    - Development of cooperation formats that facilitate the participation of Start-Ups and SMEs.
    - Development of participation models for citizens, communities, energy regions, peer groups, etc.