Input Paper for the 14th SET Plan Conference 2020

"Making the SET Plan fit for the EU Green Recovery"

The SET Plan contribution to the Energy System Integration Strategy

Setting the scene

The 14th Conference of the Strategic Energy Technology Plan (SET Plan) will take place on 23 - 24 November 2020. Since 2008, this EU energy research and innovation initiative is key in further shaping and implementing energy technology policy across Europe. In 2015, the launch of the Energy Union saw the SET Plan incorporated as the Energy Union's fifth pillar on 'Research, Innovation and Competitiveness' and, through the Communication "Towards an Integrated Strategic Energy Technology (SET) Plan", the Integrated SET Plan set ambitious R&I targets in each of its 10 priorities, to address the objectives of the Energy Union.

Today, the European Green Deal, with the 2050 decarbonisation strategy as well as the recovery plan for Europe set a new scene, requiring the SET Plan to quickly adapt to the new political objectives and challenges. National and European green R&I policies need to follow the pace in order to lower the cost of low-carbon energy and to contribute to the implementation of the new energy system. The role of the European Commission is to support Member States and Associated Countries in better aligning their clean energy R&I approaches and funding programmes to the European policies and goals. Therefore, this year conference will focus, among others, on three main European energy policy initiatives under the European Green Deal for 2020, namely the Energy System Integration Strategy (next to the Hydrogen Strategy), the Offshore Renewables Energy Strategy and the Renovation Wave.

All SET Plan Implementation Working Groups (IWG) have been asked to contribute on a voluntary basis to any of these policy papers, answering the following question:

"How is your work within the IWG contributing to the development and implementation of the three strategies, taking into consideration the #NextGenerationEU package?"

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SET Plan IWGs contributions to the Energy System Integration Strategy

- IWG Photovoltaics
- IWG CSP
- IWG Wind
- IWG Deep Geothermal
- IWG Positive Energy Districts
- IWG Energy Systems
- IWG Buildings
- IWG Industry
- IWG Batteries
- IWG Renewable Fuels and Bioenergy
- IWG CCUS

The Energy System Integration Strategy has received the most attention from the IWGs. This Strategy aims at sector integration through the interlinkage of various energy carriers (such as electricity, heat, cold gas and so on) and with the end-use sectors (such as buildings, transport or industry) as way of optimisation. The energy system would then not be linear anymore but will flow between users and producers reducing wasted resources and money.[1]

The strategy includes six priorities in the Action Plan:

1. A more circular energy system, with 'energy-efficiency-first' at its core;
2. Accelerating the electrification of energy demand, building on a largely renewables-based power system;
3. Promote renewable and low-carbon fuels, including hydrogen, for hard-to-decarbonise sectors;
4. Making energy markets fit for decarbonisation and distributed resources
5. A more integrated energy infrastructure;
6. A digitalised energy system and a supportive innovation framework.

[1] https://ec.europa.eu/energy/topics/energy-system-integration/eu-strategy-energy-system-integration_en

Such strategy opens the R&I field to many technologies working in harmony and various IWGs contributing to this field.

The **Photovoltaics IWG** contributes to the strategy through the deployment of cost-effective, smart, modular and integrated options for flexibility and electrification. The improvement of the PV power plant's inherent grid services (power-fail-ride-through technologies, black start capability, power conditioning,...), integrated storage and conversion (power2heat, power2fuel, power2feedstock) will allow to integrate much larger shares of renewable energies into the electricity grids, to improve the reliability of the grid operation and to reduce the costs of renewable electricity generation. Such technology has a major impact on the power sector, mobility and electromobility, industry via P2X technologies as well as in the building sector, all contributing to this strategy. Based on the CETP (Clean Energy Transition Partnership) Input Paper on PV, this area faces some challenges as the cost reduction to enable large-scale deployment of integrated PV applications, storage and solar P2X. But also issues like optimised PV system components, in particular power electronics, converters etc., advanced and automated functions for data analysis, fault detection, diagnosis, maintenance planning and/or reporting as well as technical solutions and business models to support high plant performance, availability and income over the expected lifetime of the PV plant are addressed. The ongoing Project "PV-Kraftwerk 2025 - Innovations for the next Generation of PV Power Plants" (budget EUR 9.6 million), funded by the German BMWi and carried out by 6 partners from industry and research, aims at realizing a new generation of PV power plants with advanced grid functions. This will allow to integrate larger shares of PV into the electricity grids, improve the reliability of PV power plant operation and reduce the costs of PV electricity generation. Thereby, the consortium will investigate new technologies for PV inverters and PV power plant systems technology and architecture. It is foreseen to improve the grid functions of the PV power plants to meet the future worldwide grid-code requirements and to allow all kinds of ancillary services for the grid.

The **Concentrated Solar Power IWG** brings additional input to the strategy as a smart integration of Concentrated Solar Thermal Technologies (CST) in energy policies will result in innovative multi-technologies solutions benefitting the electricity, heating and cooling as well as the transport sectors. This IWG promotes the technological development and demonstration of the concentrating solar thermal technologies, including Thermal Energy Storage, to make them more cost effective and competitive to support a wider rollout and market penetration. To do so, the IWG is working in finding suitable financing to develop specific projects to provide technological innovations to the industry which could be, eventually, introduced into new commercial solar thermal power plants or solar process heat plants.

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Achieving the necessary regulatory and financial conditions is also crucial in building new innovative commercial solar thermal power plants and applications of solar heat in industrial processes. Such strategy will also help to overcome the lack of power interconnection capacity and facilitate electricity exportation from countries with solar potential.

From an R&I point of view, the main objective of this IWG is the technological development of the contracting solar thermal technologies to make them more cost effective and competitive. In order to do so, this IWG has planned short (2021-2024) and mid-term (2030) objectives of R&I projects contributing to the ESI Strategy as for example:

- The installation of Thermal Energy Storage (TES) system into existing CSP Plants
- The installation of PV into existing CSP plants for hybridisation (innovation/sector coupling)

Power to Heat to Power: The combination of CSP with PV and Thermal Storage can contribute to the whole system reliability and flexibility by integrating non-dispatchable PV and others renewable electricity into a more secure and robust energy system. The European solar thermal industry can provide power on demand at utility scale without further delay, at lower costs than renewable electricity stored in batteries or hydrogen.

Power to gas: The use of "decarbonized gas" will also play an important role in harder-to decarbonize areas, in the mid/long term. CST can help scale-up green hydrogen, allowing an efficient carbon-free operation of its production at constant load and at high capacity factors.

Decarbonisation of the Industrial sector: CST can provide and store high temperature heat (up to 900°C) at costs clearly below renewable fuels or electricity-based options with a very high capacity factor (7000 hours per year). Due to these characteristics, it also allows an efficient operation of renewable fuel production facilities at constant load and at high capacity factors.

CST has also the potential to decarbonise heat grids, as it can provide and store heat more efficiently at suitable temperature levels (120°C), compared to non-concentrating collectors, even in central European climate zones.

The **Offshore Wind IWG** outlines four main actions. The first one is through the priority action 2 of the Updated Implementation Plan *Offshore Wind Farms & System Integration*, which outlines key R&I priorities to enable increased electrification, zero-emission power systems, sustainable hybrid solutions including storage and power2x as well as new tools for market developing and financing. The second is the SETWind Lighthouse initiative on large-scale integration of offshore wind energy, which is developing an ambitious R&I agenda to accelerate offshore energy system integration. The third pillar is about a new impact assessment criterion for offshore wind energy R&I due to the changing market

and energy system as a result of closer integration of systems. Finally, the last action is to foster co-creation and public engagement in order to activate citizens and consumers towards an active role in developing an integrated energy system.

When it comes to the **Deep Geothermal IWG**, such energy technology provides ample supplies of renewable heating, cooling and electricity for buildings and industry. Beyond the heat extracted from geothermal brines for heat and electricity systems, lithium extracted from geothermal brines is key the decarbonisation of mobility. Principal R&I activities include geothermal heat in urban areas, the integration of geothermal heat & power in the energy system and grid flexibility, as well as circular economy.

The **Positive Energy District IWG** contributes to the strategy through the implementation of an innovation-ecosystem, connecting Positive Energy Districts to buildings and integrating them in the regional energy systems. To do so, the specific contribution of this IWG is to participate in the Joint Implementation Working Group (Energy Systems IWG, Positive Energy District IWG and IWG Buildings) to coordinate on strategic issues and transnational joint calls. The planned transnational calls will build the interface of the Driving Urban Transitions and the Clean Energy Transition Partnership in Horizon Europe.

The **Energy Systems IWG** focuses on the implementation of smart and integrated systems. This IWG has two flagship initiative: to develop an Optimised European Power Grid and to develop Integrated Local and Regional Energy Systems. Based on the main objectives of the strategy, the IWG contributes in the following ways:

- The IWG contributes to the acceleration of the electrification of the energy demand, building on a largely renewables-based power system, through its first flagship initiative devoted to the power system, considered as the backbone of the future integrated energy system.
- Another objective of this strategy is making the energy markets fit for the decarbonisation and distributed resources, which the IWG tackles with a consideration for energy market along the value chain from business models, to market design and market governance.
- The strategy also has for objective to create a more integrated energy infrastructure, and this is at the core of this IWG where RD&I activities are organized around clusters.
- This IWG also contributes to the digitalised energy system and a supportive innovation framework objective.

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The input from the **Buildings IWG** is based on all its key Research and Innovation Activities: innovative materials for buildings, heating and cooling technologies, thermal energy storage, multifunctional building elements and systems integration.

- Innovative materials such as biomaterials or phase change materials, technical solutions such as smart windows and innovative thermal insulation with higher thermal performance and without any materials from fossil sources are important research topics for new as well as existing buildings. Low embedded energy and recycling (circular economy) are essential issues. Prefabrication, standardization and modular construction (e.g. serial renovation) are crucial to increase the building refurbishment rate.
- Heating and cooling offers enormous potential for reducing energy consumption at the building level, especially as the demand for cooling is expected to increase massively in the coming years. The development of cost-effective, intelligent and flexible heat pumps (including thermally driven ones) and heat pumps for high temperatures, as well as cost-effective and energy-efficient hybrid technologies aiming at integrating micro CHP/CCHP with other renewable energy based processes have great potential to contribute to this objective. Multi-source district heating integrating renewable and recovered heat sources, high temperature district cooling to integrate additional sources for natural cooling and optimisation of the building heating system to minimise the temperature level in district heating networks are measures of particular importance for the building stock.
- Thermal energy storage systems are crucial for the energy system integration. On a district or city scale, large thermal energy storages enable a more flexible and fully renewable provision of heat to new and renovated buildings through district heating systems. The development needs for these large thermal storage systems are in materials improvement, in optimising storage concepts and storage construction processes, and in the system integration. On individual building or building block level, compact thermal energy storages are crucial. They enable the short- or medium-term storage of available renewable electricity in power to heat configurations or of solar thermal energy for seasonal thermal storage with minimal space requirements in the building. There is still a big need for further materials, components and system development.
- Ventilated façades offer a great opportunity to host in a modular way active and passive heating and cooling and storage technologies in order to contribute to the energy system integration and to decarbonize the building sector. The integration of PV, solar thermal, energy storages, power electronics, insulations, PCM, etc. in a packaged, active, modular, prefabricated panel ensures easy assembly, low impact at worksite, reduction of space requirements inside the buildings for

the storage systems, reduction of the construction and maintenance costs of Nearly Zero Energy Buildings or Positive Energy Buildings.

Buildings are increasingly complex "systems" in the complex structures of their neighbourhoods. This applies in particular to non-residential buildings and includes the renovation sector. The commissioning of such buildings requires a period of intensive adjustment and optimisation. Even during operation, suitable skills and tools are required to constantly guarantee user comfort in an energy and cost-efficient way. The development and demonstration of digital planning and operational optimization instruments is of great importance here. BIM-based, automated fault detection and diagnostic is suitable to identify, and even predict, technical faults in the building based on on-board measurement data. These methods can significantly reduce cost and effort of renovation and maintenance while improving the energy efficiency of buildings. The use of GIS-based district and city energy assessment can provide appropriate support for the renovation of neighbourhoods or the deployment of e.g. 4th generation district heating systems to reduce the CO2 emissions while increasing the penetration of renewables into the energy system. The development of future-proof methods of building energy performance assessment will support the transition to a carbon-neutral housing stock, e.g. by helping to plan energy-saving retrofitting measures or by fostering control and auto-control of the quality of renovation works.

An integrated approach is needed to address these issues properly. In order to intensify the transfer of research and innovation into building practice through a broader application and demonstration of outstanding concepts for new and existing buildings and neighbourhoods, the Building IWG proposes a European competition format, a Living Labs European Competition (LLEC). This systemic competitive approach addresses the energy system and end-use technologies in buildings. Energy management, monitoring systems and intelligent technologies, synergies between different energy sectors and infrastructures will be topic of a new format to achieve optimal solutions both for local or regional energy systems and for the European energy system as a whole. The activity aims to promote the transition from the current habits to a permanent living lab for climate-neutral urban living spaces in a sustainable way, taking societal issues and the economy as serious factors for transformation. The regular event, which demonstrates excellence within the competitive format, will have a motivating influence on society and create acceptance for innovation across Europe as groundwork for an economic transition to the green new era.

The **IWG6 on Energy Efficiency in Industry** is particularly supporting the overarching objective of decarbonising the energy system focusing on the most energy-intensive industry sectors. Energy intensive industries such as Iron & Steel, Chemicals, Pulp & Paper and Cement are essential to EU's

economy as they supply several key value chains. Thus, fostering energy efficiency and supporting R&I programmes in this sector will have a major impact for a climate-neutral economy. The IWG contributes to the strategy in the following ways:

1. A more circular and efficient energy system, with ‘energy-efficiency-first' at its core:
    - The activities on Heat & Cooling contribute to recover the industrial excess/waste heat, upgrade it by means of heat pumps and reuse the heat in other processes, or convert excess heat to electricity
    - The activities on System Integration and in particular industrial symbiosis contribute to energy and resources reuse across industrial sectors, contributing to circularity

2. A greater direct electrification of end-use sectors:
    - Activities related to the Steel and Chemical sector address the electrification (e.g. making steel by electrowinning (electrolysis of iron ore); alternative heating systems – micro-wave, plasma …- in chemical sector)
    - Activities on Heat address the electrification of low-medium temperature heat generation by heat pumps operating at increasing temperatures

3. The use of renewable and low-carbon fuels, including hydrogen, for end-use applications
    - Activities related to the Steel address the decarbonisation by switching from fossil fuels/feedstock to renewable and low-C fuels (e.g. making steel using hydrogen)
    - Activities in System integration, especially industrial symbiosis, address the production of chemicals or fuels by reusing a mix of CO2 and CO (e.g. from steel mill plants) by fermentation process, or CO2 (e.g. from Cement) by combining the CO2 with hydrogen.

Within energy system, batteries can provide a multitude of services for the electrical grid on all levels all the way to the customer behind the meter supporting. Charging is without doubt an important topic for the extended use of batteries and uptake of e-mobility in this strategy, which is why the **Batteries IWG** has for contribution to facilitate the roll-out of the necessary public charging infrastructure starting with 1 million charging stations by 2025. As batteries allow to store energy to be used at a later time or in another place, their contribution to the strategy is key for many reasons. Furthermore, electric vehicles as such gradually penetrate the market of flexibility services, including vehicle-to-grid services.

The **Renewable Fuels and Bioenergy IWG** contributes as well to the strategy as sustainable bioenergy can provide flexible energy solutions and enable higher shares of variable renewable energy in the energy grids, by stabilising and balancing it. Furthermore, integrated bioenergy hybrids can ensure flexible operation for both energy supply and energy storage. Biomethane is an efficient solution in order to increase the share of renewable energy in the natural gas grid. Biomass conversion through renewable electricity and heat from intermittent renewable energy resources and through carbon capture and utilization is the versatile link to energy system integration of all energy sectors, power, heat, cool and transport. When it comes to the viability of biomass supply chains and to develop an efficient heat and power technology, adding digitalisation of and integration of Artificial Intelligence within biomass value chains is a key action in contributing to a resilient, affordable and green electricity and heat production.

Finally, the **CCUS IWG** plays a key role, being both an enabler for industrial decarbonisation and a complementary technology to further reduce CO2 emissions and go carbon negative. Its contribution to the strategy is through the strategic development of CO2 infrastructure (transport and storage) that will create opportunities for CO2 emitters across Europe to have access to cost-efficient decarbonisation pathways. Furthermore, when geological storage of CO2 is not the final aim, some CCU applications can be deployed to store CO2 in a manner that is intended to be permanent or to produce synthetic energy carriers, therefore contributing to the integration of the energy system. Accurate carbon accounting should always be applied. This IWG's contribution is based on an Implementation Plan laying down specific targets for CCS and CCU deployment and associated prioritised R&I activities. Built on five clustered areas: full-scale projects, clusters and infrastructure, capture, storage, and CCU and modelling. The primary goal is to accelerate the large-scale deployment of CCUS technologies in accordance with the Implementation Plan. In light of the European Green Deal – climate-neutrality by 2050, making the role of CCS and CCU even more critical for Europe, the CCUS Implementation Plan targets have been reviewed and updated.

Together with the Energy System Integration Strategy, the European Commission published the **Hydrogen Strategy**, being a key enabler to meet the decarbonisation targets. Several IWGs already work also with this technology to better integrate it I the system: the **CSP IWG** underlines that, in the mid/long term, CSP can help scale-up green hydrogen, allowing an efficient carbon-free operation of its production at constant load and at high capacity factors – both factors of cost reduction. The **Energy Efficiency in Industry IWG** is already familiar with the use of hydrogen and clean hydrogen can be easily (technically) adopted. In steel industry, hydrogen has huge potentials. In addition, in chemical

industry hydrogen is already used, but in the future will be further developed and will rely only on the clean hydrogen form. When it comes to the **Renewable Fuels and Bioenergy IWG**, the hydrogen production and use of hydrogen or synthetic fuels in the transport sector has connections to the power production and it is very much linked to the energy system integration, indeed, hydrogen from electrolysis can significantly enhance the utilization of biogenic carbon in synthesis gas processes. The **CCUS IWG** also has potential regarding hydrogen as CO2 infrastructures can deliver early, large-scale volumes of low-carbon hydrogen produced from reformed natural gas with CCS, which will enable many industrial processes to be redesigned to avoid CO2 emissions.

Questions for discussion and next steps:

- In order to deploy an integrated energy system in Europe, more efforts in research and innovation are needed across the sectors and parts of the system. How can the SET Plan contribute to create stronger links between energy carriers, infrastructures and consumption sectors?
- One of the components of the strategy is the acceleration of the electrification, building on a largely renewables-based power system. How can the IWGs better cooperate to develop common innovative processes working on decreasing costs and increasing competitiveness of renewable energy sources?
- Hard-to-abate sectors will rely on technologies such as hydrogen, an area with a lot of potential for the coming years where significant R&I efforts and Member States' coordination will be needed to decrease their GHG emissions. At the moment, the SET Plan does not include an IWG on hydrogen. How should the SET Plan include hydrogen technology into its activities and plans?