Energy storage and sectoral integration towards a low carbon economy

Background Note

Sectoral integration refers to linking the energy (electricity, gas and heat), transport and industrial infrastructures with a view to increase the penetration of renewable energy sources and decarbonize the economy. Energy storage and sectoral integration would have the potential to make the energy transition faster and more cost-effective.

Energy transition to a low carbon economy requires action in all economic sectors. Europe is not only committed to achieve the objectives of the Paris Agreement, but to be in the front lead, mainly due to the innovation and perseverance in improving energy efficiency, in developing renewable energy sources and in promoting a regulatory framework and market mechanisms supporting the energy transition. If this leadership role is due to be pursued, a more integrating approach and dynamic business environment need to be forged.

The energy sector and the CO2 emissions

Fuel combustion activities are responsible for 75% of total GHGs in the EU (at the level of 2015).

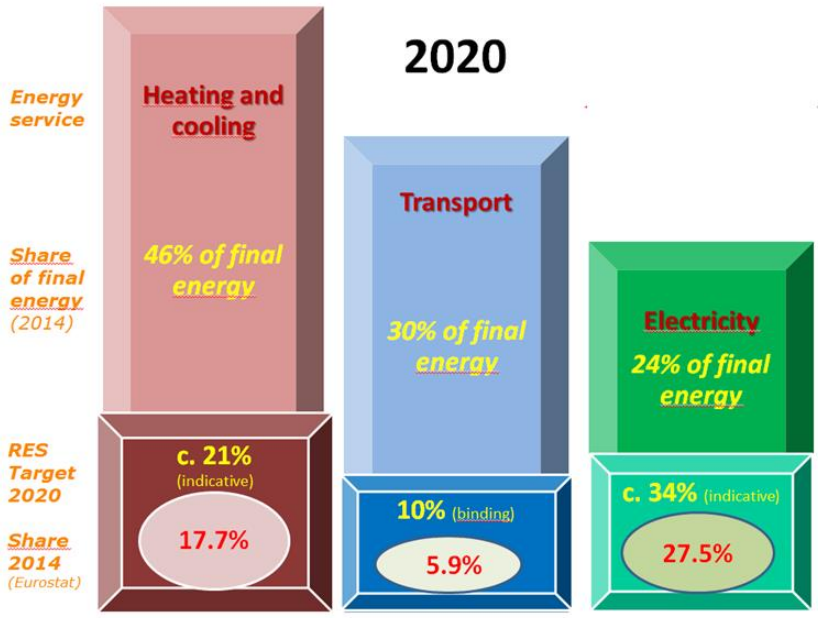
The energy/power sector is responsible for about 31% of total GHGs emissions in the EU, while transport follows with 21%, industrial manufacturing with 20% agriculture with 12% and residential and commercial with about 13%. It is to be noted that since 1990, the emissions in the energy sector decreased with 29%, due mainly to increasing shares of RES and fuel switching. In transport, emissions increased with 16%, but this was not a linear process, as they increased even more until 2007 and then somewhat decreased due improved car efficiency and higher shares of biofuels. In manufacturing and construction industries emissions decreased by about 37% due mainly to efficiency gains. Efficiency gains and fuel switching supported also reaching targets in end use sectors not covered by the emission trading scheme, such as buildings. Altogether, GHGs decreased by about 22%, and some of those can be also attributed to structural changes in industries and general economic contexts.

Renewables in final energy consumption

In all this period renewables increased from an infant to a mature level of technologies. Increasing the share of RES is definitely one of the major ways to decarbonize the energy sector. In addition the benefits in terms of jobs creation and security of supply make renewables a first choice in the energy transition at global level. For the first time in 2016 more than half of all added power generation capacity in the world came from renewables. At EU level the 2020

target for RES has helped technologies to get more into the market. R&D together with support schemes made RES a significant part of the energy system.

The 2020 target of 20% RES in primary energy consumption will be reached. However the degree of penetration of RES in electricity, in heating and cooling, and in transport is quite uneven. It is estimated that the share of RES in power generation is currently 27%, in heating 16% and in transport 5.9%. On another hand, most energy consumption is in heating and cooling 46%, in transport 30% and electricity represents only 24%. The significantly higher penetration of RES in power generation sets the first basis for using this green power to achieve decarbonisation also in transport and in the heating & cooling sectors. The case becomes even stronger towards 2030, when RES power (mainly wind and solar) is estimated to represent about 45% of the total electricity generation.

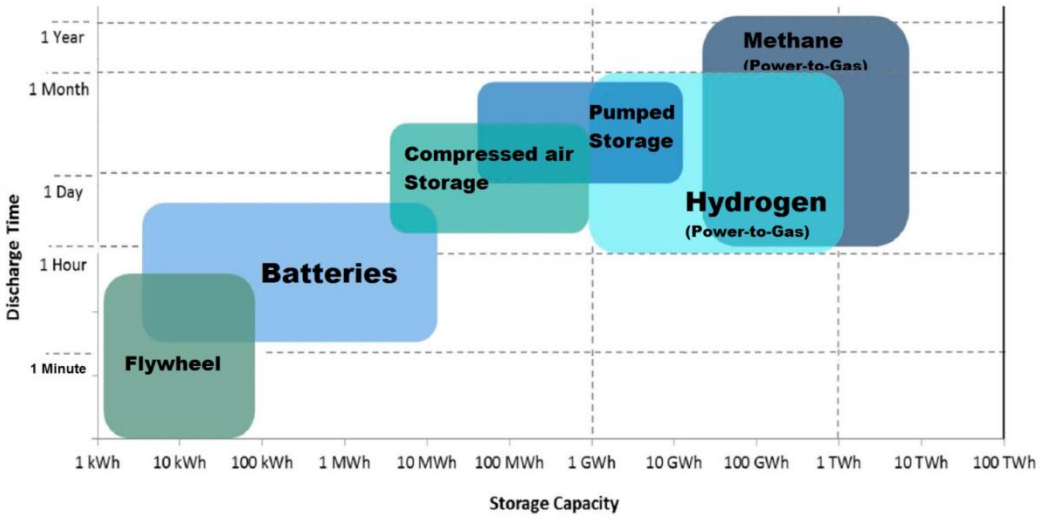


RES electricity could therefore become a main vector for decarbonizing the economy. For this to happen it is important to explore the pathways that allow the cost effective integration of electricity into other economic sectors. An important challenge is that RES power is mainly generated from variable sources, in particular wind and solar, with availability (annual average capacity factor) in the range of 25% for wind and 13% for solar. While a good mix of renewables can already improve the availability through the complementarity of their seasonal cycles, energy storage is a key enabler for the RES power to be used at the time when is required, either as electricity or converted into another energy carrier. Power-to-power energy storage solutions together with power-to-x solutions, notably within the thermal and gas sector, but also in transport and in industrial use as feedstock, could increase the efficient uptake of variable RES and contribute to the balancing of the electricity grid along other flexibility mechanisms.

Energy storage

In terms of technologies, currently pumped hydro storage represents the most mature technology (97% of the global market) but batteries, compressed air, heat storage and hydrogen contribute with an increasing quantity of services to the electricity grid and to the energy system. In particular batteries are generally suitable for relatively short duration of storage offering in most cases very fast response times and being therefore especially suitable for medium or low-voltage distribution networks. Batteries made significant progress in terms of cost reduction, with a drop of 70% from 2007 to 2014[1]. Another reduction of 70% is forecasted towards 2030[2].

The set of services that a storage technology can provide in a defined location determines which solution is most suitable. Several different storage technologies have developed rapidly over the last few years, but further technological progress and cost competitiveness remain essential for large scale deployment. Therefore, the development of storage technologies is an important component of the Strategic Energy Technology Plan and is also identified as a key priority in the Communication on accelerating Clean Energy Innovation. The main indicator for the technological development that will be used focuses on the cost reduction by 2030, the objective ranging from 50% to 70% depending on the specific technologies for the same storage function.



Source: School of Engineering, RMIT University (2015)

[1] Björn Nykvist & Måns Nilsson (2015), Rapidly falling costs of battery packs for electric vehicles, *Nature Climate Change* 5,329–332

[2] *Fuel Cells and Hydrogen Joint Undertaking* (2015) Commercialisation of Energy Storage in Europe

From the perspective of integration of higher shares of RES electricity, the opportunities offered by Power to Heat and by Power to Gas need to be further investigated. The largest potential is offered in medium and long term by chemical storage, based on hydrogen production (mainly through electrolysis), at least as a first step. Chemical storage can provide storage services over various timeframes (up to days and weeks), depending on the specific application. Hydrogen could be stored at a low cost in for example salt caverns in very large amounts. The potential is significant, as the underground storage sites for methane (natural gas) in Europe (EU-28) have a capacity of approximately 1200 TWh[3], while the annual electricity generation from all sources in 2014 was around 3000 TWh[4]. In addition, the power-to-gas conversion could exploit the possibility to use the already developed natural gas infrastructure for long-distance transport. Hydrogen can be blended in the natural gas infrastructure up to a certain percentage (between 5-20% by volume, as demonstrated by the EC research project NaturalHy).

Sectoral integration

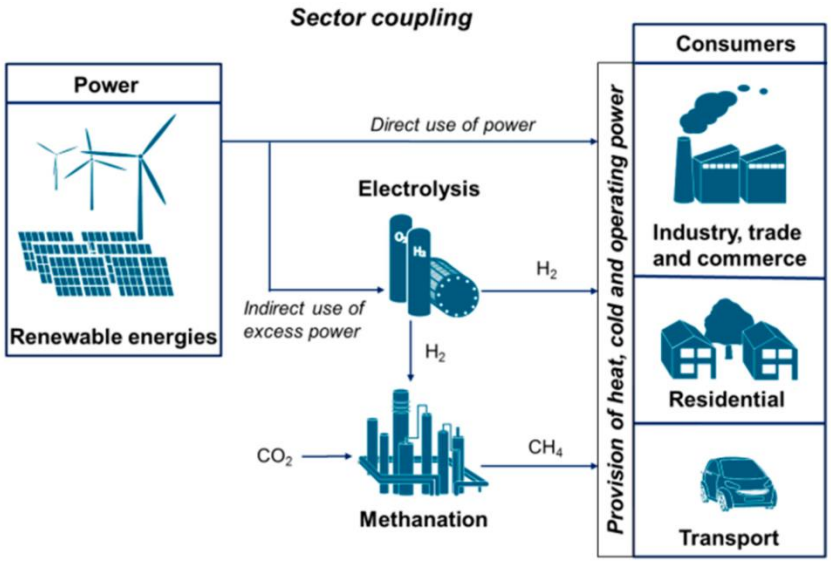
Large amounts of variable RES stored in the form of gas (hydrogen and other synthetic gases) with various power-to-gas (P2G) technologies can provide significant flexibility to the electricity system. P2G could exploit the possibility to use the already developed natural gas infrastructure for long-distance transport. Hydrogen can be blended in the natural gas infrastructure up to a certain percentage (between 5-20% by volume, as demonstrated by the EC research project NaturalHy).

Green hydrogen can contribute to decarbonisation of transport and other energy intensive sectors. It could replace a part of the 15 Mt of hydrogen used globally in refineries and the impact on emissions would be immediate. It could be also used to decarbonise the fertilizers industry, replacing hydrogen produced from natural gas in ammonia production. At global level this could reduce emissions with 360 million tons of CO_2, approximately equal to the annual CO_2 emission of France. And using green hydrogen in the steel industry as a reduction agent (although in this case we speak of a much larger investment, involving changing the technological process) could reduce CO_2 emissions in this sector with up to 95%[5].

[3] http://www.gie.eu/index.php/maps-data/gse-storage-map

[4] http://ec.europa.eu/eurostat/statistics-explained/index.php/Electricity_production,_consumption_and_market_overview

[5] http://www.mdpi.com/1996-1073/10/4/451; Power-to-Steel: Reducing CO2 through the Integration of Renewable Energy and Hydrogen into the German Steel Industry



Source: *Energies* **2017**, *10*(4), 451, *Power-to-Steel*

The Commission took first significant steps for positioning energy storage in the EU energy policy through specific provisions in the clean energy for all Europeans package. Energy storage is a very adaptive technology and could take many roles in generation, grid, consumption, sectorial integration and transport. These different applications would need to be further reflected in the regulatory and market framework not only for energy, but also other economic sectors. Combining the value streams from the services provided in relation to the various activities would support creating a sound business case for investing in energy storage and sectoral integration.

Transferring the green value of renewable electricity to energy intensive industries, to the heat and gas infrastructures, coupling the balancing of the electricity markets with e-mobility, are just illustrations of the areas on which a more integrated approach could support transition to a low carbon economy. Europe is currently leading both in renewables and in the technologies supporting sectoral integration. Europe is also investing in innovative clean energy solutions and created instruments to mobilize public and commercial funding (e.g. EFSI). Efforts in research and innovation, in standardisation and in setting the right regulatory framework can bring more benefits also in terms of jobs creation and economic growth.