Energy Transition in Europe

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Successive European legislative packages, as well as subsidized renewables deployment, impacted on electricity markets, which became unstable with concerns about security of supply. These packages also failed to deliver what was their first objective –benefits for end-users – as the latter are paying for renewables subsidies through higher electricity prices.
Reforms are needed and the article analyses the new European legislative package issued and suggests more actions to restore a sustained market.
It analyses also the main technology progress that have enabled wind and solar energy spectacular costs reductions and the drivers for future costs decreases. Combined with competitive mass storage development and digitalization technologies, those lower cost renewables should get in the future a significant share of the electricity mix contributing to decarbonized energy consumption.
Nuclear energy is a good dispatchable, carbon free complement and should not be shut down, except for safety reasons.

Energy transitions are going on in many regions in the world. Their goals and implementations differ from region to region with a multitude of objectives as: nuclear phase out, renewables development, ban on shale gas and shale oil exploration, on diesel cars… that create confusion and prevent the public to get a clear understanding of the real goals. It should be clearly stated that the unique and clear objective should be to decrease Greenhouse Gases (GHG) emissions in order to mitigate climate change issues.

The COP21 was a real diplomatic success for France. In December 2015, nearly all countries in the world committed to the Paris Agreement, which aims to restrict the increase in global temperature to 2°C (or less) by 2050.

Despite this agreement, additional efforts from all countries are needed as the sum of their commitments in Paris would lead to a larger than 3°C temperature increase by 2050, as the CO_2 atmospheric concentration reached a record level in 2016 at more than 400ppm.

By adopting in 2010 the Climate-Energy package, the European Union (EU) was a front runner. This package of mandatory objectives for 2020 are to:

- reduce emissions of greenhouse gases by 20% (taking 1990 emissions as the reference) ;
- save 20% of European energy consumption ;
- reach 20% of renewable energy in the total energy consumption.

While the three objectives all contribute to reducing GHG emissions, they were established separately, without economic coherence.

Renewables development is the most expensive way to reduce GHG emissions, while energy efficiency is the cheapest.

Energy savings

Measures implemented worldwide over the last 25 years have saved an amount of energy equivalent to the total current demand of China, India and Europe combined. By 2015, energy intensity was more than 30% lower than it was in 1990. This was an important achievement and Europe, together with Japan, is the best.

Because of the granular nature of energy savings, the EU 2020 objective could be difficult to reach despite financial incentives at the national or regional levels.

It could still be possible to reach that ambitious target if major efforts are made in buildings and transportation. Buildings account for 40% of total energy consumption in the EU and 75% of them have poor energy efficiency.

The timescale for reaching that goal is short as energy sobriety relates also to cultural and behavioral aspects that evolve slowly over time.

Renewables development

They are often viewed as the main energy transitions component as they do not emit GHG emissions. However, this is not accurate as other technologies, such as nuclear, are carbon free and their development is not part of the 2020 objectives.

As an illustration, Germany that decided in 2011 (after the Fukushima nuclear accident) to stop half of its nuclear reactors and to phase out the remaining ones by 2020-2022, will very probably not meet its 2020 GHG emission decrease objectives. According to a German environment Ministry report (11 October 2017) the decrease should only be around 32% (instead of 40%). Also German GHG emissions are decreasing slower than the EU average.

Renewable inherent characteristics

Renewables belong to two main categories: renewables with storage (hydropower, biomass, concentrated solar power) and those without (mainly photovoltaic solar and wind).

Wind and solar are dispersed energy forms occupying a significant amount of land surface. For example, replacing a 1,000 MW nuclear reactor with photovoltaic farms would require to cover a surface area equivalent to Paris.

The latter are variable by nature and thus need backup (storage, other generation sources). In the absence of competitive mass storage their share of the electricity mix is limited (around 40%). Their non-dispatch nature creates grid disturbances (balancing problems, grid overhaul), leading to extra cost (depending on grid structure, around 30%) [1,2,3] that have to be added to the renewables cost in order to make a fair comparison with schedulable generation.

Technology improvements and costs decreases

Except for hydropower, renewables are not yet mature technologies and there is a significant potential for technologic improvements and cost decrease.

Wind

Onshore wind: The main technology improvements are larger turbines, advanced blades, advanced towers, and improved turbine reliability, which increases electricity yields from the same wind resource and reduces the land occupied. In addition to these technology drivers, improved micro-siting of turbines from better wind resource measurement and modeling will also help.

However, in certain countries (notably France), increased local opposition to onshore wind is making new projects more complex and more costly.

This is a one reason of offshore wind development.

Offshore wind is currently far more expensive than onshore wind notably because marine installation costs and power transmission to the shore. Technology improvements are similar to those for onshore wind with additional economies of scale obtained by increasing turbine size (from average of 5 MW in 2016 in Europe it could more than double by 2024 [4]), improving power transmission cable technologies, and moving to floating sea foundations. Progress is also expected in the offshore wind farms operations.

Solar

The cheapest and fastest growing technology is photovoltaic (PV). Significant technological progress has to be reported in efficiency increases: manufacturers have been able to create solar panels that are nearly 30% efficient, and in 2016 high-end commercially available cells had an efficiency between 19-21% generating 25% more electricity than average cells and reducing the area required for a given watt of power output. In France's CEA-LETI labs, efficiency of 46% was reached. However, super-high-efficiency panels are typically made of more expensive materials and are not yet cost efficient.

Cost

The renewables LCOE (*Levelized Cost Of Electricity*) : a project is determined by wind or sun resource quality, the technical characteristics of the wind turbines or solar panels, operation and maintenance costs, the economic life of the project, equipment and installation costs and regulations including local public acceptance (which can cause delays). The renewables market's spectacular growth has triggered increased competition and enabled economies of scale and supply chain optimization.

Onshore wind is, after hydropower, the cheapest renewable with LCOE (between 40 and 110 €/MWh), Offshore wind cost vary between 100 and 160 €/MWh. Utility scale PV costs have decreased spectacularly in the last year. In Europe they vary between 55 and 160 €/MWh – much higher than in sunny regions as Chili (30€/MWh).

Storage

Because of wind and solar renewables intermittence, storage is needed to get a reliable electricity generation. In comparing electricity costs from renewables to dispatchable generation (as nuclear), one has to add storage cost. Even if batteries costs did not fall as quickly as renewables', they are declining and should fall from $227 kWh in 2016 to less than $190/kWh in 2020 (and to less than $100/kWh by 2030).

Future trends

This renewables costs decrease trend should continue. In the next ten years, onshore wind cost should fall by 25%, offshore wind by 35% and utility-scale solar PV by more than 50%.

Subsidies

In order to meet their 2020 objective, European Member States put in place subsidies organized around feed-in tariffs, which guarantee fixed revenues for renewable energy producers. These tariffs played a major role in renewables expansion but generated huge costs for consumers (for example, in 2015, German end-users paid ~20 billion to green energy producers).

(1) LEWINER C., 16th Capgemini EEMO, editorial.
(2) WIESMETH M., BARTH R. & VOSS A. (2013), Cost-Supply Curves of renewable electricity in Germany – First Results, IRENA-ETSAP Joint Session: REMAP 2030.
(3) Energy Group (2015), "Position paper", European Physical Society.
(4) http://www.telegraph.co.uk/business/2017/05/16/worlds-largest-wind-turbines-may-double-size-2024/

In 2014, following Spain, Germany reformed its energy law, replacing those tariffs by auctioned "feed-in premiums" and placed a cap on the amount of clean energy capacity eligible for subsidy payments. These new measures will give the German government more control over the integration of renewables.

Following Germany, the EU has promulgated a similar reform that started to be applied in 2017.

Thanks to those subsidies and the renewables, present and future cost decreases the 2020 Energy Climate package allows, renewable objective should be met.

Greenhouse gas emissions

In 2005, the EU established the Emissions Trading System (ETS) enabling emissions rights exchanges and delivering market-related carbon prices. However, during the 2008-2010 crises, the European Commission granted too many emissions rights and has since been unable to efficiently reform this rigid system. As a result of this emissions rights glut, carbon prices are at too low levels (around €7/t in September 2017), with no incentive to choose carbon-free investments. Not enough real efforts are put into reaching a high enough carbon price (around 50 €/t), probably because of opposition by coal-rich Member States.

Despite this, and thanks to renewables development, energy efficiency improvements, and also the economic crisis that pushed energy-intensive industries to move to lower-cost countries outside Europe, the GHG reduction target will be reached, and even surpassed, in 2020.

The unique 2030 objective of 40% GHG reduction is also attainable.

Security of supply

The renewables development triggered by the Climate Energy package has hit the market just as electricity consumption was stagnating because of the financial crisis. The result was a glut of power-generating capacity that has pushed wholesale prices down to very low levels, triggered massive coal and gas plants premature closure thus threatening security of supply.

During the 2016-2017 winter, low availability from French nuclear plants (due to the French Safety Authority inspections requests) resulted in spiking spot prices (around €100/MWh at the end of 2016) and worries about security of supply.

After that episode, wholesale spot prices fell again below €40/MWh. If the French nuclear plants availability is not restored before the 2017 winter, similar security of supply threats could happen again.

In many Member States (including France), capacity markets, designed to ensure that sufficient reliable capacity is available during tense periods, have been launched and are functioning, though with different models (strategic reserves, capacity auctions, capacity obligations).

Reforms

The Clean Energy for All Europeans package (Winter package):

The recommendations of this package should be adopted in 2017 for entry into force between 2020 and 2021.

Its ambition is to reach seamless electricity flows through European Member States, to pursue the renewable energies market integration, increase energy efficiency efforts, and to enable consumers to become more effective players in the market.

It endorses nearly all the 2030 energy-climate package quantified targets:

- achieving 27% renewable energy share in the EU's energy mix,
- improving energy efficiency by 30% and
- decreasing by 40% GHG emissions compared to 1990.

However, with a high renewables share, the document's reforms are insufficient to restore sustained wholesale markets delivering significant electricity prices that would prevent closing dispatchable generation capacity, and thus insure security of electrical supply.

However, the agenda is dense for the coming years: concerning energy, the clean energy package should be approved in 2018, and be enforced in national plans in 2019, simultaneously with a new text on EU governance of energy. In 2020-2021 there might be a new package about the gas markets, and in 2021-2022 the trans-border infrastructures regulation might be enhanced. Concerning climate, the ETS reform has been proposed in February 2017; in 2019 the reserve for stability of ETS should be enforced; in 2020 there might be a revision of the objectives of the COP21; the 4th phase of ETS (2021-2030) will start in 2021.

What would have been needed

The package should have suggested reforming electricity pricing in wholesale markets. Today the "merit order" consists of calling plants in order of increasing variable costs, and renewables have very low (near to zero) variable costs.

With this merit order rule, the massive injection of photovoltaic or wind renewables pushed wholesale market spot prices down to very low levels with episodes of negative prices. This chaotic situation should be corrected by modifying the pricing rules (which this legislative package does not suggest).

On the carbon pricing side, the objective of the ETS reform project, adopted in 2016 by the European Parliament, is to raise the emission rights price. However, the Market Stability Reserve proposal uses quantitative criteria (number of emissions rights) to modulate the market offer.

In order to establish a high enough and predictable carbon price, the criterion for the reserve intervention should be defined according to price thresholds and not quantities. This would ensure that the carbon price moves in a corridor between a floor price and a ceiling price, similar to what the UK did a few years ago by establishing a carbon floor price (5). Sweden has carbon taxes. In France, this floor price question is debated and the desire is to reach a common view with Germany. However, countries having coal or lignite domestic production are not willing to establish such floor price.

Conclusions

The first directive liberalizing the European electricity markets celebrated its 20th anniversary at the end of 2016. It aimed at creating a single European energy market to produce benefits for end users with lower retail prices, and achieve a more competitive environment (6). Successive European legislative packages, as well as massively subsidized renewables deployment, impacted strongly on electricity markets, which became unstable with concerns about security of supply. These directives also failed to deliver what was their first objective – benefits for end users – as the latter are paying for renewables subsidies through specific taxes, and thus higher electricity prices. Energy market reforms are urgently needed.

The European Commission has issued a new legislative package, “Clean Energy for All Europeans”, which is currently negotiated. While this package should bring some improvements, it is not sufficient to restore a sustained market. More bold steps should be taken, but reaching agreement between 28 countries with different energy mixes and domestic resources is very hard.

In 10 years’ time (or less), technology improvements and digitalization will enable non-subsidized renewables, combined with mass storage, to have a significant share of the electricity mix, contributing to decarbonized energy consumption. Nuclear energy at competitive prices is a good dispatchable complement to renewables and should not be shut down, except for safety reasons.

The question is: what will happen in the next 10 years? One thing is certain: the path from now to then will be bumpy, for all players in this sector.

(5) In 2011 the initial carbon price was £16/t (due to increase to £30/t). Later, the UK government decided to cap the floor price at £18/t.
(6) http://ec.europa.eu/competition/sectors/energy/overview_en.html