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European Energy Markets Observatory

2014 and Winter 2014/2015 Data Set

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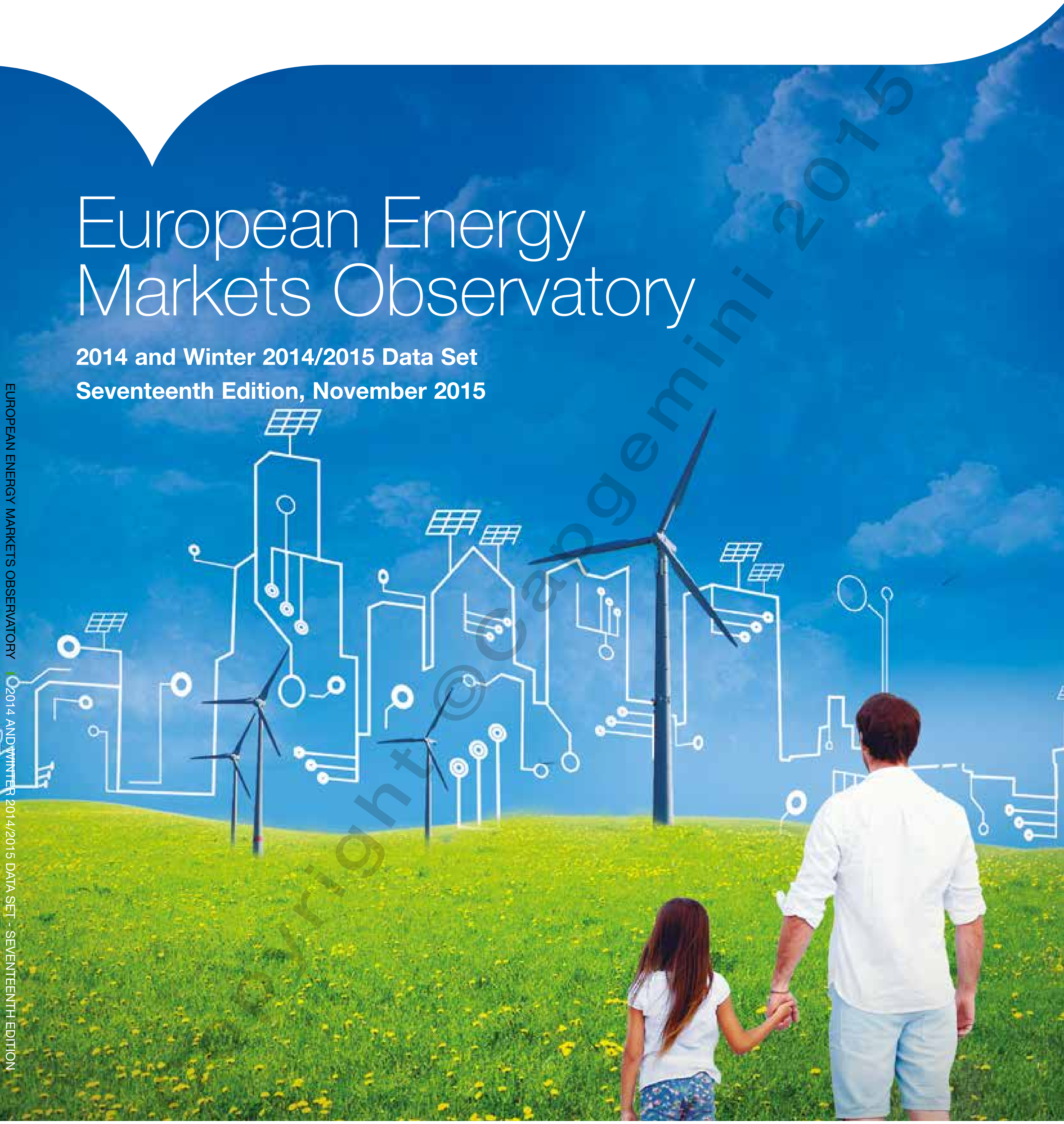

EUROPEAN ENERGY MARKETS OBSERVATORY | 2014 AND WINTER 2014/2015 DATA SET - SEVENTEENTH EDITION

In collaboration with

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NATIXIS

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Contents

Figures

Appendix Figures

Topic Focus

A Strategic Overview of the European Energy Markets

Editorial by Colette Lewiner

Introduction

The good news is that the European economy has started to grow again[1] putting an end to the 2008-2014 downward trend.

This growth is fueled by lower oil prices, the decreasing euro/dollar exchange rate (from 1.4 in May 2014 to 1.05 in April 2015), European monetary policy aimed at stimulating the eurozone economy, and US economic growth.

While developed countries are again enjoying some growth, developing countries' economies (e.g. Brazil and China) are slowing down.

Between 2008 and 2014, European gas consumption decreased and electricity remained stagnant.

The key questions are: Is this economic recovery strong enough to trigger a growth in electricity consumption, despite energy conservation measures? Will greenhouse gas (GHG) emissions grow again knowing that the crisis contributed to GHG reduction of 300 Mt over 2005-2011[2]? Combined with the February 2015 European Energy Union announcement, will this recovery be strong enough to restore robust electricity and gas markets giving the right economic signals to investors?

Despite chaotic electricity markets in recent years, sluggish consumption meant that electricity security of supply wasn't really threatened. Will this change?

EU-Russia tension over Crimea and Ukraine threatened gas security of supply. Will that continue?

Finally, what progress on climate change issues can be expected at the COP21 meeting in Paris in early December 2015?

This editorial aims at answering those questions and analyzes the impact of the digital revolution on energy transition policies and on Utilities.

1 In Q2 2015, seasonally adjusted GDP increased by 0.3% in the euro zone and by 1.2% year-on-year

2 Renewables development is the main GHG reduction factor (500 to 600 $MtCO_2$) over the period. "The CO_2 emissions of the European power sector: economic drivers and the climate-energy policies' contribution", Nicolas Berghmans, Benoît Chèze, Emilie Alberola, and Julien Chevallier, October 2014

Oil price decrease

Oil prices have fallen from US$115/bl in June 2014 to US$48/bl in September 2015. This big decrease is linked to OPEC's decision not to lower its quotas despite less growth in oil demand.

The latter is related to:

- Economy slowdown in developing countries;
- Transformation of China's economic model triggered by:
  - Manufacturing export markets slowdown,
  - Competition from other low-cost Asian countries such as Vietnam,
  - Increase in China's energy dependence,
  - Increased air pollution that has, notably, a negative impact on Chinese citizens' health.

In order to increase domestic spending and narrow the gap between wealthy cities and rural areas, China wants to transition from a manufacturing-oriented country to a less energy-demanding, service-oriented country.

Even though this change will be difficult, and will need significant public sector reform, it is probable that growth in demand for China's energy will slow down in the long term.

In the short term, China's growth has already been slowing down since mid-2015.

The reasons for keeping a high ceiling on OPEC oil production despite sliding prices are unclear.
It could be that Saudi wants to keep its market share and undermine all more costly energy sources (for example deep pre-salt oil, tar sand oil and shale oil).

- On the supply side, a debate is taking place on the future of shale oil and gas. Will their production slow down? In fact, the oil price drop has pushed the shale industry to plan and implement productivity gains of 15-20% in the first part of 2015[3]. In 2014, some analysts forecasted that when it fell below US$70/bl, shale oil production would stop. They are now revising this threshold downwards to US$60/bl.
  Thanks to shale oil production, US production increased in 2014 by 1.6 million barrels per day (Mb/d) to reach 11.64 Mb/d. As a result of Saudi's production[4] of 11.5 Mb/d, the US recovered its 1975 position of worldwide leader in oil production. Due to productivity gains in shale oil operations, the US Energy Information Administration forecasts that US output will grow by more than half a million barrels in 2015 before stalling in 2016.
- In addition, the global oil supply should grow next year when Iran resumes oil exportation after sanctions are lifted. The current oil price is anticipating that move;
- All other energy sources are threatened by the current low oil prices, for example:
  - Coal consumption grew in 2014 by 0.4% against a 10-year average according to BP's energy review. But supply cuts have been slow in coming so coal prices have dropped: thermal coal (used in power generation) has fallen from about US$120/t in 2012 to US$59/t in 2015. Demand for coal is not going to disappear – many countries are more worried by unreliable electricity supplies than by carbon emissions.
  - However, coal's share of global energy, now 30%, should fall to 25% by 2035,
  - As gas-fired plants emit 80% less CO_2 than coal ones, gas is viewed as a substitute to coal and many political and industrial leaders have committed to abandon coal in favor of gas[5].
    Thanks to cheap shale gas production, the US gas price is nearly three times lower than in Europe and nearly four times lower than in Asia. Thanks to oil price decrease, the gap between Europe's long-term contract prices[6] and spot prices has narrowed: in June 2015 it was only 10%.
    This cheap energy gives US-based producers a huge cost advantage over foreign competitors, especially in energy-intensive industries such as chemicals.
    Global gas consumption is forecast to increase by 2% per year between 2014 and 2035[7] and by 0.9% per year during the same period[8] in Europe,
  - Renewables, nuclear energy, and "negawatts" (energy savings) are also negatively affected by low oil prices. These points will be addressed in detail later in this editorial.

3 Declaration of shale oil producers: Continental Resources, Pioneer Natural Resources or Apache
4 BP Statistical Review of World Energy 2015
5 Bavarian G7 declaration in June 2015, large companies climate change forum statement
6 Long-term price includes 60% spot price
7 BP Energy Outlook 2035, February 2015
8 Medium- and long-term gas outlook, Cedigaz, February 2015

European policies

The EU climate and energy package has focused EU energy policy on sustainability and a low-carbon economy, neglecting two other equally important objectives: security of supply and competitiveness of European companies.

Year after year, the EEMO has emphasized the importance of security of supply and, more recently, following the shale gas revolution in the US, the threat to the competitiveness of Europe's high-consumption industries compared to their American counterparts.

The present situation:

- The 3x20 objectives for 2020 have led to a chaotic situation: wholesale market electricity prices have stayed low[9], not giving the right economic signal for investments, while retail prices continued to increase[10], affecting the European standard of living.
  The CO_2 price on the Emissions Trading Scheme (ETS) market stayed at €7/t which is far too low to promote low-carbon energy or investment in de-carbonized industry.
  Gas- and coal-fired plants have continued to shut down[11], weakening electricity security of supply;
- Several root causes explain this situation:
  - The adoption of three "independent" objectives[12] when there should be only one: GHG emissions reduction,
  - A short-term perspective (2020) compared to the time needed to industrialize non-mature technology such as renewables, to upgrade or build housing stock, to renew domestic equipment (such as white goods), to build public transportation infrastructures, and to change people's consumption habits,
  - Setting renewables development as an objective in itself when it is only one way to decrease GHG emissions. This, in the absence of competitive large-scale storage, has had negative impacts on network stability,
  - Subsidizing imported goods such as Chinese low-efficiency photovoltaic panels, made using old technologies, instead of helping to build a innovative European industry;
  - Failure to deal with the impact of the economic recession on CO_2 emission rights and to manage the ETS market which, like all markets, needs to be controlled and guided.

The Energy Union principles, announced in February 2015, are based on broader objectives than the climate and energy package. These are: security of supply, sustainability and competitiveness. To reach these objectives, the Energy Union focuses on five "pillars": energy security, solidarity and trust; the completion of a competitive internal market; energy efficiency; de-carbonization of the EU energy mix; and investment in technologies for research and innovation.

When analyzing the Energy Union intentions, it appears that competitiveness, including carbon leakage[13], and security of supply are the least well-addressed.

Research and innovation are addressed through Horizon 2020, the EU Framework Programme for Research and Innovation, with nearly €80 billion of funding available. Research and development topics that are worthwhile funding are considered later. Significant RD&D[14] budgets have been already spent, comparable to US expenditure. However, the EU decision-making process (with 28 Member States) is very complex, the stringent project partnership rules sometimes exclude good quality research teams, and European Commission (EC) project management is often weak.

Also, while large budgets were allocated to renewable energies, perhaps not enough went to other areas such as electricity storage, high voltage DC[15] cables, mobility or to new de-carbonized electricity generation technologies such as small modular nuclear reactors.

What follows is an analysis, based on the EEMO findings, of the state of the main issues covered by the five Energy Union pillars and of the EU initiatives, and some recommendations.

Energy security of supply and internal market development

These objectives are strongly linked as enhanced solidarity between EU members through better connections improves security of supply.

The current position:

As described above, the electricity wholesale market is currently chaotic with periods of negative prices

9 On average, European electricity wholesale prices have decreased by 10% in 2014 compared to 2013

10 On average, residential electricity retail prices in 2014 were €207.9/MWh in EU-28 and have increased by 2.9% in H2 2014 compared to H2 2013

11 About 10,000 MW of coal- and gas-fired plants were shut down in 2014

12 20% renewable energy share in the energy mix, 20% GHG emissions decrease compared to 1990, 20% energy savings compared to 2005 projection

13 Carbon leakage: when, for reasons of costs related to climate policies, businesses transfer their production to other countries that have less strict constraints on GHG emissions, the end result is an increase in their total emissions.

14 RD&D: Research, Development & Demonstration

15 DC: direct current

(64 hours, for example, in Germany in 2014). In fact, the market is oversupplied but not by the right types of energy generation. There is too much volatile generation capacity (solar and wind) and not enough schedulable generation (nuclear and gas-fired plants).

Infrastructure investment requirements for electricity and gas are estimated at €1,100 billion[16] for the next 10 years (of which €500 billion has to be invested in generation, €400 billion in the distribution network and €200 billion in transportation grids). It is clear that current market prices are giving the wrong signal to investors.

Gas plant closures have continued, threatening security of supply.

- However, the **capacity markets**, finally accepted by the EC, should improve the situation.
  Capacity markets have all the same objective – to maintain the generation capacity needed during peak periods – but European capacity markets are built on different models:
  - *Strategic reserves:* capacity designed to ensure security of supply in exceptional circumstances is placed in reserve. These reserve plants cannot take part in commercial electricity exchanges. This model has been adopted in Spain and Sweden,
  - *Capacity obligation:* suppliers are required to contract a certain level of capacity from generators at a price agreed between the parties. France has adopted this model and is due to start in winter 2016-2017,
  - *Capacity auction:* the total required capacity is set several years in advance by the transmission system operator (TSO) or the regulator. The price is set by forward auction and paid to all participants in the auction.

  The results of the first UK auction for 2018-2019 were announced in January 2015. Through this auction, the government procured 50 GW of capacity at a high clearing price of £19.40/kW,
- Another positive trend is the **interconnections** development that improves security of supply.
  In 2014, 17 European countries market places were reunified, making it possible to buy day-ahead electricity in all those countries, provided that interconnection capacity is sufficient. Since May 2014, the electricity markets of three EU zones (South West, Central-West Europe, and Nordpool) have been operating under a common day-ahead power price calculation using the Price Coupling of Regions (PCR) solution;
- On October 23, 2014, the European Council announced objectives for interconnections: each Member State must have interconnection capacities amounting to at least 10% of their peak capacity and to at least 15% by 2030. Many EU members (such as the UK, Italy and Spain) do not meet the 10% threshold.
  The EU has allocated funds for priority electricity interconnection corridors. In 2014 and early 2015, four important interconnections were inaugurated, such as the one between France and Spain (a project that took 25 years to complete and that is partly underground). These interconnections represent an investment of about €1.4 billion.
  Many transmission lines are under construction – for example, France-Italy, Lithuania-Sweden, and Portugal-Spain – and at the planning stage – for example, France-UK (the UK is currently a net importer but it should become a net exporter around 2025, when its nuclear plants start operating);
- In 2014 and early 2015, security of supply questions focused on **gas**, in view of the Ukraine-Russia tensions that started during summer 2014 and are continuing.
  Following Russia's invasion of Crimea, EU sanctions against Russia were agreed and implemented in summer 2014. During 2015, tensions have been increasing and the specter of the Cold War has resurfaced.
  One way to improve gas security of supply is to diversify import pipeline routes. After the successful completion of the Nord Stream pipeline, Russia had intended to build South Stream to connect Russia and Austria via the Black Sea, Bulgaria and Hungary.
  On December 3, 2014, Vladimir Putin announced Russia's withdrawal from that project in favor of a shorter pipeline, Turkish Stream, which would go to Turkey. It had been expected that gas would start to transit through this pipeline in 2016, but in September 2015, it appeared that the project had been dropped.
  Many reasons, including administrative ones, could underpin these decisions but the main factor is probably the unprofitability of these huge investments while gas demand is decreasing in Europe.

EU initiatives:
The EU has a range of proposals regarding energy security of supply and internal market development, such as: exploring new technologies, further developing indigenous resources, and improving infrastructure to access new sources of supply (including LNG).

On the first two points, and unlike the DOE[17], the EU has not really boosted shale gas development. Some general rules and recommendations were drafted but nothing else. Nevertheless, some projects are going ahead in the UK and Eastern European countries but progress is slow.

16 "Energy priorities for Europe", a presentation by J.M. Barroso at the European Council on May 22, 2013

17 DOE: US Department of Energy

Also, as European gas demand has decreased, no new LNG regas infrastructure is needed as existing regasification terminals are operating at only 20% of their capacity.

Despite opposition from large US gas consumers fearing that shale gas exportation would lead to price increases, the first LNG gas from Sabine Pass will be shipped in late 2015.

In 2014, gas storage capacity increased by 9.4% compared to 2013; however, with decreasing gas demand, the return on those investments is low.

Regarding electricity, the Commission has committed to provide enhanced rules for cross-border energy trade. In terms of finance, in addition to specific energy-related financing for CEF[18], the European Fund for Strategic Investments (EFSI), also known as the Juncker fund, will provide finance for energy infrastructure projects. However, the procedures to access this fund have so far been complex.

Recommendations:

- Domestic gas resources should be developed when it is economic to do so, and shale gas exploration and production should be encouraged when appropriate;
- A true European grid should be built. Even though significant progress has been made with interconnections, the European grid is still a juxtaposition of national grids. Studies are being made of "supergrid" projects[19] with the aim of designing and building a new high-voltage grid overlay (with DC[20] current) managed at European level. This new seamless grid would enable optimization of the European energy mix as some countries (Spain, for example) provide more electricity from renewable sources (such as solar) and others (like France) provide more from nuclear sources. In addition, peak consumption times vary from one country to another and peak demand at the European level would be relatively less pronounced. Balancing these different sources of energy with more level demand would potentially save between €60 and €100 billion per year by 2030[21].

Energy efficiency

This is one of the main ways of decreasing energy demand.

The current position:

Of the three 2020 objectives set by the climate and energy package, energy consumption decrease is the most difficult to meet.

There are many root causes of this situation:

- Transportation is the main energy-consuming sector, accounting for 32% of EU-28 final energy consumption. Today, public transportation projects to save energy are slow to build because of complex administrative procedures and difficulties in financing;
- Complexity in buildings renovation because of the numerous stakeholders, and lack of trusted advisors and financial incentives. The stakes are very high as savings in buildings consumption worldwide is equivalent to transportation sector consumption;
- Slow changes in individual behavior in terms of consumption patterns;
- In general, energy prices are relatively low and the return on investment in energy-saving projects is not high enough.

EU initiatives:

Based on the on-the-ground experience of Member States, the Commission will support ways to simplify access to existing financing to make building stocks more energy efficient.

Recommendations:

In reality, the Commission has a limited playing field as decisions are taken at a much more granular level:

- Information and persuasion are important levers as energy consumption is very much linked to cultural and behavioral issues. Targeted information campaigns are a means to achieve this objective, using messages that are simple and easily accepted;
- Regulations and standards are also very good tools for reducing energy. For example, European regulations led to significant reductions in car fuel consumption and CO_2 emissions (-5.2% in energy consumption by road transport and -6.3% in CO_2 emissions from all modes of transport over the past decade). In addition, regulations regarding energy consumption of white goods are effective;
- Low-energy regulations are efficient at reducing new buildings' energy consumption but also at imposing new perceptions in this sector. Some construction companies, such as Bouygues in France, are proactive in promoting low consumption and even positive energy buildings, as they believe that building "traditional" offices or housing will lead over time to stranded assets.

Decarbonisation of the economy

The unique EU objective of a 40% GHG emissions decrease in 2030 compared to 1990[22] is better than the 3x20 targets in the climate and energy package. It

18 CEF: Connecting Europe Facility

19 European electricity grid infrastructure expansion in a 2050 context, Jonas Egerer, Clemens Gerbaulet and Casimir Lorenz, May 2013

20 DC: direct current as opposed to AC, alternative current

21 Michel Derdevet: "Energie, l'Europe en Réseaux" Documentation Française

22 This 40% GHG emissions reduction objective was adopted by EU leaders in October 2014. The two other objectives, 27% of renewables in the energy mix and 27% energy efficiency, are binding at EU level and only guidelines for Member States

addresses the right challenge, which is climate change, and does not impose too rapid development of renewables, which are still maturing technologies.

The current position:
The ETS market has failed to deliver the right price signal as today's price of around €7/t is insignificant and gives no price incentive for carbon-free technology.

Too many emission rights were allocated during the pre-crisis period. Thus, today there is a bubble of emission rights on the market pushing down prices. The EC was not proactive enough to manage this situation. After two years of discussion, it succeeded in backloading 900 Mt to the end of the third period (2020). This measure was in the right direction but the amounts were too small, so the market did not react positively and prices stayed low.

Based on an EC proposal from 2014, the European Union has adopted in September 2015 a legislation to reform the EU ETS by introducing a market stability reserve (MSR)[23]. This mechanism allows the neutralizing of negative impacts of the market surplus on low-carbon investment incentives. The co-legislators are currently negotiating elements of the MSR proposal, which will determine the pace of absorbing surplus allowances into the MSR.

EU initiatives:
In order to deliver the 40% GHG reduction in 2030, emission reductions of 43% for sectors in the carbon market (that is, within the ETS) and 30% for sectors outside it (non-ETS sectors) are required, compared to 2005.

Beyond the MSR, the Commission will propose further changes on how the ETS should operate in the decade up to 2030. This includes an increase in the linear reduction factor (the rate at which the emissions cap is tightened from year to year) from 1.74% to 2.2% as of 2021.

In addition, legislation will be changed to allow some industries to benefit from carbon leakage measures and free allocation of emission allowances beyond 2020.

Finally, changes to the ETS directive will be made to create a legal basis for establishing an innovation fund and a modernization fund, both financed with the money paid for emission allowances in 2021 to 2030.

Recommendations:
As atmospheric pollution does not stop at EU borders, all emissions (EU and non-EU) generated by EU activities need to be accounted for.

There is a need to accelerate ETS market reform. The MSR is a good first step but more vigorous market management measures are needed, such as the creation of a central bank of carbon allowances[24]. This raises the question: what is the right GHG emissions rights price level?

In Europe, the UK introduced a carbon floor price in 2013, froze its level at £18/t (€25/t) in March 2014, and plans future increases. However, the theoretical price is much higher: it is the price needed to enable the marginal technology for CO_2 emissions reduction to be competitive. This technology is probably CCS[25] and the price would be more than €40/t.

Decarbonized generation

Renewables

The 2020 objective of 20% renewable energies in the energy mix should be achieved.

- In 2014, US$270.2 billion was invested in renewables worldwide and US$57.5 billion in Europe. There was a record 51 GW in installed wind turbines. Solar PV[26] installations amounted to nearly 40 GW. Investors come from different categories: individuals for small PV rooftop installations, construction companies, project management companies and investment funds. Utilities have also continued to invest:
  - Iberdrola has invested over €750 million in renewables in 2014,
  - EDF, through its EDF-EN subsidiary, has 4,388 MW in wind and 516 MW in solar,
  - On July 1, 2015, ENGIE (ex GDF Suez) announced its acquisition of Solairedirect for around €350 million, making it the leading French player in solar power, with an installed base of 383 MW,
- There was significant technology progress both in solar PV generation and in wind power, and more can be expected in the future.
  Photovoltaic cell efficiency has increased: for example, Sunpower (US) cells have hit a record of more than 25% efficiency for silicon cells. Cell production and assembly have also improved. Overall, solar PV prices have decreased by 80% from 2008 to 2014. More progress and lower costs are expected in the future.
  Offshore wind turbine capacity is increasing and the technical achievements are impressive. Thanks to its 150-meter diameter rotor, the new 6 MW Alstom turbine has a yield 15% better than existing offshore turbines. Improvements have been made in coupling wind strength with turbine operations, and in linking electricity output with grid status;

23 The MSR has been adopted by the European Commission mid 2015

24 Europartenaires report "Énergie, Climat et Prospérité: L'Europe attend des décisions fortes" (lead author Claude Mandil), September 2015

25 CCS: carbon capture and storage

26 Solar PV: the use of solar photovoltaic panels to generate electricity

- Despite this progress, and except for onshore wind, these renewable technologies are still expensive[27];
- In addition, they have a dual negative impact on the grid:
  - As their marginal costs are zero, they come first in the merit order used by dispatchers to connect plants to the grid. So they are brought online first and the gas plants that have high marginal costs are brought on line last (for only a few hours). It is thus not profitable to continue to operate them and that is why they are closing.
    In countries like Germany, on days where there is a lot of wind or sun, nearly all generation is provided by renewables, pushing wholesale prices down towards zero or even into a negative zone.
    This negative price is misleading and does not reflect the reality that investment is needed in schedulable generation,
  - Cost of grid: electrical grids have to continue to balance uncertain demand with an increasingly uncertain supply due to renewable energies being unschedulable. Grids need to become smarter (see below) and will have to be reinforced to connect the new dispersed renewable installations. In addition, when a massive shift from centralized large generation plants to decentralized smaller renewable units occurs (as in Germany), the grid would have to be redesigned and partially rebuilt. This would be complex and onerous. On average, these grid-related issues lead to 30%[28] extra-costs that have to be added to the cost of renewable generation.
    To overcome these difficulties, competitive large-scale storage technologies are needed but their development is slow,
- Due to their ease of implementation and apparently simple nature, direct support for renewables through subsidies, tax measures, or guaranteed prices has been very heavily used in Europe. As mentioned above, the resulting growth in renewables was spectacular.
  However, these tools present some big disadvantages: in the long term, they can trigger unacceptable energy drift, they protect inefficient technologies and therefore do not always promote technical progress, and they cause major distortions in the markets by removing any meaning from the signals given by prices;
- In addition, these subsidies, ultimately paid by customers, are pushing up retail prices. For example, in 2006, German prices were 58% higher than French residential prices whereas today they are almost double. Spanish residential prices were 68% higher than French prices in 2014, but were similar in 2006. This discrepancy results from renewables having a different share in the electricity mix in Germany (39%), Spain (28%), and France (11%);
- Some Member States and the EU are trying to curb these increasing costs and have adopted new market rules in order to integrate renewable production efficiently into the market. In July 2013, the Spanish government introduced a "definitive reform" aimed at reducing the tariff deficit (estimated to have reached around €30 billion at the end of 2013) by €4.5 billion per year. The main measure is removal of feed-in tariffs. German electricity retail prices are among the highest in Europe. In August 2014, Germany revised its energy law: starting in 2017, feed-in tariffs will be replaced by a premium on wholesale market prices. This has the benefits of stabilizing the EEG Umlage[29] and triggering a virtuous behavior by renewable installations operators who will decrease their electricity output when the market is already oversupplied and the prices low.
  In April 2014, the EU adopted a similar position to Germany.
  In France, the government is considering extending the CSPE tax (levied on electricity bills to fund renewables) to include all forms of energy.

Nuclear energy

Existing nuclear plants are generally considered to be safe and are competitive. For example, the existing cost of nuclear power in France is €59/MWh[30], which is lower than offshore wind and combined cycle gas turbines.

In some countries (e.g. Spain, France, Belgium, and the UK), programs to extend reactor lifetime beyond 40 years have been launched, with the knowledge that a majority of US nuclear plants have obtained 60-year lifetime permission from the Nuclear Regulatory Commission[31].

EDF, the French nuclear operator, has decided to launch a €55 billion program called the Grand Carénage (major overhaul) to:

- Increase its reactors safety by including new safety features

27 In France, renewable costs were in 2013, in the range of €60-80/MWh for onshore wind, €60-90/MWh for solar PV and €100-150/MWh for offshore wind compared to hydropower at €55/MWh and existing nuclear at €60/MWh

28 See EEMO 16th edition editorial

29 EEG Umlage: the German tax on electricity to support the extra-cost of renewables

30 As calculated by the French Government Accountability Office

31 It is interesting to note that some US operators have decided not to extend reactor lifetime because of competition from cheap shale gas plants

resulting from lessons learned after the Fukushima accident;
- Obtain ASN[32] permission to extend the lifetimes of its 58 reactors to beyond 40 years.

This large industrial program will last until 2025.

Existing nuclear reactor operations and safety are well under control, but construction of **new, third-generation reactors** is proving more difficult than anticipated with long delays and cost overrun. As investment costs represents around 80% of the electricity cost, overcoming construction delays and cost issues is essential to keeping nuclear electricity competitive.

There are many reasons for these difficulties, which are also affecting the Areva EPR[33] and the Westinghouse AP1000:
- Third-generation reactors that include new safety features are still first in kind, and have complex design issues and construction difficulties[34]. An EPR simplification project (EPR NM) has been launched jointly by EDF and Areva in order to decrease construction time and cost while maintaining third-generation safety levels;
- Managing large projects such as the construction of nuclear plants is difficult; similar problems are experienced by oil and gas companies on large offshore production platforms;
- The nuclear industry was out in the cold for more than 10 years (1997-2007 in France). During that time, no new reactors were built and thus recruitment was low and no managers were able to be trained on large projects. Recruitment has restarted (EDF recruited 1,500 engineers in 2014) but it takes time to train managers of large projects, especially in the nuclear sector;
- With EU electricity consumption stagnant Europe, the need for new large plants is less pressing;
- Public opinion and politicians have become more cautious about nuclear energy, and nuclear safety authorities have become more demanding;
- Finally, successful nuclear industry companies such as Areva are now facing financial difficulties. To maintain important key competencies for construction of new reactors and for services to existing ones, at the end of July 2015, a memorandum of understanding was signed by EDF and Areva in order for EDF to start the acquisition process to become a majority shareholder in Areva NP (the nuclear power part of Areva).

It is important that the nuclear industry overcomes these difficulties, as nuclear energy is needed to control GHG emissions in order to limit global warming. The International Energy Agency (IEA) has calculated that the use of nuclear energy has avoided releasing 56 Gt of CO_2 since 1971.

Climate change – COP21

Controlling GHG emissions is critical to combating global climate change.

In this regard, the results of the COP21 meeting in Paris will be crucial and it is reasonable to ask what might be expected from this UN conference.

Looking first at the achievements since COP20 in Copenhagen, it appears to be a mixed picture.

In Copenhagen, the EU delegation was unable to convince representatives from other regions to commit to quantified GHG emissions reduction.
It should be recognized that these commitments are not acceptable for developing countries that don't want to jeopardize their necessary economic development. They rightly say that the current level of atmospheric pollution by GHG is due to the economic and correlated emissions growth of developed countries.

Despite this inauspicious position, there are some positive milestones:
- US-China commitments: in November 2014, the presidents of the US and China announced their respective post-2020 actions on climate change. The US intends to achieve an economy-wide target of reducing its emissions by 26-28% below its 2005 level in 2025, and China intends to achieve the peaking of CO_2 emissions around 2030.
  - As described above, China plans to switch from a manufacturing country to a service country with lower energy consumption and GHG emissions.
    In early July 2015, and in preparation for the COP21 conference, the Chinese Prime Minister, Li Keqiang, committed to reducing China's carbon intensity per unit of GDP by 60-65% by 2030 (compared to 2005). He confirmed the President's earlier commitment to reach 20% of non-fossil fuel in China's energy consumption by the same date. This commitment entails building non-fossil energy sources

32 ASN: Autorité de Sûreté Nucléaire (French Nuclear Safety Authority)
33 EPR: European Pressurized Reactor (1,600 MW)
34 Flamanville EPR construction is likely to take more than 10 years and its cost could be triple the initial figure

equivalent to Japan's total energy capacity,

- President Obama has put climate change issues at the heart of his remaining mandate policy. However, as he no longer has a majority in the Senate, he is trying to impose through EPA stricter regulations on car fuel consumption, on coal plants (under the Clean Power Plan – CPP), and more recently on airplanes. EPA is finalizing the CPP regulation and stakeholders' negative reactions will trigger lengthy legal battles. Cheap shale gas is replacing coal in fossil fuel fired plants, thus helping to limit the increase in CO_2 emissions (in 2014, US emissions increased by "only" 0.7%).
  In addition, there are significant state incentives for renewables and efficiency,

- At the Copenhagen Climate Change Conference in 2009, and then in Cancun in 2010, developed countries committed to fund poorer countries to help them transform their energy systems and adapt to climate change.
  In early June 2015, G7 leaders at the Bavaria summit reaffirmed their 2009 pledge to provide funds rising to US$100 billion per year by 2020 from public and private sources to help poorer countries; but they failed to offer the details many developing nations want. As at mid-2015, only US$10 billion had actually been allocated to the fund.
  At the same summit, the G7 leaders said they wanted GHG emissions cut by 40-70% by 2050 from 2010 levels[35]. This is a more precise long-term target than previously agreed. There is much uncertainty on how the emission pledge that countries are due to make in the Paris COP21 summit will be monitored and stepped up in the coming decades to ensure that the broader de-carbonization plans backed by the G7 are actually carried out.
  In addition to the level of real funding, successful transfer of technologies from richer to poorer countries has to overcome at least two difficulties:
  - Protection of developed countries' industrial and intellectual property rights,
  - Implementing these new technologies requires a certain level of education and industrial development,
- Europe was to some extent the "good student in the class". However, the economic crisis has contributed significantly to its CO_2 emissions reduction, for which the population paid a high price. To maintain the decrease in CO_2 emissions when the economy improves, Europe must ensure consistency between the various measures taken to reduce CO_2 emissions (e.g. ETS, renewables and energy efficiency) because they generate very different costs for the community and give inconsistent signals to the market.

Whatever progress is accomplished at the December 2015 Paris meeting, a higher than 2°C temperature increase of our planet is to be expected, with consequences such as a higher sea level and an increase in the frequency of exceptional weather events. It is therefore important to identify and implement adaptation measures at all levels (national and local governments, regulators, industry, buildings and transportation sectors, etc.).

They include:

- Industrial assets design: for example, if the Fukushima plant emergency auxiliary motors that provide electricity in the absence of the grid had been built at a higher level, they wouldn't have been flooded by the tsunami and the cooling systems would have continued to work. This was the case at other Japanese nuclear reactors, and it's why the catastrophic situation of Fukushima didn't occur in those places;
- Development and maintenance of dikes to protect cities. The lack of rigorous dike maintenance, in particular, led to the catastrophic floods in New Orleans in 2005;
- Building walls to protect against rising water levels;
- More accurate forecasting of exceptional climate events (hurricanes, tsunamis, floods, etc.).

Good governance of companies requires an annual risk review and mitigation measures at board level. An assessment of climate change related risks should now be included in those annual reviews.

Energy transition

Key success factors

Energy transition policies must comply with the same objectives as all the other energy policies: transition to a low-carbon economy, security of supply, and economic development. Unfortunately, often the first objective is the only aim. These three objectives are interdependent.

- A low-carbon economy implies decreasing fossil fuel consumption. As Europe is importing 12.6 million of oil barrels per year and 365 bcm of gas, these importation savings improve security of supply and save significant amounts on the balance of trade;
- Similarly, a successful energy transition policy has to aim at decreasing energy consumption, which in turn improves security of supply;
- Also, energy savings create local jobs (for example in building

35 Note that Kyoto protocol refers to 1990

refurbishment), which should boost the economy;
- Finally, creating a European renewables industry will allow domestic development.

Despite the fact that the present situation is different from this ideal world, movement in that direction needs to continue but it has to be done in a comprehensive manner:
- The timing and pace of change need to be right and not too fast as investment funding is limited and individual habits are slow to change;
- More needs to be invested in R&D and less on deploying large-scale non-mature and non performing technologies.

Energy transition policies should accelerate the emergence of competitive electricity storage and boost high-tech, European renewable energy industries:
- Safe, competitive nuclear plants that don't emit GHG should not be phased out; their lifetime should be extended if the relevant nuclear safety authority agrees;
- Administrative procedures to build the electricity lines needed to accommodate more decentralized electricity generation have to be simplified. Today, because of public opinion opposition to overhead lines and multilayer procedures, it takes 10-13 years on average to build a new line in Europe.

Energy transition projects are different from one country to another

In **Germany**, after the Fukushima accident, the Chancellor decided to phase out the 17 nuclear reactors that contributed around 25% of the country's electricity generation.

At the same time, an ambitious renewable energies program was launched with the objective of becoming 80% of the energy mix by 2050.

- In economic terms, the German experience so far is not convincing. Comparison with the French figures is revealing. The French nuclear power program represents a total capacity of 63.2 GW, installed over a 20-year period between 1970 and 1990. Renewable energies in Germany represent 60 GW over 20 years from 1993. On paper, these figures are comparable; total costs are also close: €96 billion for France and €120 billion for Germany. The major difference lies in production: in 2013, French nuclear facilities produced 410 TWh while German renewables, in the same year, produced 75 TWh[36].
  The German energy transition cost is estimated at US$1,700 billion until 2030.
  On the environmental side, results are mixed: after growing during 2010-2013, GHG emissions decreased in 2014 by 4%. This encouraging result is mainly explained by the mild winter and lower energy consumption;
- The overall impact on the grid of the generation pattern change, with nuclear plants closures and renewables development, was under-estimated. Replacing centralized nuclear generation in the south of the country with decentralized offshore wind in the north, has triggered the need to build north-south electricity lines to transfer electricity from the north to the south.
  This is proving to be difficult, mainly because of public opposition to overhead lines and multilayer procedures. Also, the regional organization of the country adds complexity.
  The subsidized renewable energy increase in the electricity mix has led to an increase in the EEG Umlage: it rose from €13.4/MWh in 2009 to €62.4/MWh in 2014 and decreased slightly in 2015 to €61.7/MWh, as a result of the new energy law.
  German electricity prices for

36 Philippe Chalmin Paris-Tech magazine, December 2014

domestic customers are among Europe's highest. The situation is different for large energy consumers which, at a cost of around €5 billion per year to the country, are exempt from certain taxes (such as EEG) in order to maintain their competitiveness. For these 2,000+ customers, German prices are 8-21% lower[37] than French ones.
Despite these German exemptions, and thanks to cheap shale gas, a Texan electro-intensive industrial company (in chemicals, for example) pays for its electricity only half of what its German competitor pays;
- At the Sixth Petersberg Climate Dialogue in May 2015, Chancellor Angela Merkel committed to a 40% reduction in GHG emissions by 2020 (compared to 1990) and to an 80% decrease by 2050.
Even with efficient energy conservation measures and accelerated renewables development, this objective could only be met by closing Germany's lignite and coal plants[38].
This lack of generation capacity could jeopardize the electricity supply unless imports are increased from neighboring countries (such as France and the Czech Republic, which both have electricity from nuclear power plants). This should be possible if those countries don't prematurely phase out their nuclear plants and if interconnection capacities are sufficient.

After a lengthy process, the **French energy transition bill** was adopted on July 22, 2015.
The main objectives are:
- 50% energy consumption decrease by 2050 (compared to 2012);
- GHG emissions decrease of 40% by 2030 (in compliance with EU objectives) and of 75% by 2050;
- Renewables share in the energy mix of 23% in 2020 and 32% in 2030 (with 40% of electricity generation). A new incentive mechanism for building renewables capacity will be established with a premium on market prices paid to producers;
- 30% reduction in primary fossil fuel consumption by 2030 (compared to 2012);
- 500,000 houses to be renovated per year starting in 2017. This objective was previously announced in 2012 but is far from being reached;
- The transportation sector is in France the main GHG emitter (27%). Objectives have been set to develop electric or hybrid vehicles, and to deploy 7 million electric vehicle charging stations by 2030.

François Hollande's election promise to reduce the share of nuclear in the national energy mix from 75% in 2015 to 50% by 2025 has been adopted in law.
In the shorter term, the law has capped current nuclear capacity at 63.2 GW.

This means that if a new nuclear power plant is connected to the grid, the equivalent nuclear capacity has to be phased out elsewhere.

The new EPR nuclear plant at Flamanville had been scheduled for connection to the grid in 2017. This would have meant discontinuing 1,600 MW of nuclear capacity, and the two Fessenheim reactors (which are the oldest and are located near the German-Swiss border) would have had to be closed.

However, technical and regulatory difficulties are delaying the Flamanville starting date and it will only be connected to the grid end 2018, which means no reactors will have to close in 2017.

In addition, closure of the Fessenheim reactors is raising strong opposition from unions and the local population, which anticipate job losses. A parliamentary report has estimated the cost of closure at €5 billion.
In 2014, Minister of Ecology, Sustainable Development and Energy, Ségolène Royal, did not exclude the possibility of selecting reactors other than those at Fessenheim for closure. This demonstrates clearly that the closure decision is political and symbolic, and unrelated to safety issues.

Of course, 2017 is an election year in France and a conservative government if elected could decide not to close the Fessenheim reactors or other reactors.

In fact, the French energy transition law is more of a general framework, and specific undertakings will be defined in the PPE[39] five-year plan.
After adoption, large Utilities and, in particular, EDF (of which 83% is owned by the government) will have to apply the agreed measures.

The law is ambitious in terms of decreasing fossil fuel consumption and of energy efficiency,
especially in the building sector, but the allocated funding is insufficient. According to experts, an extra €10-30 billion per year will be needed. This will be challenging considering France's large and rising public debt.

37 Roland Berger 2014 study

38 In 2014, coal and lignite generation contributed to 45% of the electricity mix. In July 2015, the German government decided to close around 10 lignite and coal plants (2.7 GW). These plants would be put in strategic reserves. This decision would cost €250 million per year

39 PPE: Programmation pluriannuelle de l'énergie (multi-year energy plan)

The Utilities sector is undergoing a profound transformation

This energy transition trend coincides with a very large and sustained revolution: the digital revolution. Energy transition involves changes in business and operating models, such as distributed generation; complex management of the electricity grid with an increasing share of renewables (smart grids); demand-side management; new consuming patterns; smart meters improving operators' knowledge of customers; data mining; new customer relationships and expectations; Internet of Things related services, and so on.

In addition, new players trying to enter the Utilities value chain in the areas of both generation and customer services are a potential threat to Utilities' businesses.

Due to tough market conditions (see above), Utilities' financial situation remains difficult. Operational costs have become hard to shed following many waves of operational efficiencies programs.

In this dual context of managing energy transition while improving profitability, it is imperative that Utilities fully and rapidly implement digital transformation in order to provide multiple levers to improve customer experience and the operational processes, and to motivate younger, Y generation employees.

The digital revolution

We are entering into a new digital era with enhanced mobility, virtual (via the Internet) communication, social media, Internet of Things, machine-to-machine communication, cloud computing, and so on. More and more data will become available and data analytics, modeling and new usages are developing.

We are only at the beginning of this revolution.

Energy transition will be enabled and accelerated by this digital revolution. It will affect both internal Utilities' operations and customer behaviors and demands.

All parts of the Utilities value chain will be affected:

- Generation, especially decentralized generation, will change. For example, gathering more data on wind turbines' electricity output will improve modeling of wind power generation on an hourly, daily, weekly and annual basis. This in turn improves grid balancing and allows a higher proportion of renewables in the electricity mix;
- Smarter grids will incorporate more stabilization equipment[40] and more sensors.
  Electrons, but also megabytes, will flow on these grids. Again, data collection, data cleaning, and improved modeling will lead to better grid operations. Since 2002, nearly 460 smart grid projects in 47 countries have mobilized hundreds of stakeholders for a total investment of €3.15 billion[41]. Lessons learned from those projects should allow improvements both in grid operations and in knowledge of customer behavior;
- Smart meters are the first smarter equipment and 72% of European customers will be equipped in 2020. Smart meter deployment has at least two benefits: improving electricity flow information and enabling better maintenance; and providing detailed information about customers and their energy consumption. Combined with time-of-use tariffs and targeted customer information, this knowledge should incentivize customers to defer part of their consumption (around 15%[42]) during peak periods to off-peak times. Decreasing peak power intensity has positive impacts on the grid and on plant investment, and increases security of supply.
  Disappointingly, it appears that the impact of smart meters on energy consumption is low (around 5%[42]);
- Real-time energy management combined with decentralized generation (mainly solar PV) and storage should directly connect supply with demand and improve grid management.
  In 2014, in Germany, around 6 million customers used electricity they produced themselves for part of their needs.
  Tests are being conducted on specific types of electrical equipment that only run when electricity is cheap because high volumes are being generated by renewables. One possibility is to use the excess energy to manufacture methane from hydrogen and carbon dioxide. The electrical energy is used to produce hydrogen from water; carbon dioxide can be obtained from biomass gasification, cement plants, or carbon capture from coal-fired power plants. Additionally, the methanation process releases heat, which can be used in other processes. The generated methane can then be fed into existing natural gas grids that have storage capacity. Many projects are being undertaken, using different technologies, and sponsored by public bodies (such as the German Federal Ministry of Education and Research – BMBF), industrial companies, and gas grid operators. These projects should lead to a decrease in methanation costs, which are still too high;

40 Impedance matching in order to better control the reactive current
41 Smart Grid Projects Outlook 2014, European Commission
42 Demand Response study 2012 – Capgemini Consulting, VaasaETT and Enerdata

- Electric vehicles are emerging. Their range should increase from 300 km in 2020 to 500 km in 2030, with a forecasted number of 30 million e-vehicles in Europe by then.
  A recent European Directive[43] has ensured greater interoperability of charging stations. Building European corridors of 1,750[44] charging stations, each 80 km apart, on 70,000 km of highways linking Poland to Portugal and the UK to Greece would require investment of around €450 million[45].
- E-vehicle development will have a significant impact on distribution networks, which would need to be reinforced. Long-distance trips would necessitate quick recharges, using a lot of power from the grid. In order to limit the need for grid reinforcement, deployment of recharging stations has to be optimized.
  There is a clear link between smart grids and e-vehicle growth. The concept of vehicle-to-grid, which would use the million future batteries connected to the grid to balance renewables intermittence, is being tested in Germany and Austria[46]. However, as before, these ideas depend on battery cost and performance improvements;
- Hydrogen will have a role in future storage and mobility.
  Electric cars that use hydrogen produce water as result of the electrolyte reaction and emit no CO_2. When taking into account the total process (hydrogen produced using natural gas) the CO_2 emissions are 20-30% lower than for existing cars. In the future, it could be possible to produce competitive hydrogen by using cheap excess electricity from renewables.
  Some vehicle manufacturers are already selling expensive hydrogen-fueled cars[47].
  There is also a need to build a charging infrastructure, although each charging station would costs around US$1 million.
  As the technology develops, all those costs should decrease; this is a prerequisite to hydrogen development for mobility.

New trends in customer relationships

Electricity and gas customers are looking for more flexible and reactive suppliers.

In many cases, they would like more added-value services. Utilities are expanding in this field, which is less capital-intensive and thus suited to their weak balance sheets.

- Internet of Things development (worldwide estimates suggest 30 to 50 billion[48] connected objects[49] by 2020 compared to 9 billion today) will improve the granular energy management. However, it will fundamentally change energy services by connecting customers directly to smart devices and thus threatening service providers;
- Utilities also have to improve their commercial competitiveness. Switching to online customer relationships would allow them to meet the goals of improved customer satisfaction and reduced costs;
- The key success factors of online offers are:
  - Simplicity,
  - Reactivity,
  - Branding,
  - Added-value services,
  - Lower prices,
- Some Utilities, such as ENGIE and EDF, are targeting these new offers at specific client segments. For others, such as Eneco (the Netherlands), it is part of their core strategy. Eneco's offer combines green electricity with innovation. Customers get a free "energy box" allowing them to track and control their consumption;
- By implementing these types of online offers, Utilities can improve their efficiency, in particular by simplifying their IT system, decreasing call center size (and selling the premises), increasing client satisfaction, and decreasing client churn;
- The digital transformation journey has only just started. A recent Capgemini report[50] shows that 80% of Utilities see Big Data analytics as a source of new business opportunities but only 20% have implemented initiatives in this area. The following difficulties are holding them back:
  - Data complexity, access and privacy issues (54%),
  - Data storage and manipulation costs (26%),
  - Skills shortage (13%).

43 AFI Directive (Alternative Fuel Infrastructure), October 2014
44 Compared with 60,000 gasoline stations in Europe
45 "Energie, l'Europe en Réseaux", Michel Derdevet, La documentation Française
46 Smart Grid Projects Outlook 2014, European Commission
47 The Toyota Miral hydrogen car sold in 2015 for more than US$60,000
48 ABI Research and Cisco estimates
49 A smart meter is of course a connected object
50 Big Data BlackOut: Are Utilities Powering Up Their Data Analytics? – Point of View, Capgemini Consulting, May 2015

Conclusion

The European energy market remains very unsettled and despite analysis of the causes, Energy Union announcements in early 2015 do not provide sufficiently quick and tangible measures to restore a consistent market and improve security of supply.

To restore market stability, the following measures should be implemented:

- Accelerate reform of the Emissions Trading Scheme;
- Implement stronger market management in order to attain higher prices and give the right signal for low-carbon investment;
- For all intermittent renewables (especially solar and wind), quickly abolish feed-in tariffs and replace them with selling prices linked to the market.

To improve security of supply, the following measures should be implemented:

- Develop capacity remuneration mechanisms more quickly and consistently throughout Europe;
- Continue to search for domestic gas sources including shale gas;
- Study and finance the implementation of a truly unified and smarter high voltage grid.

Finally, more research and development resources should be allocated to competitive electricity storage solutions.

COP21 will take place under more favorable auspices than the Copenhagen conference as countries with large CO_2 emissions have taken positive steps to mitigate climate change consequences. However in the short term, low oil prices will have a negative impact on energy efficiency (insufficient return on investments) and on the development speed of renewables as their price is going to be increasingly linked to depressed wholesale market prices.

Europe is to some extent the "model student", but to keep this position, it must urgently reform its ETS system and establish consistency between the different EU measures to decrease GHG emissions. Finally, whatever the success of the COP21 conference, it is unlikely that it will lead to strong enough measures to limit the global temperature increase to 2°C. Therefore, measures must be designed, implemented and financed to adapt public and private infrastructures to the effects of global warming.

Energy and digital transition
Utilities remain in a difficult financial situation and they need to significantly improve their competitiveness while adapting to the energy transition plans implemented in their countries.

Luckily, the technical improvements enabled by the digital revolution, if adopted quickly, will enable them to build a sustained business model.

Paris, October 1, 2015

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Initiated in 2002, Capgemini's European Energy Markets Observatory (EEMO) is an annual report that tracks progress in establishing an open and competitive electricity and gas market in EU-28 (plus Norway and Switzerland) and the progress in reaching the EU's 3x20 climate change objectives. The report looks at all segments of the value chain and analyzes leading-edge energy themes to identify key trends in the electricity and gas industries.

The analysis is made by a team of consultants and regional experts of **Capgemini Consulting**, the global strategy and transformation consulting organization of the Capgemini Group. Their in-depth knowledge combined with sector news crunching provide an insightful analysis which is enriched by the expertise from our selected partners: I4CE, Natixis, CMS Bureau Francis Lefebvre and VaasaETT.

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