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European Energy Markets Observatory

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EUROPEAN ENERGY MARKETS OBSERVATORY | 2015 AND WINTER 2015/2016 DATA SET - EIGHTEENTH EDITION

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Topic Focus

The energy industry faces many obstacles on its journey to successful transition

Editorial by Colette Lewiner

Energy transition laws are being implemented in European countries and at European Union (EU) level. While they vary from one country to another, they have common aims: decreasing greenhouse gas (GHG[1]) emissions in order to limit the increase in our planet's temperature, increasing renewable energy generation, and shifting towards more distributed generation and more autonomous territories. These shifts are enabled by the digital revolution.

Because this energy transition is occurring in complex and inconsistent European and national regulatory environments, it is distorting energy markets, weakening security of electricity supply, and threatening Utilities' business models and financial situations.

Climate change: the strength of the COP21 agreement lies in emissions scrutiny

With the commitment of 195 countries to a global climate deal, COP 21 was a milestone in the fight against global warming and on the path to energy transition. The **Paris COP 21 Agreement** will start in 2020 and will be binding for the countries that sign it. For it to be enforced, countries representing 55% of global emissions needed to ratify it.
Following the positive announcements at the G20 meeting in September 2016, that China and the USA (the two biggest emitters) would join the agreement, this agreement should be ratified in 2017.

The Paris meeting was a real diplomatic success and a catalyst for global awareness of climate risks. It sets out the ambition to keep the increase in global average temperature below 2°C, above pre-industrial levels between now and 2100.

Unlike the Kyoto protocol, the Paris Agreement is based on a bottom-up process. Countries submit their Intended Nationally Determined Contributions (INDC) and then review them every five years to increase their

1 Greenhouse gases include carbon dioxide (CO_2) and methane (CH_4)

goal. The first review will take place in 2025.

During the COP21 meeting, the INDCs were collated. The resultant total pointed to an increase in the global temperature of more than 3°C, underlying the need not only for mitigation but also for adaptation measures.

The Agreement recognizes the role of non-state players as part of an institutionalized "action agenda" that will reinforce successive national contributions.

In 2015, energy-related carbon emissions remained constant for the second consecutive year even though the global economy kept growing – a sign that efforts to tackle climate change may be bearing fruit faster than previously thought. An upsurge in renewable power around the world was the main reason pollution levels stalled, according to the International Energy Agency.

The United Nations Climate Conference to be held in Marrakech from November 7-18, 2016 will focus on the themes of mitigation of climate change and innovation in adapting to climate change.

Countries and regions are taking concrete steps to reduce GHG emissions. In mid-April 2016, the National Development and Reform Commission and the National Energy Administration of China halted plans for new coal-fired power plants in many parts of the country, and construction of some approved plants will be postponed until at least 2018. This announcement means that about 200 plants of 105 GW capacity may not be completed.

China is aiming at reaching a peak in carbon emissions by 2030. A recent economic slowdown, policies to discourage coal-fired power plants near big cities, and a huge investment in wind and solar energy helped reduce coal use in China in 2015.

The EU was the first region to set binding objectives for GHG emissions. It first set an EU objective of 20% reduction by 2020 (compared to 1990 levels), and consistent Member States objectives were then negotiated and allocated. Thanks mainly to renewables development, economic slowdown, and energy savings, this objective will be met and perhaps even surpassed. In 2014 the EU set a new objective of 40% GHG emissions reduction by 2030 (compared to 1990 levels).

In France, starting in 2017, a new carbon tax of €30/t for coal-fired plants should be levied and will accelerate closure of these plants.

In 2016, the US Energy federal tax credits for new wind and solar projects were extended until 2020; they will then be extinguished. Combined with renewables energy costs drop, the total renewable energy consumed in 2016 should increase by 9.5%[2].

Like countries, funds and enterprises have committed to reducing coal usage. For example, Norway's $860 billion oil fund will no longer put money into 52 companies that are seen as too reliant on coal; this is the biggest ever fossil fuel related divestments by a single investor.

The UN-backed Principles of Responsible Investing initiative was signed by companies collectively managing $59 trillion.

Utilities are also committing to phasing out their coal-fired plants and to developing renewable energies. For example, ENGIE, the French utility, has committed not to build any new coal-fired plants worldwide.

Among OECD countries, Australia has the highest coal electricity generation percentage. AGL, Australia's biggest utility, recently opened solar farms in New South Wales (a coal-producing state) with a combined 155 MW capacity (enough to power 50,000 households), showing AGL's determination to replace fossil fuels with renewable energy.

Many hurdles have to be overcome

Barely a month after world leaders signed the Paris Agreement, the global commitment to renewable sources faced its first big test as the **price of oil decreased** to $30/bl. It has since stabilized at around $50/bl (end August 2016). Low gasoline prices have made driving more attractive and sales of large vehicles have increased.

In the US, several nuclear power plants that emit no GHGs have closed and fewer are under construction because of the competition from cheap natural gas.

Since 2000, **coal** combustion is responsible for 60% of the increase in GHG emissions. Despite European and other developed countries committing to phase out coal combustion, coal will still be used for decades to come in developing countries, providing electricity to hundreds of millions of people. In China coal provides two-thirds of the energy demand and in India coal consumption is likely to double by 2020. Even in Germany, thanks to low international coal prices and very low carbon prices, coal plants are more competitive than gas plants, and German CO_2 emissions are not decreasing despite growth in renewable generation.

In this global context, it is vital to continue investing in Carbon Capture and Storage (CCS) technologies, either by developing industrial prototypes in order to benefit from lower costs by scaling or by searching for new technologies. Today, the initial capture of CO_2 accounts for 80% of the total

2 US Department of Energy forecast

cost partly because it reduces the efficiency of the power plant by 30%.

Present CCS technologies are competitive with a minimum \$50/t CO_2 price, which is 10 times higher than mid-2016 prices!

It is worthwhile exploring new technologies, as Exxon is doing by partnering with FuelCell energy to develop a new way to strip carbon dioxide from the flue gases emitted by power plants at a much lower cost.

Paris Agreement ratification

It is unclear whether the Paris protocol will be enforced in 2016. On the one hand, it has to be ratified by the US Congress before the November 2016 presidential election and on the other hand, the European process is slowed down by lengthy negotiations with some EU Member States, notably Poland, on their individual 2030 goals.
Following the UK referendum result on June 23, 2016, the UK will start a long process of negotiating a new status with the EU; it is not clear whether it will continue to share the 40% CO_2 reduction objective, or still be part of the Emissions Trading System (ETS). No doubt Brexit will make these negotiations even more complex.

There are also doubts about whether the US can meet its obligations under the Agreement. In February 2016, the Supreme Court blocked the Obama administration's plan to curb GHG pollution from power plants, which was the centerpiece of his climate change plan and the main way for the administration to meet its targets under the Paris Agreement. The plan will not be put in place until legal challenges by 29 states and several business organizations have been resolved which is unlikely to happen before 2017.

Carbon pricing

The business community expressed disappointment around the fact that carbon pricing didn't feature as strongly in the text of the Agreement as it could have, despite numerous business leaders urging for a decision in this field and asking for a price signal. A quick decision on this point would reduce uncertainties and orient decisions towards carbon-free investments.

The most advanced carbon market in the world is the European ETS system. However, it needs profound changes in order to deliver a credible price signal.

In 2015 the EU decided that in 2019 it would implement a Market Stability Reserve (MSR) mechanism in order to regulate the Energy Union Allowance (EUA)[3] price. This announcement did not lead to a price increase and in August 2016 prices stayed at an extremely low 5€/t.

While the principle of a market exchange that does not create additional tax is good, it is proving difficult to implement.

Adaptation measures

Despite mitigation actions, the global average temperature will increase with numerous consequences on agriculture, cities, industrial assets, and so on. Adaptation measures have to be taken in all countries and technologies, and funds have to be available. Disappointingly, no clear decision on this point was taken in Paris, and up to now the "green fund" decided at the Copenhagen COP meeting in 2009[4] has not received significant cash commitment from the developed countries.

In addition, companies and municipalities must thoroughly assess their climate change related risks and take appropriate action.

A striking example relates to the 2011 Fukushima disasters: on the heels of immediately following a destructive magnitude 9.0 earthquake came a tsunami that reached a run-up height of 30 meters in some areas.

Within the affected area were three nuclear power plants: the two Fukushima nuclear power plants operated by the Tokyo Electric Power Company (Tepco), and the Onagawa Nuclear Power Station operated by the Tohoku Electric Power Company. Although the power stations shared similar disaster conditions and nuclear reactor types, their fates were very different: while the Fukushima Daiichi plant in particular experienced fatal meltdowns, Onagawa managed to remain generally intact. The most obvious difference between the Fukushima and Onagawa plants is that Tohoku Electric took into account surveys and simulations aimed at predicting tsunami levels and constructed its plant at 14.7 meters above sea level. Tepco, on the other hand, built the reactor at a much lower elevation of 10 meters to save construction costs.

At the beginning of the earthquake, all three plants were shut down automatically. However, there is a need to continue to cool the reactor by pumping water. As the grid collapsed the pumps had to rely on backup generators for their power supply. In the Fukushima plant these backup generators were flooded by the tsunami and it is this absence of cooling that triggered the reactor's meltdown.

At the Onagawa reactor the backup generators, installed higher above sea level, were not flooded and the cooling system continued to work.

3 EUA: the right to emit GHGs and in particular CO_2

4 In Copenhagen, developed countries decided to mobilize, by 2020, \$100 billion per year to finance developing countries' adaptation actions

Renewables costs are continuously decreasing – is it enough?

Energies costs are on a downward trend

There are two good reasons to support the development of renewable electricity: first, the world must significantly cut its CO_2 emissions; second, it has to be prepared for a future in which fossil fuels will be exhausted, or at least scarce and thus more expensive.

As discussed above, reducing emissions is an absolute necessity and all available technologies and regulations have to be implemented: renewable energy, but also nuclear power, energy efficiency, CCS, and a high carbon price.

Many reasons – economic slowdown especially in China, an over-supplied market, and Saudi policy protecting market share – explain the early 2016 oil price decrease to around $30/bl. Hopes of coordination among producing countries (including Iran) to limit production pushed oil prices to around $50/bl in mid-2016.

Unlike coal prices, which only slipped by 4% to €51/t, gas prices have been pushed down by 35% year on year[5] as Cheniere Energy has started offering exports of US liquefied natural gas (LNG) to Europe.

During the same period renewable energy costs decreased but to a much lesser extent than competing gas and oil energy costs.

However, oil prices are governed by supply and demand, by geopolitical considerations, and by OPEC policies that are difficult to forecast, whereas renewables costs are governed by technology improvements and regulations that are more predictable, so this picture may change.

Wind and solar energy are, with hydropower, the main contributors to renewable electricity generation in Europe.

Onshore and offshore wind costs

Installation costs and wind speeds vary widely, so it is difficult to pick a single figure to quantify generation costs. According to the European Commission (EC), the onshore wind levelized cost of electricity (LCOE) ranges from €52 to €110/MWh. Offshore wind LCOE is much higher, ranging from € 100 to €150/MWh.

In 2015 and during the first half of 2016, offshore wind installation costs[6] decreased for the first time, bringing down generation costs. For example, in July 2016, DONG Energy won the Dutch Borssele offshore wind project at a price of €87/MWh[7]. During the same period, worldwide onshore wind costs fell by around 3%.

The first commercial project on floating foundations was announced in 2015 (Hywind Scotland), providing the potential to access high wind speed regions in deep water.

Wind's principal low-carbon generation competitor is nuclear energy, and in this respect prices for new nuclear under the UK's contracts-for-difference regime confirm that new onshore wind is cheaper than new nuclear even when grid costs are added (see below). However, we can expect a "series effect" on third-generation nuclear reactors that would decrease their cost.

Photovoltaic solar installations (PV)

In 2015, global solar installations increased by 34% over 2014 figures, reaching almost 60 GW of new capacity. Auctions delivered the cheapest prices ranging from $30/MWh in sunny Chile to €74/MWh in France and €80/MWh in cloudy Germany[8]. Thanks to technology innovation in inverters, as well as continuous price reductions at the panels' level, the total installation cost of utility-scale PV is expected to decrease by a further 20% over the next three years.

Investment in renewables is growing but these energies are still expensive

Worldwide, investments in renewables were at a historic high level in 2015[9]: $286 billion was invested mainly in solar and wind power. Conversely, Europe saw lower investment in 2015, at $58.5 billion, down 18% on 2014 and its weakest figure since 2006. The UK was by far the strongest market, with investment up 24% to $23.4 billion. Germany invested $10.6 billion, down 42% with a move to less generous support for solar and, in wind, uncertainty about how a new auction system will work from 2017. France saw an even bigger fall in renewables investments, of 53% to $2.9 billion probably due to less investment in PV and a period of uncertainty before the new Energy Transition Law enactment.[10]

Since 2004, investments in renewable energy in the EU amounted to €750 billion, representing more than a quarter of global investment in renewables although Europe has only 7% of the population of the planet, reflecting the political will of Europe to implement rapidly – perhaps too rapidly – these technologies. These sizeable investments have allowed the current European renewables fleet to be built, with a nominal nameplate output of around 212 GW. However, when the capacity factor[11]

5 Mid-2016 compared to mid-2015

6 "Global cost analysis, the year offshore wind costs fell", January 29, 2016 by David Milborow (Wind Power Monthly)

7 Enerpress, July 7, 2016

8 http://energyandcarbon.com/solar-revolution-continues-in-2016/

9 Source: REN21 (Renewable Energy Policy Network for the 21st century)

10 Bloomberg: www.bloomberg.com/company/clean-energy-investment/

11 Because the wind does not blow all the time and sun does not shine all the time, the renewable power capacity factor (energy produced / nameplate capacity) is much lower than when fossil or nuclear fuels are used; i.e. a capacity factor of about 18% overall as opposed to some 85% for nuclear, coal and gas (Lionel Taccoen, letter, Géopolitique de l'énergie, no. 64, May 2016)

is included, the energy output that these renewables contribute to the European grid is only equivalent to around 40 GW.

Today, renewable energy is more expensive than existing nuclear electricity, which is also a low-carbon technology. For example in France, the official plan is to produce in 2023 an additional[12] 43 TWh per year coming from renewables. At today's prices for each renewable energy and its capacity factor, the investment cost would be about €61 billion.
A smaller investment of €55 billion would extend the lifetime of existing nuclear plants for 20 years and would produce 440 TWh per year (around 10 times more).

To become competitive without subsidies, renewables costs have to continue to significantly decrease.
It is forecast that by 2025, average electricity costs could decrease by 59% for photovoltaic solar, 35% for offshore wind, and 26% for onshore wind compared to 2015.[13]

In addition to reducing panel costs, obstacles related to regulations (notably construction permits) and grid management (notably electricity surplus injection) have to be removed.

Effective R&D and innovation efforts are needed

- With €80 billion , the *EU R&D initiative*, Horizon 2020 has an equivalent funding to other large Regions. However, because of the complexity of the EC decision process these funds are probably less efficiently used than in the US, for example.

  A recent Capgemini report[14] shows also that, without a comprehensive strategy for research and innovation bringing together supply, demand and regulatory aspects, the EU risks losing its comparative advantage to Asian and American competitors. This is already the case with specific technologies such as solar PV and the EU faces similar risks in other areas such as battery storage, and electric, hybrid and hydrogen mobility. The forthcoming European Research, Innovation and Competitiveness Integrated Strategy (EURICS) is an important milestone to redefine Europe's competitiveness and innovation strategy, and to align all the pieces of the puzzle.
- Some *Utilities* are taking a stake in R&D and industrial manufacturing in order to push down renewables prices: A group of Europe's largest energy[15] companies has promised to cut the cost of offshore wind farms to €80 / MWh by 2025, making them closer to the cost of gas and coal power stations, almost half of today's average level.
  In solar PV, the French Utility EDF has created, with French research centers, a Research Institute (IRDEP[16]) whose purpose is to contribute to the emergence of PV technologies with low production costs.
- In October 2015, Colas, world leader in transport infrastructure, unveiled *Wattway*, a solar road[17]. The fruit of five years of R&D in a partnership with the French National Institute for Solar Energy, Wattway is a PV road surfacing concept, able to provide power to street lights, signs and tramways, as well as housing, offices and so on. Colas has created a dedicated unit to move from prototypes to commercial implementation.
- *New renewables*, such as marine energies that use kinetic energy from the tide or underwater currents, are a potentially significant resource for Europe. For underwater turbines, the load factor is higher than offshore wind (46-57%, compared to 30-35% for offshore wind) and as the turbines are much smaller than wind turbines, their impact on the environment is lower. Conversely, investment and operating costs related to the marine environment are higher (about double that of wind turbines at equal installed power).
  The UK is the most advanced European country in this area and it also has the most substantial natural resources. The Marine Energy Action Plan 2010 from the British Department of Energy and Climate Change (DECC) aims to save 17 million tonnes of CO_2 by 2030 and 60 million tonnes by 2050, while creating 16,000 jobs. The UK also has a world-class testing center used by all international industrial companies.
  For these promising marine energies to contribute to European renewables generation, it is imperative that their cost is significantly reduced.

New efforts are needed

While renewables implementation allows decarbonization of electricity generation and increased energy independence, their deployment should not be an end in itself. As has been recognized in the 2030 EU objectives and during COP21, the real goal is to reduce GHG emissions. Competitiveness of renewable energies, as of other non-carbon generation technologies, is thus crucial. Future competitiveness requires new efforts to lower direct costs (solar panels, wind turbines, facilities construction prices, cheap land for solar) but also indirect costs, notably grid management and related costs.

12 Compared to 2015

13 "The Power to Change: Solar and Wind Cost Reduction Potential to 2025", International Renewable Energy Agency (IRENA) June 2016 report

14 "Scaling up innovation in the Energy Union to meet new climate, competitiveness and societal goals" by i24C prepared in partnership with Capgemini Consulting

15 Germany's two biggest power utilities RWE and E-ON, Vattenfall and Norwegian Statoil together with seven other companies including turbine makers such as Siemens and General Electric

16 IRDEP: Institut de Recherche et de Développement de l'Energie Phovoltaïque, created in 2005

17 www.wattwaybycolas.com/

Significant problems are arising from the renewables energy share increase in the electricity mix

This renewable share increase is challenging grid management

Electricity grids have to balance uncertain demand with an increasingly intermittent supply due to renewable energies not being schedulable. Grids need to become smarter and will have to be reinforced to connect the new dispersed renewable installations.

In addition, when a massive shift occurs from centralized large generation plants to decentralized smaller renewable units (as in Germany), the grid has to be redesigned and partially rebuilt. This is complex and onerous.

For an average proportion (10-30%) of intermittent electricity, the additional grid costs translate into renewable electricity having additional costs of around 30%, which must be taken into account while assessing renewables competitiveness.

Once there is more than 30-40% of intermittent electricity, the European Physical Society, based on Franco-German studies, warns that grid management solutions become very expensive.[18]

At high levels of penetration, variable renewable energy increases the need for additional equipment or new financial incentives that contribute to system flexibility by matching electricity supply and demand.

- *Battery storage* is one option allowing electricity supply fluctuations management.

  Different types of energy storage systems provide solutions for different challenges:
  - Increasing grid resilience
  - In association with PV installations, providing schedulable electricity to isolated sites in order to replace expensive and polluting engines generating electricity from liquid fuels
  - Allowing self-consumption from solar PV facility installed in businesses and in homes
  - Helping consumers manage their electricity bills

In a nutshell, energy storage is key to enable higher renewable penetration

Batteries are the main technology supporting renewable integration at multiple scales, from domestic use to utilities production. There are dozens of different suppliers providing battery storage systems.

Though battery storage technology has made significant strides, several key concerns must still be resolved for the technology to achieve its potential. These include an increase in safety and performance along with a decrease in cost.

Li-Ion batteries (Lithium-Ion) prices have significantly decreased in recent years. It is forecast that their price in 2020 will be half that in 2014, at around $250/kWh for a battery “module”. Tesla (and Panasonic) have a price objective of less than $200/kWh. With new technologies such as Zn-Air (zinc-air batteries), costs could drop below $100/kWh in 2020-2025.[19]

As well as ensuring grid parity[20], it is important to compare electricity prices provided by the grid to similarly schedulable electricity prices provided by renewables associated with batteries (allowing this electricity to be available irrespective of sun or wind intensity). Today in continental European countries such as Germany and France, the so-called “schedulable renewable electricity prices” are still higher than grid prices. However in more insular geographies , the gap is starting to close.

- *Demand side* management objectives are to incentivize consumers to adapt their demand to more volatile generation and take advantage of very low prices when renewables generation is high. Studies show that customer’ information, time of use tariffs and consumption aggregation are usually good tools increasing Demand Response. In addition, competitiveness of specific usages industrial processes taking advantage of electricity periods of low electricity prices should be improved.
- *Aggregation:* Many Companies are offering to aggregate electricity consumption and to sell peak shaving services to grid managers. Energy Pool is one of these companies operating in the industrial sector. For residential customers, who account for roughly one third of European electricity consumption, the process developed by Swisscom Energy Solutions, under the name “tiko”, uses existing assets (heating equipment, including heat pumps, water boiler, and, in the future, electric car batteries), which are connected by broadband. Some global/local intelligence is added to these assets to transform them into a virtual residential power plant. By mid-2016, “tiko” had 6,500 participating households in Switzerland and the savings per customer were estimated at €75-150 per year.

18 European Physical Society – Energy Group position paper July 30, 2015

19 EDF source

20 Grid parity occurs when a renewable energy source generates power at an LCOE that is less than or equal to the purchasing power price from the electricity grid.

- *Smart meters deployment:* by 2020, 80% of EU customers should be equipped with intelligent meters[21]. After Sweden and Italy, who were the front runners, many European countries (such as Spain, France, Norway and the UK) are deploying smart meter programs.
  The largest program is the "Linky" deployment in France where by 2021, 35 million smart meters will be deployed. By end 2016, 3 million meters will have been installed mainly with the G1 technology. However after a testing phase, the G3 Power Line Carrier (PLC) communications technology has been chosen for the following tranches.
  This program is on time and within the budget which should amount to around €4bn.
  Besides better grid management, these smart meters will also enable demand response and energy savings
- *Power to gas:* when the wind is strong or when there is strong sunlight, the wholesale price of electricity becomes almost zero and the question arises of how to use this cheap electricity.
  The production of either hydrogen or methane (methanation) can take advantage of this almost free energy by using electricity to convert water into hydrogen by electrolysis. The hydrogen can then be combined with carbon dioxide (CO_2) to obtain synthetic methane. This is particularly attractive as it allows recycling of CO_2 produced by power plants.
  The hydrogen or methane can be either stored or injected into the gas transmission system.

The cost is still too high but in 2015-2016, progress was made both in R&D and in industrial deployment.
In early 2016, researchers[22] boosted the efficiency of water electrolysis by using new electrodes. This modified system generated twice as much hydrogen than the classical platinum electrode, thus increasing hydrogen production competitiveness.

At the end of 2015, during the COP21 meeting, GRTgaz and its industrial partners officially announced Jupiter 1000, the first power-to-gas project to be connected to the French gas transmission network.

While around 20 demonstrators are already operating in Europe, particularly in Germany, the Jupiter 1000 project with a capacity of 1 MW is the first facility of this size in France. It is forecast that by 2050, the power to gas sector in France could deliver 15 TWh of gas per year.

This high renewable share is disturbing the wholesale and retail markets and threatening security of supply

Wholesale markets
As the merit order takes only variable costs into account (ignoring the capital costs), wind and solar come first as their "fuel", wind or sun, is free. It is thus difficult for plants having significant fuel costs (as coal or gas plants) to compete and as a consequence, these plants are idle for too many hours per year to be economically viable; so operators are closing them.

According to EWA[23], a net capacity of 10.7 GW of schedulable electricity (mainly coal and gas) generation was retired from the market in 2015. The combination of reduced demand and yet more renewable energy additions will force more closures until the remaining coal- and gas-fired plants can stabilize profits.

At the end of 2015 and in early 2016, decreasing oil prices triggered a fall in coal and gas prices. The low prices of these commodities, combined with the increase in the renewables installed base, have pushed down wholesale electricity prices to €22-26/MWh compared to an average of €41/MWh in 2015. Prices have slightly recovered since. These very low prices are threatening the financial stability of electricity producers that are not making profits even on past investments. In France, where regulated tariffs for industrial and tertiary businesses have been finally abolished, EDF and other Utilities are now exposed for two-thirds of their revenue to those low spot prices, and their margins are dwindling.

Retail markets
Electricity retail customers pay for renewables subsidies via special taxes (such as the EEG Umlage[24] in Germany and the CSPE[25] in France). Denmark and Germany have large renewable installed capacity and their household retail prices are among the highest in Europe.

While still almost 50% lower than the German retail price[26], in 2015 retail French prices increased by 4% mainly due to the CSPE tax increase. In 2016 this tax will reach €7 billion, an 11% increase compared to 2015 (and 17% compared to 2014).

In Spain, where feed-in tariffs were abolished in mid-2014[27], retail prices have stabilized, showing the clear link between the cost of renewable energies and retail price increases.
To shield globally competitive, high energy consuming industrial companies from the negative impact of energy

21 2009, EU electricity and gas packages recommendation

22 The team from the Ruhr-University Bochum, the Technical University of Munich, and Leiden University published these results in March 2016 in the journal Nature Communications

23 http://www.ewea.org/fileadmin/files/library/publications/statistics/EWEA-Annual-Statistics-2015.pdf

24 EEG Umlage: tax relating to the German Renewable Energy Act (EEG)

25 CSPE: Contribution to Public Service Electricity: 70% of this tax is linked to renewables subsidies

26 €16.8/MWh in France compared to €29.5/MWh in Germany (43% lower)

27 The law was passed in 2013 but began to be applied in mid-2014

transition, Member States including Germany[28] and to a lesser extent France have decided to exempt them from these related taxes. So it is small businesses and residential customers who bear the burden of the energy transition cost. Despite the high degree of concern for environmental matters and a national will to shift to renewable energies, one might wonder how long these retail customers (especially the Germans) will accept that they have to pay such a high price for their electricity.

Security of supply

Very large investments by the EU in renewable energies have enabled building a renewable nominal capacity of around 212 GW, contributing on the European grid to a schedulable energy output equivalent to around 40 GW. In the meantime more than 70 GW[29] schedulable capacity (mainly coal- and gas-fired plants) was retired. Security of electricity supply has thus deteriorated. With stagnating consumption, there is on average enough electricity available. However, on high-demand winter days with no sun and little wind, when renewables don't generate electricity, security of supply can be threatened because gas plants able to connect to the grid and deliver electricity in a few hours or less[30] are being closed down.

Capacity markets

One way to ensure security of electricity supply during these tense periods and to encourage new investment, is to create capacity markets in addition to existing energy markets. Capacity markets are designed to ensure sufficient reliable capacity is available by providing payments to encourage investment in new capacity or for existing capacity to remain open.

Different types of capacity mechanisms have been adopted in Europe:

- *Strategic reserves* (Sweden, Finland): capacity is placed in reserve, to be used in exceptional circumstances. These reserve plants cannot take part in commercial energy exchanges;
- *Capacity obligation* (France, delayed to 2017 by the current EC investigation): electricity suppliers are required to contract a certain level of capacity from generators at a price agreed between the parties;
- *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 is paid to all participants in the auction up to the level of power requested.

As the various European countries have adopted different capacity market models, the EC questioned the risk of distortion of competition.

For France, the Commission is concerned that the capacity mechanism envisaged may favor certain companies over their competitors and prevent new players joining the market. The Commission will also examine whether the objectives of the mechanism could not be achieved by less expensive measures and if the proposed mechanism is appropriate to encourage investment.

UK Brexit impact

On June 23, 2016, the British voted to leave the EU. The impact of this vote on the British energy market will depend on the type of agreement that will be finalized between the UK and the EU after lengthy (at least 2.5 years) negotiations.

Already, the UK is facing the risk of price spikes this winter after a number of plants finish their life in service[31]. With more than a dozen power plants due to close in the next decade, the UK government needs to find £100 billion (€118[32] billion) to keep the lights on nationwide after 2020. Financing these investments could be more difficult now[33].

One question, among others, is whether European Investment Bank loans will still be available to UK projects. The institution has lent €42 billion to the UK over the past eight years, including €7.7 billion in 2015. Almost half went to projects that fight climate change.

In addition, uncertainty created by the Brexit decision may slow investment decisions in the energy industry for two or three years, which would be detrimental to the security of supply of British electricity.[34]

Market reforms

To restore an electricity market delivering meaningful price signals, significant market reforms are urgently needed. The EU winter package will propose reforms on renewables subsidies that some Member States have anticipated.

While maintaining its objective of 45% of renewables in the electricity mix by 2025[35], Germany has, like Spain, adopted a new law. From 2019, feed-in tariffs will be abolished and projects will be selected through bidding processes.

In this new context, onshore wind capacity should grow by 2,800 MW each year (equivalent in schedulable generation to 600 MW); this is far less

28 In 2015 Germany had a net electricity use of 521 terawatt hours. Of that, 351 terawatt hours fell under the category of non-privileged end use and were thus subject to the full EEG. The others (energy-intensive industries, railways) benefit from exemptions and consume 32% of the total electricity. www.agora-energiewende.de

29 www.energypost.eu/ubs-closures-coal-gas-fired-power-plants-europe-accelerating

30 In France the new Bouchain combined cycle plant that was inaugurated in June 2016 by EDF and GE is able to reach its full power in less than 30 minutes

31 7 GW of closures were announced for 2016, equivalent to 11% of UK peak demand

32 At end of August

33 Fatih Birol, executive director of the International Energy Agency in an interview with Bloomberg, June 2016

34 Bloomberg, June 2016 note: reporters Jessica Shankleman and Anna Hirtenstein; editor Reed Landberg

35 Compared to 33% in 2015 www.bundesregierung.de

than the 4,750 MW capacity installed in 2014. In PV, the ceiling has been fixed at 600 MW (not including residential installations).

Northern Germany will reduce the number of projects in order to lessen their capacity surplus because transmission lines to wheel renewable electricity to other German regions are not yet built.
In a nutshell, the previous very costly system[36] that guaranteed a fixed price for renewables electricity output is thus abolished, which should generate substantial savings[37] and slow down investment in renewable electricity.

Conclusion

Costly development of renewables, particularly solar and offshore wind, is supported by subsidies borne by retail customers who are experiencing electricity price increases while wholesale market prices are decreasing.

In addition, these large subsidized investments have undermined traditional energy markets while having a limited impact on GHG emission reductions.[38]

To limit GHG emissions, a healthy Emissions Trading Scheme (ETS) market is vital. The exact MSR mechanism that will apply in 2019 has still to be approved by the European parliament. This decision is on the right track but will it be sufficient or is it coming too late compared to the urgent need to reduce GHG emissions?

Small is beautiful

Energy transitions, combined with technology changes, are increasing customer desire for more information and greater autonomy in managing their energy consumption. The market models are switching from centralized, long-term planning management to a decentralized customer-centric approach. Customers, cities and districts are willing to manage their own energy needs. Small is beautiful!

Smart grids

Grid management has been greatly affected by major changes that include the increased share of renewables in the electricity mix, the switch from centralized generation to more distributed, small-scale production, changes in customer behavior, the emergence of new technologies, and the digital revolution.

To improve understanding of the technical, regulatory, environmental, economic and human challenges posed by this new environment, many smart grid demonstrators were launched in Europe and elsewhere.

After 51 months of operation, GRID4EU, one of the major European initiatives, delivered its final report[39]. This large-scale demonstration project of advanced smart grids solutions was led by six electricity Distribution System Operators (DSOs) from Germany, Sweden, Spain, Italy, the Czech Republic, and France, in close partnership with a set of major electricity retailers, manufacturers and research organizations. In total, the consortium has 27 partners.

The project aimed to test innovative concepts and technologies in real-life environments, in order to highlight and help remove barriers to the deployment of smart grids in Europe. It focused on how DSOs can dynamically manage electricity supply and demand.

Among other conclusions, it highlighted the need for DSOs to actively engage with a wider range of stakeholders such as regulators, end consumers, distributed generators, equipment manufacturers, information and communications technology (ICT) service providers, TSOs, suppliers and aggregators. It also pointed out that regulators, who usually focus on ensuring investment adequacy and incentivizing DSOs to cut inefficient expenditure, have to move away from short-term cost reduction incentives to encourage DSOs to innovate and integrate distributed energy resources (DER) efficiently over the long term.

In addition to analyses of enabling technologies and economic incentives, there were extensive analyses of consumers, with account taken of critical subjective factors such as motivation, trust in suppliers, and privacy issues.

Smarter grids enable local energy management initiatives and there is a good appetite for them. Here are just a few examples.

Smart local communities development

Smart homes

Web-based services focused on energy management, provided by Utilities, service companies, real estate firms, and GAFA (Google, Apple, Facebook, Amazon) are finally giving substance to the smart home concept.

Also, home self-consumption is something customers want and,

36 In 2016, German consumers will be forced to pay €20 billion for electricity from solar, wind and biogas plants www.spiegel.de/international/germany

37 In 2014, the EEG Umlage represented 21% of the electricity price. It is forecast that this tax will increase until 2023 and then fall despite increasing shares of renewable energy. The main reason is that starting in 2023, EEG funding for renewable plants from the early years with high feed-in tariffs starts to expire, and new renewable energy plants produce electricity at lower costs. www.agora-energiewende.de

38 The observed reduction in GHG emissions in the EU is mainly due to economic stagnation and offshoring of industrial production. The renewables effect is lower and ETS markets have had a very low impact

39 http://grid4eu.blob.core.windows.net/media-prod/29375/grid4eu-final-report_normal-res.pdf

thanks to technical and economic developments, the number of customers benefiting from it is growing. For example, in 2016, the French Ministry of Ecology, Sustainable Development and Energy[40] will launch a 50 MW tender for self-consumption targeted at the industrial, commercial and agricultural sectors.

For the residential sector, EDF ENR[41] presented in June 2016 a new self-consumption PV offer, “Mon soleil et moi”[42], with electricity storage included. Its goal is to exceed 3,000 installations per year.

Smart cities

Cities consume more than two-thirds of the world’s energy and account for more than 80% of global GHG emissions[43]. With continued urban population growth[44], it is important to accelerate the deployment of sustainable energy initiatives and find ways to replicate best practice in cities of all sizes.

Copenhagen, Stockholm and Oslo were among the first 10 global cities announcing that they had achieved compliance with the ambitious climate action plans of the Compact of Mayors[45] to make urban communities more resilient to climate change[46].

Many innovative energy solutions have emerged or been tested at city or district level. These include energy efficiency initiatives, electricity, heating and cooling supply systems, and integration of renewables in the built environment. They are being integrated with transport systems, smart construction, urban planning solutions and waste and water treatment, as well as ICT solutions for the urban environment.

Research and innovation around urban issues has long been supported within Europe. Cities such as Barcelona have created urban labs to foster and test innovative projects in a real environment. As a result of urban planning innovation and the mobilization of citizens and local companies, the city now emits less than three tonnes per capita of CO_2 equivalent emissions, which is very low compared to cities of the same size.

Smart districts

IssyGrid is one of the first French intelligent energy networks at a district level (near Paris). Created in 2012 by a consortium of companies[47], it was completed in April 2016 with the aim of sharing energy-related data as widely as possible. Residents of homes connected to IssyGrid can find out their average power consumption over the day and be informed six hours in advance of the level of PV production available hourly, allowing them to choose the best time for their electricity consumption. In the near future, IssyGrid will include 2,000 dwellings (5,000 inhabitants) and 160,000 m² of offices (10,000 employees).

Conclusion

Energy management decentralization is what citizens desire and it is probably a permanent shift. It has the advantage of giving individuals better awareness of electricity/energy consumption and triggering modest use.

However, with the present low fossil fuel prices the return on investment in those projects is not attractive enough to find financing and, except for some cases (with little or no grid), those decentralized operations are today more costly than the classic centralized solutions.

During this decade, and probably the next, decentralized energy management should coexist with grids and centralized generation. Smart meters will generate a lot of data that will be collected by the DSO. This data, containing rich information on electricity or gas consumers’ standard of living and way of life, needs to be “sanitized” before being made publicly available. Even so, the embedded information is very useful to other sectors (such as retail, banking and telecommunications). The question is, how could DSOs become data service providers?

Distribution grid operators are fully occupied in integrating renewables and deploying smart meters. On the other hand, the new autonomous communities will generate less electricity flow on transmission grids, and the latter should stay stable or even decrease. Thus, financial investment in transmission grids has to be carefully examined, notably for interconnections that have to be designed. in the context of a future European grid pattern. If not, those investments could become redundant.

40 France is late compared to Germany where 2.3% of the electricity consumption comes from self-consumption. Higher electricity prices in Germany than in France, allowing bigger savings, explain the development difference

41 EDF ENR is the renewables EDF subsidiary

42 Mon soleil et moi: my sun and I

43 C40 Cities Climate Leadership Group

44 In 2014, the urban population accounted for 54% of the total global population, up from 34% in 1960, and continues to grow (WHO – Global Health Observatory data)

45 The Compact of Mayors is a global coalition of city leaders dedicated to reducing their GHG emissions

46 The EC describes a smart city as a place where traditional networks and services are made more efficient with the use of digital and telecommunication technologies, for the benefit of its inhabitants and businesses

47 Bouygues Immobilier, Alstom, Bouygues Energies and Services, Bouygues Telecom, EDF, Enerdis, Microsoft, Schneider Electric, Sopra Steria and Total

With low electricity and gas wholesale prices and chaotic markets[50], the Utilities' financial situation is becoming critical.

Will Utilities succeed in their transformations?

Large Utilities financials are impacted

Low electricity and gas wholesale prices and disturbed markets[48] are impacting Utilities top and bottom lines. In Germany, electricity wholesale prices fell from €60/MWh in 2011 to €22/MWh in early 2016. The French price moved from €56/MWh to €26/MWh over the same period. European Utilities wrote off a record amount from their assets in 2015 bringing the total cost of impairments to more than €100 billion since the start of 2010.[49]

In 2015, 12 of Europe's biggest energy companies had to reduce the value of their assets by more than €30 billion. Peter Atherton at Jeffries said: "Utilities went through a golden period from 2002 to 2010 when rising power prices meant that earnings roughly doubled across the sector. They spent most of the proceeds of that, buying each other, inflating asset prices, and what we are seeing now is the deflation of that bubble".[50]

In Germany, E-ON and RWE are under pressure from the country's ambitious Energiewende (energy transition) and have implemented a structural overhaul by separating their regulated activities (renewables and grid) from conventional power. At the request of the German government, concerned about the funding for decommissioning costs, E-ON could not allocate nuclear plants to Uniper (the spin-off company) and had to retain them. As a result, the Uniper portfolio will be limited to fossil fuel power plants and to energy trading. Despite the negative H1 2016 environment[51], Uniper was listed on the stock market in September 2016.

RWE took a different approach: instead of carving out the older assets, it split off the more attractive ones (its renewables, grid and retail operations) which should be listed on the stock market by the end of 2016.

Despite the improvement expected from these organizations' restructuring, the key to the fortunes of RWE and E-ON in 2016 will be government decisions on nuclear liabilities and court rulings on the legality of shutting down nuclear stations and on a nuclear fuel tax.

In France, after writing down €8.7 billion worth of assets in 2015 and generating a net loss of €4.6 billion for that year, ENGIE is proceeding with an organizational reshuffle in order to confront the energy transition challenges. Under the leadership of its new CEO, Isabelle Kocher, ENGIE is looking at greening generation and pipeline installations, reinforcing its services activities and adapting to a more decentralized, customer-centric approach. The Group intends to divest upwards of €15 billion by the end of 2018. In parallel the Group will invest €22 billion over the same period of which €10.5 billion will be invested in infrastructures and €4.5 billion in services. For the longer term, the Group is betting on digital transformation and new technologies.

In 2015, EDF, which has many nuclear-related challenges to overcome, adopted a new strategic plan, Cap 2030, to establish its forward vision and positioning in the energy transition and renewables development context. It also has a €10 billion divestment plan that it has started to implement. These divestments together with new capital injection from the French government should help finance Grand

48 Negative price intervals were also observed on the wholesale markets in 2016

49 Jefferies: www.ft.com/cms/s/0/5b2dd030-1e93-11e6-b286-cddde55ca122.html

50 Jefferies: www.ft.com/cms/s/0/5b2dd030-1e93-11e6-b286-cddde55ca122.html

51 Uniper suffered losses of €3.9 billion in H1 2016

Carénage a major safety improvement and life extension program for existing nuclear plants. In order to reinvigorate the French nuclear industry, EDF committed to acquiring a majority stake in the Areva nuclear plant division (valued at €2.5 billion). In addition, on September 27, 2016, the board of EDF took the decision to go ahead with the construction of two new generation nuclear plants (evolutionary power reactors – EPRs) at Hinkley Point in the UK at an estimated cost of £18 billion.

In this context, EDF is expected to divest partially from RTE, the French TSO.

Incumbent companies are being challenged by smaller Utilities players but also by new entrants from different sectors. A recent example is coming from the oil sector.

Having acquired SunPower, the American PV panels manufacturer, for $1.4 billion in 2011, French oil and gas major Total decided in 2016 to invest $500 million per year in decarbonated energies. Following this strategic move, it acquired for €1 billion, the battery company Saft (a complement to its involvement in solar energy) and Lampiris, the innovative new Belgian entrant in retail electricity and gas, realizing Total's ambition to become an electricity and gas retail supplier.

Attempts by majors to enter the "clean energy sector" are not new; however, BP and Shell initiatives launched in 2000 have failed. In contrast, the recent Total acquisitions are giving credibility to its new strategy.

To improve their situation, Utilities are using traditional remedies such as cleaning their balance sheet, changing their organization, spinning off activities, implementing productivity enhancement plans, and reducing their capital investments. They should also embrace a more customer-centric approach by shifting to new services and accelerating their digital transformation.

Incumbents and new players are both targeting the services markets

Traditionally, Utilities have developed services aimed at industrial or tertiary businesses and local communities. In Cofely, ENGIE has historically the largest service activity despite the 2013 Dalkia acquisition by EDF. More recently, Utilities have developed internet-based residential services, responding to customer requests and generating revenue in a low capital-intensive sector, which fits well with their high level of debt.

For example, British Gas offers home services including the "Hive Active Heating" system enabling heat control at home or from a mobile, tablet or laptop. This system should enable customers to save up to £150 on their energy bills.

In 2015, EDF launched an internet-based service "e.quilibre". This application allows EDF's residential clients to analyze their energy consumption, compare it (in kWh and euros) with similar homes, spot high energy consuming equipment, and get personalized advice. By mid-2016, it had been downloaded one million times. In conjunction with its R&D division, EDF's commercial division is now measuring the real customer benefits of this application.

The most striking example of this shift to services is Eneco, a medium-size Dutch Utility. Since 2007, when Jeroen de Haas was appointed CEO, it has established a strategic vision based on shifting from a commodity company to a services company in carbon-free energy. "Toon", a smart home system, is an example of the services promoted by Eneco. The system includes a display connected to the full electricity and heating network that is installed in the home. It also has a special application used on smart phones and tablets. According to Eneco, Toon users save 10% of their energy consumption on average[52]. In addition to generating monthly recurring revenues from related services[53], Toon increases the number and quality of Eneco customer contacts and customer loyalty is improved (with a churn reduction of more than 60%).

The shift from selling commodities to selling services is a real trend. It is, however, easier for smaller Utilities to embark on that journey. Scaling up innovation and accelerating "go to market" requires a refreshed organization, mindset and agile collaboration mechanisms, which are more difficult, or at least slower, to implement in incumbents.

With low barriers to entry, competition in services will be strong, notably from new players like GAFAS, real estate companies like Bouygues immobilier[54] in France, or telecom companies, for example.

Finally, it is unclear how much customers are ready to pay for such services. In the future, it is probable that offering these types of services will become mandatory if Utilities want to increase client satisfaction and decrease churn.

52 A caveat is that the scale of the savings largely depends on the user

53 400,000 units will be sold by 2016

54 In June 2016, Bouygues immobilier launched its new connected house "Flexom"

Digitalization will allow improved operational processes through the whole value chain

Utilities should implement their digital transformation faster
In this dual context of managing energy transition while improving profitability, it is imperative that Utilities engage completely and quickly in implementing their digital transformation.

Digitalization will allow improved operational processes through the whole value chain from generation onwards, with collaborative platforms facilitating engineering work and user friendly 3D digitized plans, through transmission and distribution with smarter grids, to easier, cheaper and more agile internet-based customer relations. Research & Development will also benefit from gathering of big data and smart modeling, enabling complex local and global energy systems optimization.

Studies[57] show that on average, process digitalization enables cost reduction of around 20%. For example, nuclear sector engineering, procurement and construction (EPC) firms have reported time and cost benefits from using 3D technology, including a 15% increase in operational efficiency during the initial plant design and engineering phase.

Having become used to more advanced customer experiences in other sectors, such as retail or telecommunications, consumers now expect new and higher standards in their relationships with energy suppliers.

Through smart meters and increased web-enabled customer touchpoints, Utilities should be able to improve their customer knowledge, enabling them to improve relationship quality by reacting faster and better to client requests. In addition, DSOs will gather large amounts of data, a very useful basis for helping local communities manage their electricity and gas needs. This data has strategic importance. In 2016, the French electricity DSO (Enedis) has created open data access for data related to generation, consumption and grid investments. This data will be available in an aggregated form for groups of around 2,000 homes. For the future, they plan to reduce the aggregate size.

Web-based services generate new revenue and decrease customer churn. Also, by increasing their use of the web as a customer channel, Utilities will reduce their costly call-center activities. In summary, digitalization of client relationships generates up to 30% cost reduction while enhancing quality.

Knowing that the top three priorities for European Utilities leaders are increasing operational efficiency, lowering cost and implementing new business models[58], one wonders why Utilities (especially incumbents) are not bolder in their digital transformation.

There are various reasons, all related to human factors: accustomed to a monopolistic environment, employees of Utilities and their associates are struggling to adapt to a rapidly changing world; there is a fear of sizeable negative consequences on employment; and finally there could be a lack of internal capability. However, even if many employees are resistant to change, the new generation aspires to it, and not moving quickly enough will deprive Utilities of their key talents.

Despite these obstacles, and given their deteriorating financial situation, Utilities must act quickly and take control of their own transformation. If they don't, external factors will restructure them, and probably not in an optimal way.

55 Capgemini Consulting/MIT

56 IDC survey

So what has changed in the European energy markets, and what needs to be done?

The trends observed in previous years have been further accentuated: chaotic electricity markets, even lower wholesale prices, increasing retail prices, an insignificant CO_2 price on the ETS, renewables cost decreases but still high subsidies paid by the end customer, and threats to security of supply.

However, COP21 has created a new mindset on climate change threats and has put downward pressure on GHG emissions. Countries and companies now have to act to reduce fossil fuel utilization, and this is challenging in an environment of low oil and gas prices.

The underlying EC philosophy is unclear

More than a decade ago, most people thought that these markets should be liberalized, by allowing customers to choose their suppliers. This is still true, although all customers are not equal, as very large energy consumers don't pay for all energy transition taxes, and poorer customers get reduced prices to combat fuel poverty.

However, over the years, the system has been re-regulated, notably through the Third Package[59] and the Energy-Climate Directive imposing relatively short-term, ambitious goals for renewables expansion. Consequently, Member States adopted costly market rules favoring renewables generation. These costly policies have destabilized the wholesale markets and the Utilities financial situation while increasing retail prices and threatening the security of electricity supply.

In addition to unclear market design principles, the EU's lack of agility also contributed to this chaotic market. For example, the ETS system for CO_2 prices is not incentivizing users to shift to low-carbon energy sources, and successive reforms have been unable to establish a viable market.

While it is essential that the European Union accelerates putting in place the necessary reforms, in particular in the carbon market and the financing of renewable energies, the major utility players need to transform themselves, notably by embracing innovation and inventing new business models to grow profitable revenue streams.

I hope you enjoy reading this 18th edition of the European Energy Markets Observatory.

Colette Lewiner

Senior Energy Adviser to Capgemini Chairman
September 2016

It is now imperative that EU market policy undergoes fundamental change; **if it doesn't, existing Utilities (which must also reform themselves) will get into even more trouble and the much needed investment in electricity and gas systems will not occur.**

57 https://ec.europa.eu/energy/en/topics/markets-and-consumers/market-legislation

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About I4CE

« I4CE – Institute for Climate Economics » is an initiative of **Caisse des Dépôts and Agence Française de Développement.** The think tank provides independent expertise and analysis on economic issues linked to climate & energy policies in France and throughout the world.

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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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