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European Energy Markets Observatory

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EUROPEAN ENERGY MARKETS OBSERVATORY | 2012 AND WINTER 2012/2013 DATA SET - FIFTEENTH EDITION

In collaboration with

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Contents

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Tables

Appendix Tables

Topic Focus

A Strategic Overview of the European Energy Markets

Editorial by Colette Lewiner

European and global energy demand

In Europe, the **economic crisis** worsened during 2012 with a GDP[1] negative growth of -0.4% and a forecast zero GDP growth for 2013[2]. While the US has started to recover (with a 2.2% GDP growth in 2012 and a 2.4% growth in Q1 2013), the BRICS growth, still significantly higher than in advanced countries, has slowed down.

The present feeling is that while the US will accelerate its growth in 2014/2015, Europe should have only a modest recovery in 2014.

Hopes of a quick and strong recovery have vanished and forecasts on global and European economies are prudent.

The primary global energy demand is still growing, triggered by emerging countries. The primary energy demand share of non-OECD compared to OECD has increased significantly (42% in 2000 to 56% in 2012). This trend will continue, fueled by growing populations and standard-of-living improvements.

The crisis impacted both electricity and gas consumption. In 2012, European electricity consumption decreased slightly year-on-year by 0.2%. This decrease was more pronounced in H1 2013 (-1.2% in H1 2013 vs. H1 2012[3]) while gas consumption decreased more significantly year-on-year by 2.2% (and -0.4% in H1 2013 vs. H1 2012[4]).

Economic recession and energy efficiency measures are limiting growth in electricity consumption but new electricity usages are fueling it, with Information Technology and mobile communication needs, for example, now accounting for around 10% of global electricity consumption[5].

Gas consumption is correlated to direct usage and to the needs of gas-fired generation plants; the latter represents currently 27% of total consumption. This share that had increased in the past should start to decrease with numerous gas plant closures in Europe (see hereafter).

1 GDP: Gross Domestic Product

2 Source: Eurostat

3 For an aggregated group of countries comprising France, Belgium, the Netherlands, the UK, Germany, Spain, Italy and the Nordics, and representing almost 80% of European total electricity consumption

4 For an aggregated group of countries comprising France, the UK, Spain and Italy, and representing almost 50% of European total gas consumption

5 Digital Power Group Study, August 2013

Forecast scenarios of future electricity and gas consumption are below those established one year ago, reflecting a pessimistic view of the European economic future and probably an optimistic view of energy efficiency.

Energy efficiency: The European energy efficiency results are a combination of national energy efficiency measures and the economic crisis (mainly impacting industrial consumption and to a lesser extent tertiary and residential consumption).

After studies performed by the EC[6] in 2012 showing that the 2020 energy efficiency (non binding) objective would be difficult to meet[7], the EU[8] adopted in October 2012 a new Energy Efficiency Directive. This Directive sets compulsory objectives of a 17% decrease in EU primary energy consumption by 2020, and requires Utilities to make energy savings equivalent to 1.5% of their annual sales each year from 2014 to 2020. If this objective is not met, the latter would have to buy white certificates for the missing savings. The cost of acquiring those certificates could be important and reach €1 billion per year for large Utilities. According to a compilation of the national estimates reported to the EC covering 80% of European consumption, it is believed that the Member States' commitments in energy efficiency should lead to a 17-18% decrease in consumption. However to obtain these results, many actions need to be successfully implemented. Successful energy efficiency programs leverage passive and active actions:

- Passive measures include: home insulation, improved energy efficient appliances (e.g. low-energy lighting), stand-by modes reduction (notably for computers) and eco-designed construction & equipments,
- Some active measures aim to increase the financial benefit of energy savings through dynamic tariffs (e.g. "time of use" tariffs) and higher energy prices. Other active measures are designed to increase customer awareness by launching information campaigns or by providing more accurate information through the deployment of smart meters that give hourly consumption. Focused and intensive information campaign, deployed in Japan during the 2011 and 2012 summers when nuclear plants were closed, were efficient and helped avoid blackouts during this peak consuming season.

Capgemini Consulting's Demand Response (DR) study[9] shows that electricity peak consumption shaving potential is significant (12-14%) as customers are re ady to shift their use of electrical devices from peak to non-peak hours while electricity savings potential in absolute terms, is more limited (2-3%).

While energy efficiency is generally satisfactory in the industrial sector, the problems lie in the transportation and buildings areas. Since a few years, regulation has imposed low energy consumption norms on buildings, with success on new projects. The **main problem remains with existing buildings** where progress in energy efficiency is slow. In countries like France, subsidies and various types of financial help exist. However they are not well known by the potential users, and their costs compared to the end results are not good enough. A simplification and clarification of this complex system is needed.

With no doubt, the best energy is the energy that you don't consume, so implementation of energy efficiency policies is the right long-term action to take. However such policies involving financial help (in a difficult economic situation) and cultural behavior changes (that are slow to happen) will probably take more time than expected. Their results should not be overestimated in the energy transition scenarios.

Fossil fuels situation

The global **oil demand** is still growing but modestly (1.2% CAGR[10] from 2000 to 2012).

While demand in developed countries is forecast to stay flat, emerging countries will continue to absorb more oil. Their total demand share is continuously growing from 37% in 2000 to 49% in 2012 to a forecasted 54% in 2018.

While global gas demand has grown twice as fast as oil (2.5% CAGR over the same period), growth in coal demand has been triple that of oil (3.6% CAGR on the same period).

Despite this slower oil consumption growth, the unsettled situation in Arab countries and Iran's continuous nuclear military program development, triggering fears of conflict, have impacted oil prices that stayed around $106 per barrel over the last 12 months (September 2012 to August 2013).

The shale revolution is also impacting oil production and will change the landscape drastically. US crude oil production is growing at a quick pace (4.2% CAGR from 2007 to 2012) and

6 EC: European Commission

7 The 2020 target was at 1,474 Mtoe (toe: tons oil equivalent) for primary energy consumption. After years of growth, primary energy consumption peaked at 1,825 Mtoe in 2005-2006 and started to decrease in 2007 reaching 1,680 Mtoe in 2012

8 EU: European Union

9 Demand Response study 2012 - Capgemini Consulting, VaasaETT and Enerdata

10 CAGR: Compounded Annual Growth Rate

according to recent IEA[11] forecasts it should surpass Saudi Arabia, becoming the number one worldwide oil producing country by around 2020. By around 2030, North America (including Canada and Mexico) could even become a net exporter.

Surely, this will impact geopolitics, probably lessening the global influence of the Middle East oil producing countries. However many events could occur in the two coming decades, making it difficult to forecast today what will really happen in 2030.

It is no exaggeration to say that this last decade, the rapid development of American **shale gas** is **THE** revolution in energy.

Non conventional gas[12] growth in the United States

Since the beginning of the 21st century, American shale gas production has grown in a spectacular way. In 2000 it accounted only for 2% of the US gas production. In 2012, its share grew to 34% and it should grow to 50% by 2040. This spectacular growth has led to a significant decrease in gas spot prices. This price bottomed at $2/MBtu in April 2012 to grow again at $3.3/MBtu in August 2013.

These low prices are favoring gas usage instead of coal in electricity generation plants, leading to decreased US greenhouse gas emissions (-2.4% in 2011 vs. 2010 and -1.6% in 2012 vs. 2011).

These gas prices have triggered an American industrial renaissance by allowing the repatriation of gas intensive industries (e.g. chemicals or fertilizers). Around 600,000 new industrial jobs have been created in addition to more than 1.7 million direct jobs linked to oil and gas unconventional activities[13].

Shale gas producers want to export their gas by converting re-gas facilities into gas liquefaction plants. American gas-intensive industries are trying to oppose these projects, fearing that the US gas price would grow to reach an international price and that consequently, they would lose their competitive edge.

In May 2013, the Department of Energy authorized the Freeport LNG project in Texas to export to countries that do not have a trade agreement with the US, including Japan and the members of EU. It was the second such approval after the Cheniere Energy's Sabine Pass project in Louisiana. Out of the 27 applications, some other exports terminals projects should be approved.

With low gas prices and consequently lower electricity prices, US industries are getting more competitive than their European peers and especially their German peers who will suffer from increased electricity prices following Germany's nuclear phase out policy.

Could such successful shale gas development occur outside the United States?

According to the EIA recent study[14], China and Russia followed by certain Latin American countries, South Africa, Australia and Canada are the countries with the largest reserves after the US. In Europe, many countries, including France, have significant unconventional gas reserves.

However fears linked to the consequences of fracking[15] technology are slowing down shale gas development in Europe.

France and Bulgaria have embargoed this technology and they are now isolated in Europe. Other countries, such as Germany and the Netherlands, having performed preliminary studies, are moving closer to shale gas exploitation. Moreover the British government is adopting very advantageous fiscal condition in order to develop fracking. Finally some countries are launching exploration activities, such as Poland and Ukraine. In the latter countries, shale gas development is strategic as it would decrease their very high dependency on Russian supplies.

There are a few pre-requisites for rapid shale gas development in Europe among which:

- A dense gas pipeline grid able to gather the numerous gas flows,
- A legal revision of the underground ownership rights[16],
- Highly protective environmental legislation notably regarding waste water treatment, well casing security, suppression of toxic gases releases,
- Operators improved transparency notably regarding the composition of "slick water", used for fracking,
- Objective and simple information for decision makers and public.

In an optimistic scenario[17], shale gas production could compensate European gas production decline and allow to keep (and not deteriorate) the present level (60%) of gas importations dependency.

Impact on prices

As gas exchanges are highly dependent on heavy pipeline infrastructure and as LNG[18] represents only a fraction (10%) of the gas flows, the gas market is very fragmented and prices level discrepancy between different regions is high. Thanks to

11 International Energy Agency, World Energy Outlook 2012

12 Non conventional gas includes shale gas, tight gas and coal bedded methane. Shale gas has the most abundant reserves.

13 Bruce Bullock SMU COX presentation at Düsseldorf Montel Energy conference June 5-6, 2013

14 EIA (Energy Information Administration, USA) study 'Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States', June 2013

15 Hydraulic fracturing or fracking, is the fracturing of rock by a pressurized liquid

16 In the US, the underground belongs to the surface owner while it is generally different in Europe

17 http://ec.europa.eu/clima/policies/eccp/studies_en.htm, European Commission, September 2012

18 LNG: Liquefied Natural Gas

shale gas, prices are low in the US. In Japan, the March 2011 Fukushima accident and the consequent closure of nearly all nuclear plants resulted in increased gas importations and high prices. In September 2013, these prices were more than four times the US price. However, if some nuclear plants were given the authorization to restart, following the new government position, these prices would decrease. European Utilities are supplied mainly through long-term contracts indexed on oil prices. As the oil price has remained high (see above), European gas prices are much higher than in the US.

However, German Utilities followed by others have successfully re-negotiated their long-term contracts indexations notably with Gazprom and obtained a share of around 50% of spot price in the indexation. These contract prices are now “only” about three times more than the US spot price.

Shale gas development in Europe will probably take time and while the cost due to the different constraints listed above will be higher than in the US, they should be still cheaper than today’s oil-indexed long-term contracts.

When US exportations will be effective and if the gas price in Asia keeps a premium compared to Europe, the main flow of shale gas (under a liquefied form) exported from the US should go to Asia.
According to a recent study[19], 6 Bcfd[20] US shale gas exportation to Europe would narrow US and European price differences by increasing the US price by $0.20/MBtu and decreasing the European price[21] by $0.70/MBtu. While narrowing the US-Europe price difference, this impact stays small as it represents less than 6% of existing European NBP price.

A dynamic debate is occurring around the future long-term *contracts indexation to oil prices.* In the past, gas production was closely linked to oil production (gas was very often a by-product) and the gas price indexation to oil could seem logical. Thanks notably to shale gas, it is no longer the case and US gas spot contracts evolve independently of the oil price. As wholesale gas market places have developed in Europe and improved their liquidity, they become credible alternatives for long-term gas contracts prices index as is the case in nearly all commodity markets.

However, gas suppliers such as Gazprom who want long-term visibility to develop the needed heavy pipelines infrastructures are inclined to defend oil price indexation (especially when it leads to high prices[22]).
One can forecast that the share of gas price indexation on spot prices will increase in long-term contracts.

As an illustration, in November 2012, Norway’s Statoil signed a 10-year agreement with Germany’s Wintershall to supply gas linked to EU wholesale spot prices. Presently about 40% of Statoil’s gas exports to Europe are based on the EU spot gas price.

Short-term gas market situation in Europe

In 2011, the IEA was quite optimistic on gas development. In its Golden Age of Gas scenario, it forecast that gas consumption would reach in 2035 a 25% market share of primary energy, surpassing coal market share and nearing oil share.

However, presently the situation is not rosy in Europe. The gas market is depressed and the situation is deteriorating for many reasons:

- Because of the economic crisis, gas consumption decreased in Europe by 2.2% in 2012 (compared to 2011) after a decrease of 9.2% in 2011 (compared to 2010). During H1 2013, a slight decrease of 0.4%[23] was observed,
- The growth in renewable energies (sometimes uncontrolled) and the priority given to them in the electricity generation merit order (see later) has reduced the gas-fired plants utilization rate, making many of them uncompetitive. In Spain, for example, their utilization rate dropped from 66% in 2004 to 19% in 2012, while the IEA believes that gas plants require a utilization rate of 57% to be profitable. The Spanish Industry Ministry may introduce a legislative reform to mothball gas plants (10,000 MW could be impacted).
  In Germany, as Combined Cycle Gas Plants utilization rate has dropped below 21% in 2012[24], Utilities may close as much as 6,400 MW of gas stations or 25% of the nation’s gas plants capacity by 2015[25]. In a recent study IHS estimates that about 130,000 MW of gas plants across Europe, around 60% of the total installed gas-fired generation in the region, are currently not recovering their fixed costs and are at a risk of closure by 2016[26]. These plants – that are indispensable to ensure security of supply during peak hours – are being replaced by volatile and non-schedulable renewable

19 Global impact of LNG Exports from the United States, 2013 report by Deloitte Center for Energy Solutions

20 To be compared with the total US market (65 bcfd) and the UK gas markets (9 bcfd)

21 UK NBP reference

22 Long-term prices have not always been higher than spot prices: between 2002 and 2006 these prices were similar, however with spot prices spikes as in January 2006. Source: ”The future European Long-Term Natural Gas Contract” by Kjersti Hegde -Eirik Fjeldstad

23 For an aggregated group of countries comprising France, the UK, Spain and Italy, and representing almost 50% of European total gas consumption

24 JP Morgan Cazenove study, 2013

25 Deutsche Bank study March 2012

26 IHS May 2013 study

energy installations that are heavily subsidized,

- In addition, the low gas spot price in the US has resulted in more gas and less coal utilization in fossil fuel plants. It has pushed coal prices down, creating overcapacities that were exported to Europe, where coal prices dropped by 30% between January 2012 and June 2013. As a result, the utilization rate of coal-fired plants is far better than for gas plants[27],
- These low coal prices combined with the low level of CO_2 certificates prices, have made coal-fired plants more competitive than gas-fired plants, with a clean dark spread[28] reaching €20/MWh while the clean spark spread stood at -€7.3/MWh in Germany in February 2013,
- Measures should be taken to restore a more satisfactory situation regarding the EU priorities i.e. to favor low carbon energies and to ensure security of energy supply.

A few short-term measures should be taken including:

- Launching capacity markets allowing rewarding available generation capacity even if the plants don't run. A few countries including France have decided to launch such markets, however they will be in place only in a few years, their mechanism is complex and there is no uniform approach in Europe thus distorting the competition,
- Restoring the ETS[29] market credibility: The July 3, 2013 EU parliament decision to backload not more than 900 Mt CO_2 certificates to the end of the phase III period, resulted only in a very small price increase.
  In August 2013, CO_2 certificates prices stood at around €4.4/t.

Renewable energies

Triggered by the Energy-Climate package objective of 20% renewable energy sources (RES) in the final energy consumption mix by 2020, renewable projects have continued their development in the EU that accounted in 2012 for 45% of renewable energy used worldwide.

Renewable electricity generation should continue to grow in Europe and in developed countries and they should provide 60% of the electricity production growth during the next six years[30].

Because of the crisis, triggering reductions in subsidies, the growth path of renewables has slowed down: RES installed capacities grew by 21% in 2012 compared to 2011 while this growth was 29% between 2010 and 2011. Many European governments including Germany[31] are looking at reducing the RES subsidies. For example, in July 2013, the Spanish minister for industry has introduced an energy reform allowing a €1.5 billion reduction in renewables and cogeneration subsidies.

Status of wind and solar energy development

After hydropower, **wind energy** represents the largest share in renewables (11% of total installed capacity in 2012) and wind farms installed capacity growth rate has stayed more or less constant: 13% increase in 2012 over 2011 and 11% increase in 2011 over 2010.
There is a debate around the cost competitiveness of onshore wind electricity generation. A direct comparison with schedulable electricity generation costs is not correct as wind energy requires additional grid investments and new management rules. Up to a wind penetration rate in the electricity mix of 15%, no additional generation back-up is needed. It is also generally accepted that up to a 20% penetration rate, the needed adaptation solutions are at a reasonable additional cost[32]. Beyond this threshold, back-up generation (usually gas-fired plants) and investments in grids allowing to operate them in a smarter way are needed. Just as an illustration and *without including the additional costs mentioned earlier*, in France the cost of the electricity generated by onshore wind farms (at €80/MWh) is similar to the Flamanville EPR[33] (that is a first in kind) future probable cost.

As many coastal regions in Europe are already equipped with onshore wind farms and as local populations are opposing these installations, the new projects are moving offshore. During the first six months of 2013, more than 1,000 MW new wind offshore capacity was connected to the grid[34]. This is twice as much as for the same period in 2012. But the financing of new projects has slowed down, reflecting regulatory uncertainty in key offshore markets (including Germany and the UK) and highlighting the significant challenges faced by the offshore wind sector.

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27 For example, in Germany in 2012, coal-fired plants utilization rate was in the 43-71% range; a far better utilization than gas plants

28 See glossary for the definitions of Clean dark spread and Clean spark spread

29 ETS: Emission Trading System

30 IEA International Energy Agency June 2013 publication

31 German Chancellor Angela Merkel promised in July 2013 to scale back Germany's generous system of subsidies to the renewables sector if she is re-elected in September

32 L'intermittence et les aléas météorologiques, un frein au développement de l'électricité renouvelable ? L'exemple de l'éolien 04 / 2007

33 EPR: European Pressurized water Reactor (3rd generation French nuclear reactor)

34 EWEA (European Wind Energy Association) July 2013 publication

The cost of electricity produced by offshore wind farms should be around three times larger than for onshore wind. Series effect should push this cost down; however the gap is very important. Moreover there is a need to build the electrical link to the continent using HVDC[35] new cable technologies.

On the positive side, thanks to these new large projects, an offshore wind turbine industry is developing in Europe: Alstom is building a new plant in France (Saint Nazaire) and Areva is building new plants in France (Le Havre) and Scotland.

Solar energy is growing faster than wind energy but it represents a smaller installed generation capacity in Europe's generation capacity share (7%). It is much more costly even than offshore wind. In 2012, solar photovoltaic (PV) energy cost in France was estimated between €240 and €400/MWh compared to onshore wind at €80/MWh and offshore wind between €150 and €200/MWh[36].

As for wind energy, the installed capacity growth has slowed down mainly because of changes in public policies resulting in decreased subsidies. For example, the recent German solar power feed-in tariffs were reduced by 1.8% a month between May 1, 2013 and July 31, 2013 because solar expansion is proceeding more rapidly than specified in the Renewable Energy Act (EEC). These changes are putting at risk the European solar panel manufacturing industry.

Moreover, the massive importations of solar panels, mainly from China, have accentuated this decline and it is forecast that in the short-term at least half of those European Manufacturers could be taken over or go bankrupt globally[37].

In a snapshot, the huge amounts of subsidies given by Member States to the solar industry and paid by the European citizens, have helped the Chinese industry to develop instead of triggering the emergence of a solid European first class solar industry. This waste of financial resources is linked to the short time imposed on EU Member States to reach 20% renewable energy share in their end consumption while these generation modes are not mature and need to be heavily subsidized.

Investing in upstream photovoltaic Research and Development would have been a much better trade off.

Moreover, as solar PV projects are small and geographically dispersed, it is difficult to assess the right installed capacity and even more difficult to forecast it. For example, in Germany in 2006, solar energy installed capacity was forecast to reach around 5,000 MW in 2011: the reality was in excess of 20,000 MW, four times more! This has led to wrong estimations of the needed extra power capacity and thus to increase the power generation overcapacity.

Under the pressure of its solar manufacturing industry, the EU decided in June 2013 to follow the US example and to impose duties on imported solar panels. In reaction, China has decided to take retaliatory measures against EU products. So negotiations with China have been opened and resulted by July 2013 in an imposed minimum sale price of 0.56 per watt for Chinese solar panels. This minimum price is 25% lower than the average sale price of panels in 2012. So this agreement should not reduce significantly the Chinese importations and the European manufacturing industry is dissatisfied.

Thanks to cheap imported solar panels[38] and to technology improvements, the price of electricity generated by solar PV has significantly decreased. For example, in the sunny US State of New Mexico, the Macho Springs project (owned by First Solar) agreed to sell power to El Paso electricity at $57.90/MWh (compared to less than $65.6/MWh for an advanced gas plant[39]).
If this price decrease trend continues, if there is a real breakthrough in solar panel efficiency and if affordable large scale electricity storage solutions finally emerge, solar energy could provide *in the long-term* a significant share of electricity generation mainly in sunny regions.

Even if many governments are now less bullish on renewable subsidies, the increased share of these energies in the energy mix is triggering higher and higher subsidies amounts. This is becoming a burden for heavily indebted countries, and the higher electricity prices paid by consumers are damaging their standard of living already threatened by the economic crisis. For example in France the CSPE[40] that includes the increasing RES cost amounted to €3 billion in 2002, it should reach €10 billion in 2013 and grow to €20 billion in 2015.
In Germany the EEG Levy[41] increased from ct€1.31/kWh in 2009 to ct€5.28/kWh in 2013 and represents a 18% share of residential electricity prices compared to 10% for France. This significant electricity prices increase is triggering a political debate in Germany that could be tackled after the September 2013 general elections.

35 HVDC: High Voltage Direct Current
36 French Energies 2050 Commission report published on February 13, 2012
37 Ernst & Young and BNEF, May 2012
38 Solar panel prices dropped by 80% over the last 5 years
39 Financial Times, June 3 2013
40 CSPE: Contribution au Service Public de l'Electricité. Tax contributing to public service of electricity, created by the French government in 2003.
41 EEG Tax for the promotion of renewable energy

Impact on wholesale markets

Renewable energies have high investment costs (that are subsidized) and very low operational costs, as sun or wind cost nothing. Thus they come first in the power generation plants merit order and they are operating all hours when they can produce. With growing renewable production and relatively low consumption (due to the crisis), the utilization rate of gas-fired plants (that come after RES in the merit order) has dramatically decreased. Many of them are not covering their fixed cost and will be closed (see above).

As a consequence of this generation over-capacity, prices on wholesale markets have decreased and become erratic. Positive price spikes (in winter for example) have nearly disappeared and new type of negative prices spikes have appeared during some hours interval (in 2012 there were more than 70 hours during which wholesale European prices were negative[42]).

The price difference between "peak hours" and "off peak hours" has also considerably flattened making investments in hydraulic storage much less attractive.

In the present market conditions, very high consumption on cold, dry and dark days with no wind could lead to supply disruptions.

The question is how long this chaotic market created by the combination of the European market deregulation, the Energy-Climate package and the economic crisis will last

This is a vital question for the financial health of European Utilities.
In the near future, capacity will be withdrawn from the market as a result of gas plants closure and of old coal-fired plants withdrawal from the market in 2015 following the implementation of the "Large Combustion Plants" Directive[43].

If the economy rebounds, we could get a similar situation to 2000-2006 when, after an overcapacity period, generation capacity was withdrawn from the market (2000-2004) by the Utilities. In 2005 the economy rebounded and – thanks also to high oil and CO_2 certificate prices – wholesale prices grew significantly.

However, extra capacity is continuing to be built, notably through renewable and thermal plants. For example, in Germany, from 2013 to 2015, the renewable energies installed capacity should grow from 80 to 100 GW and an additional cumulative 9 GW installed thermal capacity (mainly coal) should be built. Moreover the European economy could stay slow, with flat consumptions, thus **prolonging the erratic and low wholesale prices for a few years.**

Smarter grids

Because of the increase of RES share in the electricity mix and in the absence of large scale storage, grid management is facing new challenges. Balancing demand and supply becomes more complex as RES provides volatile power generation that is difficult to schedule (despite progress in modeling) and, in addition, customers can become momentarily generators. So bi-directional and unforeseeable flows have to be managed and, for that purpose, there is a need to better equip the present transmission and distribution grids.

There will be a dual flow on these smarter grids: energy and information. Data gathering, exchanging and managing will be of utmost importance and thus TSOs[44] and DSOs[45] will have to evolve towards Digital Enterprises.

Many stakeholders are involved in this new market design: Utilities, customers, equipment manufacturers, standardization bodies, national and European regulators.

Despite many technical and economic pilots launched in Europe[46], very little progress has been achieved on the new market design and financing rules for the new equipment and systems. Regulators have a key role to play.

The first step in smart grids implementation is **smart meters** deployment.

According to the EU Third Energy Package, 80% of electricity customers in EU should have smart meters by 2020, unless the analysis performed by the Member States proves that the cost/benefit is uneconomic.

Smart meters implementation impacts all value chain segments:

- Generation: by triggering a better demand response, they contribute to decrease investments for peak capacity and decrease hence CO_2 emissions (as the fossil-fueled plants are providing the peak generation),
- Distribution: by improving field service management, reducing meter reading activities, reducing technical and non-technical electricity losses on the grid and allowing a better outage management,
- Retail: all meter-to-cash processes (including cash management) can be digitally optimized allowing a better service,

42 Dr Torsten Amelung presentation at Montel Energy Days, Düsseldorf 5-6 June, 2013
43 Adopted on October 23, 2001
44 TSO: Transmission System Operator
45 DSO: Distribution System Operator
46 According to the EC, during these last ten years more than €5.5 billion have been invested in around 300 projects in Europe.

- Customer retention: smart meters implementation enhances the Utility's competitiveness and provides better customer information and notably more accurate bills.

However with the present unbundled situation, return on Investment is only relevant on the grid part of the value chain which is not as good as on the whole value chain.

Nevertheless, smart meters rollout is progressing. In addition to Sweden and Italy that have already fully deployed electrical smart meters, many Nordic countries, Spain and the UK have started their deployment.
The decision to install 35 million smart meters in France was taken in early July 2013 with a first phase of 3 million meters to be installed by 2016. The deployment cost for the 35 million smart meters is estimated between €5 and 7 billion.

In August 2013, the French government approved the 11 million gas smart meters[47] deployment to take place on the 2016-2022 period.

As a conclusion smart grid implementation is slow and no clear economic model has emerged.
With the increase of RES share in the electricity mix, it is urgent to accelerate the industrial development of large scale competitive *electricity storage* solutions and funds should be re-directed to these developments.

Climate change

Thanks mainly to the economic crisis, the 2020 European target of 20% reduction in greenhouse gas (GHG)[48] will be achieved and even exceeded as in 2012, the EU GHG emission reduction is already at 19.9% compared to 1990.

Presently, the ETS[49] is not effective in giving the right economic signal for investments in low carbon technologies. In five years, the CO_2 price has decreased from around €20/t in 2007 to less than €5/t in August 2013. This very low price is to be compared with: the floor price of £16/t (announced by the British government in 2011 and introduced on April 1, 2013), the shadow carbon value estimated at around €45/t in 2020[50] and prices enabling competitive CCS[51] systems to be implemented that are estimated at €40-55/t for coal plants and €80-110/t for gas plants[52].

In fact the financial and economic crisis that started in 2008 was not anticipated and too many certificates were allocated in National and European Permit Rights Allocation, leading to an over-allocation of around 1,500 Mt of CO_2 equivalent[53] for the third period (2013-2020) This surplus is even increased by numerous rights resulting from the CDM[54] mechanism (created by the Kyoto protocol) that are traded on the European market.
Back loading the auctioning of a maximum of 900 million CO_2 permits was backed by the European Parliament on July 3, 2013.

While the CO_2 prices increased immediately by 11.6%, they are staying at a very low level (less than €5/t).

This decision is not sufficient to allow the ETS to deliver the right economic signals in a sustained way. A deep reform is needed as for example, there is no mechanism allowing the limitation of emission rights in case of an economic crisis.

In the absence of this ETS structural revision, carbon prices will stay low in the future.

In March 2013, the EC adopted a Green Paper to launch a public consultation on the content of a 2030 framework in order to give visibility to investors and to stimulate demand for low carbon technologies. The aim is to build the path to meet the "necessary long-term goal"[55] of cutting emissions by 80-95% by 2050. The new energy policy framework is intended to take into account the consequences of the economic crisis.
It is indispensable that this new framework takes into account all lessons learned regarding the flaws in the present system, as the ETS system design and the EU directives impacts on the energy markets. The present policy has notably led to:

- Chaotic wholesale markets with negative prices giving the wrong economic signal for the needed investments in energy infrastructures,
- Very high and growing renewable energy subsidies that will become unsustainable in the future,
- No clear financing of the smart grids that will be indispensable when renewable electricity output share grows over 20%,

47 Gazpar project

48 Greenhouse gases include many gases in addition to dioxide carbon CO_2 such as methane (CH_4), (N_2O) and CFCs. Their toxicity on the global temperature increase varies from one gas to the other. For simplicity, we will refer to CO_2 as CO_2 equivalent for all Greenhouse gases (GHG)

49 ETS: Emissions Trading System

50 Rapport Quinet « valeur tutélaire du carbone », Documentation Française, 2009

51 CCS: Carbon Capture and Storage

52 ZEP « Zero Emission Platform » estimations

53 Berghmans in *Club Tendance Carbone*, CDC Climat Recherche, April 11 2013

54 CDM: Clean Development Mechanism

55 If this goal would be met, our planet temperature increase would be limited to 2°C

- Low carbon prices enabling coal-fired plants to regain share in the electricity mix!

Moreover, until recently, Europe was isolated in its desire to limit emissions, as atmospheric pollution is global; EU efforts were a drop of water in the ocean!

The good news is that other large nations are expressing their intention to cut their emissions.

It is the case of China where Shenzhen has become the first city to pass a bill that will cap CO_2 emissions from factories and power plants. Shenzhen's emissions market, one of seven pilot schemes to be rolled out in the nation over the next two years, began CO_2 trading in June 2013.

In June 2013, President Obama announced an ambitious plan to deal with climate change by directing the Environmental Protection Agency to establish carbon pollution standards for both new and existing power plants. These new standards will almost certainly face legal challenges. The American goal is to reduce carbon pollution by at least 3 billion tons cumulatively by 2030, more than half of the annual carbon pollution from the US energy sector, through these efficient standards.

According to the climate plan released by the White House, the US will make continued progress in reducing pollution by leading the way in the development of clean energy technologies such as efficient natural gas, renewables, clean coal technology and nuclear.

Nuclear energy

Despite the slowdown in its development after the Fukushima accident, nuclear energy is still a sizable part of the needed energy technologies for reducing CO_2 emissions.

Japanese nuclear status

According to recent reports[56], it is unlikely that there will be any serious immediate or long-term health effects from radiation exposure following the March 2011 Fukushima accident to either the general population or workers at the nuclear plant. However, the report also says that the evacuation had a "very significant impact" on the social and mental wellbeing of the population.

The situation at the Fukushima site[57] is still challenging. Although a relatively stable cooling of the fuel in the reactors and spent fuel pools has been established and is adequately removing decay heat, there are several challenges to achieve a sustainable situation including the treatment of enormous amounts of radioactive liquids that have accumulated.

To draw lessons from the accident – its root causes and its management – the Japanese government has created an independent Nuclear Regulation Authority (NRA).

In June 2013 the latter approved the final draft of the New Safety guidelines which cover three main areas: safety standards, severe accident measures and emergency scenarios for earthquakes and tsunamis.

Nuclear plant operators will be obliged to take concrete steps to mitigate the possibility of serious accidents. Until now, such actions were voluntary.

56 The United Nations Scientific Committee on the Effects of Atomic Radiation (Unscear) report, which is currently being finalized.

57 IAEA: International Atomic Energy Agency reports

Only two of Japan's 50 operable reactors, Ohi-3 and Ohi-4, have restarted since the Fukushima accident.

In March 2013, Japan's prime minister, Shinzo Abe, told parliament that idled nuclear reactors will be restarted if it is proven safe to do so. In July 2013, four power companies submitted applications to the nuclear regulation authority to restart 10 nuclear reactors.

It is clear that Japanese nuclear reactor restart and, in the longer run, potential new reactors built would have a big impact on the gas markets as presently Japan is importing large amounts of LNG in order to compensate for its lack of nuclear energy. These importations have deteriorated Japan's commercial balance and the country posted in 2011 its first trade deficit in 31 years.

The longer-term **global impact** of the Fukushima nuclear accident on the nuclear industry will be less than was anticipated in the immediate aftermath of the disaster. Presently, the International Atomic Energy Agency forecasts that global expansion of nuclear power post-Fukushima will be moderately slowed, but not reversed. Before the Fukushima accident, there were 484 planned or proposed new reactors; in July 2013 this figure was 478.

There are 65 *nuclear reactors under construction* around the world. Of these, 47 are being built in Asia: China (26), Russia (10), India (7), and South Korea (4). Many countries such as China changed their plans to focus on safety. New projects are also emerging in the Middle East (Emirates, Saudi Arabia), Turkey and South Africa.

As a consequence of the very long freeze on new nuclear reactor[58] construction *in Europe*, human competencies are missing including the ability to master very large projects. Also the eco-system of nuclear quality level subcontractors has to be upgraded.

A few reactors are being built in Europe including two EPRs: one at Olkiluoto in Finland and the other one at Flamanville in France. While the same reactors built in China at Taishan (Guandong province) should to be on time and within initial investment projections, the European EPR reactors are experiencing delays and cost overruns.

In February 2013, Olkiluoto delay was estimated at 7 years and costs overrun at €5 billion.
Flamanville is now forecast to be operational in 2016 (instead of 2012/2013) and its cost is estimated at €6 billion (instead of €3.3 billion initially forecast).

However, with this delay the total Flamanville construction time should amount to 8-9 years which is not extraordinary long for a first-in-kind "generation 3" project when compared to the average construction time for French "generation 2" reactors of 7.5 years.

Negotiations are going on between EDF and the British government for the construction of 2 EPRs at Hinkley Point (Somerset). End June 2013, the UK government announced a bid to encourage investment in nuclear power by offering £10 billion (€11.6 billion) of guarantees.

The electricity price level at which this nuclear electricity would be sold, that is defined by the new "Contracts for Difference"[59], is a central point of the discussions. A decision could be taken by EDF in 2013.

As investments amount to 80% of the total nuclear electricity cost **there is a real need to master new nuclear plants construction delay and costs** as these plants will have to compete, in the future energy mix, with renewable energies (that are experiencing cost decreases) and, in the US, with gas-fired plants using cheap shale gas.

No existing nuclear plants were stopped except in Germany (for political reasons) and in Japan.

In order to implement the lessons learned from the Fukushima accident, Nuclear Safety Authorities required design upgrading and revisited operational practices. These additional safety measures are resulting in new investments that can be sizable, as in France, where EDF will spend an additional €10 billion to upgrade its 58 nuclear reactors.

Some existing plants were awarded lifetime extension as Asco 1&2 in Spain and Fessenheim, Tricastin and Bugey 2&4 in France. In 2012, EDF Energy in the UK announced that it expected 7 years life extension on average across all AGRs[60], including the recently life-extended Heysham 1 and Hartlepool.

Even if their costs are increased by these safety upgrades, existing nuclear plants are competitive. In France for example their total cost of electricity generation, including life time extensions, dismantling and radioactive waste management & storage, has been estimated at €57/MWh, which is lower than electricity costs generated by gas-fired plants and RES[61].

58 More than one decade

59 Contracts for Difference (CfDs) are intended to stabilize revenues for investors in low-carbon electricity generation projects - renewables, new nuclear or Carbon Capture and Storage

60 AGR: Advanced Gas-cooled Reactor

61 Cour des Comptes study « Les coûts de la filière nucléaire » January 2012 and « Energies 2050 Commission » conclusions February 2012

Energy transition

After the Fukushima accident, many European countries decided to revise their energy policy in order to decrease or to phase out nuclear energy.
Even if two years later, confidence in nuclear energy is improving, those debates are continuing.
Italy decided by referendum in 2011, not to build the four nuclear reactors that were planned.

In June 2011, the Swiss parliament resolved not to replace any reactors after the end of their lifetime, and hence to phase out nuclear power by 2034 (with the assumption of a 50-year lifetime for the newest unit).

Belgium's position is to phase out nuclear energy by limiting the reactors' lifetime to 40 years: so Doel 1&2 should close in 2015, Tihange 1, although reaching 40 years operations in 2015, should be prolonged until 2025 and the remaining 4 reactors will reach 40 years lifetime between 2022 and 2025.

We will examine in more detail the French and German cases:

In 2011, just after the Fukushima accident and mainly for political reasons, **Germany** decided upon an energy transition with the following objectives:

- Total nuclear phase-out by 2022 (8 reactors immediately shut down after the Fukushima nuclear accident, closure of the remaining 9 reactors by 2022),
- Greenhouse gas emissions reduction by 80-95% before 2050,
- 80% electricity production from renewable energy sources before 2050.

This energy transition plan requires Germany to:

- Build more generation capacity to replace the nuclear reactors. The plan forecasts a strong increase of renewable share – from 20% presently to 35% in 2020 generation mix share,
- Redesign the whole grid to cope with more and smaller electricity injection points in addition to solving grid balancing issues and building HVDC lines to connect large offshore wind farms,

The energy transition investments needed from now to 2040 are forecast around €1,000 billion[62], an amount comparable to that spent on German re-unification.

Mid-2013, there are significant deviations from this energy transition plan:
After the closure of 8 nuclear plants in 2011, and in order to meet the electricity generation needs, a number of mothballed coal and lignite plants were re-opened. In 2012 those plants increased their generation output by more than 6% leading to an embarrassing 2% increase in CO_2 emissions.

But the crucial problem resides in *social acceptance*: notably the construction of numerous wind farms, *grid redesign* and the construction of new power lines. As there will be fewer large generation plants but more renewable decentralized units, notably wind farm that are in the Northern part of Germany while the large industrial consumption is in the South, **a grid overhaul is required.**
This new grid construction is late compared to plan as it is encountering local public opinion opposition that is made worse by the fragmented grid organization in Germany.

62 According to M. Altmaier, German Environment Minister

More grid construction delays can be expected as 10 years at least are needed in Europe to build[63] a new high voltage overhead line. To try to overcome these important difficulties, the four German TSOs have decided to cooperate on four HVDC underground North-South network lines deemed crucial to the success of the country's energy transition[64]. The exact pathway of these future corridors, that will be between 5 and 10 times more costly than overhead lines[65], is still to be agreed with the network regulator.

Another important point is the resulting increase in electricity prices linked to the EEG levy and the grid costs increases. This price increase, which could reach 70% by 2025 for residential customers, is becoming unpopular.

Similarly and despite sizable exemptions that they are getting on electricity transportation fees and on the EEG levy, large industrial consumers of electricity fear a loss of global competitiveness. According to a recent study[66], electricity prices for big industrial customers should grow in Germany from €90/MWh in 2012 to €98-110/kWh in 2020, while thanks to cheap shale gas, they should only grow from €48 to 54/MWh on the same period in the US, giving a global competitive edge to US industry.

It is difficult to predict how the German energy policy could be modified after the September 2013 German general elections. It is very unlikely that the nuclear phase-out policy would change; however RES subsidies and the EEG Levy financial limitations could well happen.

Thanks to its 58 nuclear reactors that are run safely, electricity prices in **France** are among the cheapest in Europe and CO_2 emissions per kWh are the lowest among European countries. However François Hollande, the new French socialist president made the following commitments during his election campaign:

- Cut France's reliance on nuclear energy from more than 75% share in the electricity mix presently to 50% by 2025 and close the Fessenheim reactor by 2016,
- Accelerate RES development,
- Improve the energy efficiency of buildings.

The energy transition debate that took place in H1 2013 should lead by 2014, to a new energy policy for France.

As in Germany this energy transition should:

- Have a high investment cost: €592 billion of new investments are forecasted[67] among which €170 billion for energy efficiency and €422 billion for the electrical system (€262 billion for generation and €160 billion for the grids),
- Lead to an electricity cost increase by €30-40/MWh in addition to a similar increase linked to Grenelle's[68] commitments,
- Encounter social opposition issues for wind mills or high voltage lines construction,
- Deteriorate French trade balance if no RES industrial policy is successfully implemented.

A successful French energy transition will need to:

- Meet French energy policy objectives: security of energy supply, environmental performance and competitive electricity prices,
- Consider the continued operation of the current nuclear power plants fleet (as long as it is economic and subject to the authorization of the French Nuclear Safety Authority) as a viable option as it would be the least costly policy,
- Maintain a competitive power generation mix, by adopting a reasonable pace for the development of renewable energy,
- Finally ensure value creation for France (growth and employment) by implementing sustained industrial and R&D policies.

63 France-Spain interconnection required 20 years of consultations before being launched partially underground
64 Montel Magazine Vol 12, N02, June 2013
65 RTE: réseau de Transport d'Electricité « Les lignes souterraines et la mise en souterrain»
66 BDI (Bundesverband der Deutschen Industrie) report (November 2012)
67 UFE (Union Française de l'Electricité) estimations
68 Grenelle de l'Environnement is the Energy-Climate Directive transposition in France

Utilities situation

As already stated in the 14th European Energy Markets Observatory, major European **Utilities** are negatively impacted by a difficult environment, with a weak demand and low wholesale market prices. Their revenues are structurally decreasing[69] as RWE CEO Peter Terium stated recently, by announcing that "80% of the company revenues will be gone in 2-3 years".

Utilities EBITDA[70] margins are under pressure because of deterioration in power generation margins, rising overcapacity due to stagnating consumption and the growing burden of RES taxes. In some countries, this situation is worsened by additional taxes (such as nuclear taxes in Germany, Spain and Belgium) or by very limited tariffs increases allowed by governments attentive to their electors' standard of living.

On a sample of large European Utilities, the average EBITDA margin has decreased from 19.4% to 18.7%.

Utilities still need to restore their balance sheets by accelerating their operational excellence efforts and by continuing to divest – notably their RES assets or their high margin network activities.

Even if electricity and gas demand/supply gets better balanced again (see above), the situation will be different than before the RES fast development. There is already a trend of local demand/supply balanced clusters (eco cities for example) and this trend will develop.

Incumbent Utilities present models with large centralized generation plants and quasi- uniform supply offerings to residential customers will have to evolve towards more decentralization (including generation), differentiated offerings and better competitiveness. This challenge could be met, by analyzing and exploiting the large amount of available new data (notably through smart meters) and by taking advantage of innovations in Information Technology. A courageous human management policy aiming at modernizing collaborators behavior at work is for sure a key success factor.

Those companies should become lean digital enterprises.

69 At normal weather conditions

70 EBITDA: earnings Before Income Taxes, Depreciation and Amortization

Conclusion

The deep economic crisis, combined with deregulation of electricity and gas markets, and with the Energy-Climate Directive that favored a rapid renewable energies expansion, have led to chaotic electricity and gas markets.

On the wholesale electricity markets, prices are very erratic and even negative during some hours, CO_2 emission prices have reached low levels that give no signal to invest in low carbon technologies and finally Europe is impacted by the US shale gas boom but does not benefit from it.

Energy markets have to be rethought by:

- Reforming the ETS market or creating (as in the UK) a CO_2 floor price,
- Creating capacity markets coordinated at the European level,
- Designing and implementing a new retail market enabling the financing of smart grids,
- Establishing a more reasonable growth pace in RES capacity and limiting the related growth in subsidies,
- Keeping in operation plants that are safe and economically viable,
- Limiting the taxes and other burdens on Utilities.

Without these reforms, security of energy supply could be threatened as there are no long-term economic incentives to invest in new and vital energy infrastructure, and as the financing power of Utilities is shrinking.

Regulators and governments have to play their role and establish rules enabling the market to evolve from a liberalized market to a managed market (as is happening in the UK).

If the right reforms are not implemented in a timely way, the physical electricity system will deteriorate, and when the economy and consumption grow again, energy supply disruptions could happen.
The needed reforms will perhaps not be implemented until then!

Paris, September 6, 2013.

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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: Exane BNP Paribas, VaasaETT and CMS Bureau Francis Lefebvre.

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