Deutsche Bank
DB Research

Current Issues
Natural resources

The new global power plant order

Unconventional and green energies are driving change

July 16, 2013

Author
Josef Auer
+49 69 910-31878
josef.auer@db.com

Editor
Antje Stobbe

Deutsche Bank AG
DB Research
Frankfurt am Main
Germany
E-mail: marketing.dbr@db.com
Fax: +49 69 910-31877

www.dbresearch.com

DB Research Management
Ralf Hoffmann | Bernhard Speyer

The global power plant order has been in a process of transition for many years. This is because an ample supply of electricity is one of the basic necessities for a civilised way of life and modern industrial structures. As a reflection of the fact that the deposits of energy resources and thus also their prices vary widely worldwide, power generation structures differ from one continent to the next, from country to country and – in larger countries – also from region to region. Other important factors are the infrastructures that have developed over time and not least the energy, environmental and regulatory policy framework and interventions.

Ever since the grave natural disaster in Japan in 2011 and the subsequent nuclear accident in Fukushima the global power plant order has again been the focus of a great deal more interest. But although the initially hotly debated, radical demands for an end to nuclear power generation and usage in many parts of the world have subsided considerably in the meantime the change in the power generation mix is still fuelling debate among policymakers and decision makers in industry and society.

The avid interest is being driven by two megatrends that are currently shaking up the traditional order of global power generation and supply and might fundamentally recast it in future. There are currently at least two major battles being waged in the contest between the different power generation inputs. Firstly, at the centre of the fossil-fuel input segment a fierce contest is unfolding between coal and gas, and its outcome is likely to determine the success of future power plant investments by the utilities. Secondly, there is the expanding international scale of the attack by renewable energy sources on established, mostly fossil fuels.

The contest between coal and gas will not yield “a lone global champion” in the medium term. In the US the trend is towards gas, in Asia coal remains the number one fuel and in Europe the picture is mixed. Alternative energies will undoubtedly become increasingly important globally. Equally, the continuing rise in demand for electricity over the next 20 years, especially in the emerging markets, will provide sufficient new potential sources of revenue – both for the development of renewables as well as the usage of fossil fuels.

Containing the threats to the global climate requires a redoubling of efforts. For the fossil-fuelled power plants reducing CO_2 emissions remains a mammoth task. Technological progress and the benefits of mass production will render renewables more competitive in future. Unconventional and green energies represent a challenge to the existing power plants, but for the foreseeable future the situation is unlikely to be turned on its head, that is to say that the global power plant mix will by no means undergo revolutionary changes.

"New Policies Scenario" expects expansion in global power generation 1

	TWh	TWh	TWh
	1990	2010	2035
Coal	4426	8687	11908
Oil	1336	1000	555
Gas	1727	4760	8466
Nuclear	2013	2756	4366
Hydro	2144	3431	5677
Biomass	131	331	1487
Wind	4	342	2681
Geothermal	36	68	315
PV	0	32	846
Solar thermal	1	2	278
Wave and tidal	0	1	57
Total	11818	21410	36636

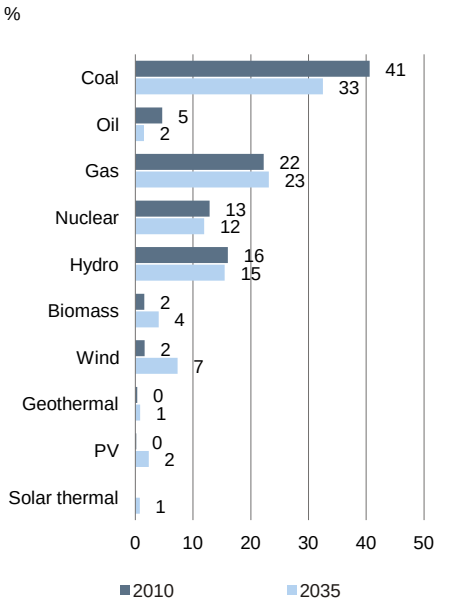
Source: IEA, World Energy Outlook 2012

1. Global power generation mix in flux

In principle all types of fossil fuels, nuclear power and increasingly also renewables can be used to generate electricity. Important factors in this contest between the different power sources are natural conditions such as deposits of coal, natural gas, crude oil, biomass, watercourses, geothermal energy, wind and hours of sunshine. Other factors include transport facilities for the individual energy sources consisting not only of road, rail and ship but also pipelines and ports right through to the availability of natural gas via efficient loading and unloading stations. The availability via efficient power grids is also of course essential for the actual business of long-distance transmission of electricity right through to its decentralised supply to households. Also of relevance are regional and/or country-specific political requirements such as the respective competition framework, taxes or environmental standards as well as emissions costs, which will possibly become more important again in future. Important parameters for power station investments are the capital, fuel and financing costs and ultimately the electricity prices that can be achieved depending on the type of customer. So it is no wonder that a look at power stations around the globe reveals that the power generation mix differs from region to region.

At present and at least over the medium term a minimum of two major battles will be fought in the competition between the input energies for generating electricity. Firstly, there is the expanding international scale of the attack by renewable energy sources on established, mostly fossil fuels. Secondly, at the centre of the fossil-fuelled power input basket there is a fierce contest between coal and gas whose outcome is likely to determine the success of future power plant investments by the utilities.

"New Policies Scenario" expects changes in global power generation mix 2



Source: IEA, World Energy Outlook 2012

2. Renewables attacking fossil fuels

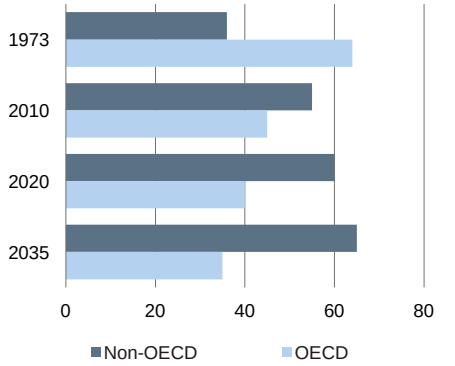
Renewable energies are seen as holding the key to the 21st century, given that they provide solutions to at least three major problem areas whose importance has grown over recent decades and that will shape this century. The first one is the continued growth in the Earth's population, which is significantly boosting the demand for energy. According to the IEA's central "New Policies Scenario" published in the current World Energy Outlook 2012, the Earth's population will have grown by 1.7 bn (and thus by more than China and the US combined at present) to 8.6 bn and energy consumption will have risen by 35% between 2010 and 2035. The driving forces are the non-OECD countries (primarily in Asia and Africa), as they accounted for more than 90% of both the population growth and the energy consumption growth in the period under review. Whereas in 1973 the non-OECD countries accounted for just 36% of global energy consumption, by 2010 their share had risen to 55% and is forecast (according to the central scenario) to climb to no less than 65% by 2035.

The second problem, which is linked with the first one, is the structural uptrend in the prices of major fossil fuels, such as petroleum in particular (the IEA forecasts a real oil price of USD 125 per barrel of crude in 2035), which in turn is feeding through to the other energy sources. This necessitates a supplement to the global energy mix and will make alternatives increasingly interesting from a commercial point of view in future. Thirdly, low-emission energy sources are needed to contain climate change. Over the last 40 years biomass and hydro-power combined have already covered up to 14% of global primary energy consumption. In future the new renewables will also grow quite vigorously, albeit from what is still a very low base compared with the global average.

The new global power plant order

Non-OECD countries' energy consumption rising continually 3

Share of global primary power consumption, %



Source: IEA

Hydropower even outscores new renewables 4

Hydropower has a long tradition. The first hydropower plants were built back in the late 19th century. Today, about half of the small-scale hydropower plants in Europe are over 60 years old, and no less than two-thirds of them are over 40 years old. Many years of experience mean that traditional hydropower plants have largely been technologically optimised.

Hydropower has many advantages over the new alternative sources of electricity. It achieves an efficiency level of up to 85%. This makes hydropower a more efficient type of electricity generation than solar cells or wind farms, which achieve efficiency levels of around 20% and 40% respectively. In addition, hydropower is in most cases independent of the time of day, i.e. is not governed by the amount of sunshine or wind speed. This enables sustainable, uninterrupted power generation. Besides, individual types of hydropower generation such as storage power plants are well suited for flexibly bridging temporary demand peaks.

Investments in hydropower, as with wind and solar energy, are marked by relatively high initial outlays that are followed by very low operating costs (less than 1 cent per kWh). This is a major advantage over fossil-fired power plants, where the risk of increases in input costs for coal, oil and – to a limited degree – also natural gas can jeopardise returns. Moreover, intelligently planned hydropower plants pave the way for multiple uses. Improvements in shipping conditions and flood protection can be integrated.

Hydropower will remain the world's leading renewable source of electricity for the medium term, …

Hydropower's public profile – especially in Europe – is often too low compared with that of the new renewables such as windpower or solar energy. This is surprising as IEA statistics state that the hydropower share of total electricity production worldwide in 2010 came to about 16%, i.e. much more than windpower and bioenergy, which each accounted for 2%, and photovoltaics (PV), whose share is barely visible in the statistics. In many other parts of the world hydropower is therefore paid a great deal more attention. One important reason for this is the very large contribution that hydropower makes to the electricity supply in many countries that are also significant in terms of volume. For instance, hydropower is not only the overwhelmingly dominant source of electricity in Norway with a 96% share in domestic power generation, but also in aspiring Brazil, where the share is 84%. The next countries in the ranking of the Top 10 hydropower producers are Venezuela, Canada and Sweden with also high shares of between nearly 50% and 73%. And even China and Russia, i.e. the world's number one and number five generators of hydropower, achieve shares slightly higher than the global average (16.5%).

Theoretically, the world's entire demand for electricity could be met by hydro-power. Admittedly, this conflicts with the realities of geographically uneven distribution in the world's regions (roughly 50% in Asia, 30% in the Americas, 10% in Africa and 8% in Europe) as well as with economic rationale, since not everything that is theoretically or technically possible is also economically feasible. For example, the dearth of inexpensive facilities for the storage and transport of electricity limits its viability.

… but will be boosted in future by other renewables

The IEA forecasts that by 2035 global electricity output will have increased by more than 71% (compared with 2010). Hydropower remains the leading renewable energy source with a share of 15%, ahead of windpower (7%) and biomass (4%). Despite posting high growth rates solar power (including concentrated solar power (CSP)) will have reached only a comparatively low level of 3% by 2035; this will nevertheless be twice as high as geothermal (1%).[1] So whereas the hydropower share will remain roughly the same, the share of the remaining renewables will quadruple from 4% to 15%. Looking at percentage shares provides only half the picture, however, as all renewables will in fact achieve volume growth by 2035. It is also revealing that only windpower can boost the absolute volume of electricity generated faster than hydropower. In this context, admittedly, offshore wind in particular still has to justify the promising outlook forecast for it. One certainly realistic prospect seems to be that about half of the world's new additional hydropower capacity of around 650 gigawatts (GW) will be installed in the globally aspiring countries of Brazil, China and India. It is also commercially interesting that even Europe still has more than enough space for the continued expansion of hydropower plant.

Hydropower is also the number one renewable source of electricity in Europe

Hydropower accounted for 15% of power generation capacity in Europe in 2011. This means that among Europe's power plants it also ranks well ahead of the new renewables such as wind energy and photovoltaics. The years of generous subsidies for wind and solar energy are helping to narrow the gaps, however. For example, windpower generated merely 2% of electricity capacity in 2000,

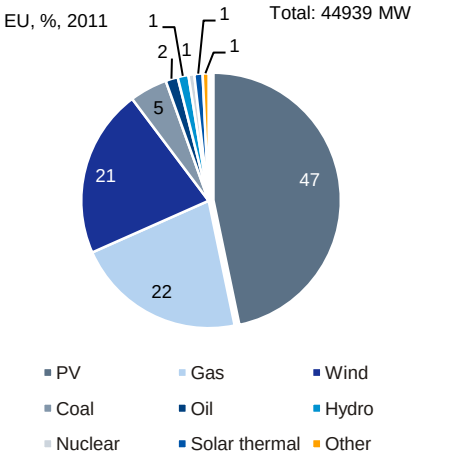
[1] See IEA, 2012. International Energy Outlook. p. 554.

but by 2011 the share had already risen to 10%. Photovoltaic technology has grown at a similarly brisk pace: from not being a factor in 2000 it had already reached a share of close to 5% by 2011.

An analysis of Europe's power plants between 2000 and 2011 reveals two major trends. Firstly, the electricity sector is relying less and less on coal, nuclear energy and oil when making its investment decisions, according to the European Wind Energy Association (EWEA). For each of these power generating alternatives, more capacities were removed from the grid than new ones were installed. The net change in capacities installed in the EU totalled minus 10 GW in the case of coal-fired plant, minus 14 GW for nuclear and minus 14 GW for oil-based electricity generation. Secondly, the trend is moving towards renewable sources of electricity and natural gas. Net growth in the case of natural gas totalled +116 GW, windpower +84 GW, photovoltaics +47 GW and hydropower +4 GW.

The trend towards renewable sources of electricity in Europe remains intact. In 2011, renewables contributed 32 GW or 71% of newly installed power plant capacity. With a share of 66% of all renewables photovoltaics lies well ahead of windpower (30%), hydropower (2%), CSP and biomass (each 1%). And the future of European power generation also belongs mainly to renewables. This is ensured by the broad political (and thus also financial) support in Europe[2], not least in the most significant country by volume, Germany, where the government and the opposition are uncommonly united in steering “the new energy policy” towards renewables.[3]

Gas and renewables accounted for 90% of new power capacity installations 5



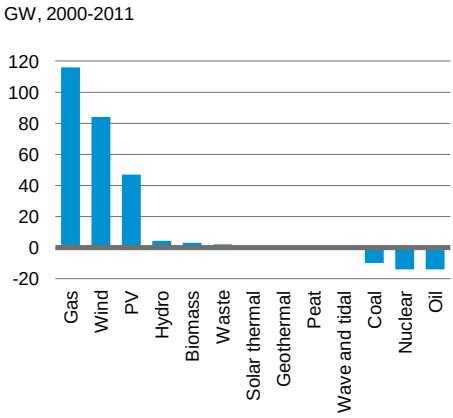
Source: European Wind Energy Association, 2012

Still considerable hydropower potential, also in Europe

Hydropower plays a key role in large-scale and important concepts for Europe’s future. For example, the offshore grid initiative of the North Sea states, which is intended to produce an additional 100 GW of clean electricity capacity for Europe, is counting on modern hydropower technologies such as pumped-storage generating plants in Norway in addition to windpower. These help to better even out the erratic peaks in windpower generation.

The potential hydropower theoretically to be tapped in Europe (excluding Russia) totals nearly 2,600 terawatt-hours (TWh) per year. Currently, 64% of the economically viable potential (870 TWh/year) is being exploited. It follows that Europe leaves no less than 36% of its hydropower potential, or more than 300 TWh/year, unused, even though related power generation would pay off.[4] Hydropower potential is not equally distributed across Europe by any means. There is still ample potential, even far away from Scandinavia, in the Alpine countries[5] or south-eastern Europe, not least in Albania and Turkey. That is why hydropower – along with the new renewables – will also be one of the winners in the European power plant sector in the coming decades.

Net electricity generating installations in the EU 6



Source: European Wind Energy Association, 2012

[2] E.g. European Climate Foundation (2010). Roadmap 2050 to a prosperous, zero-carbon Europe.

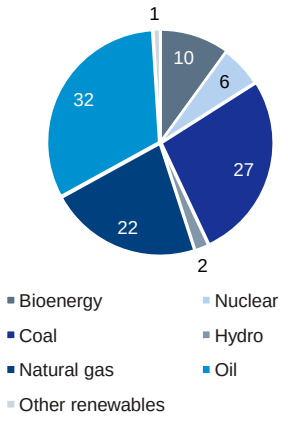
[3] See Auer, Josef and Eric Heymann (2012). Germany's energy policy turnaround: Taxing job for municipalities and municipal utilities. Deutsche Bank Research. Current Issues. Frankfurt am Main. Auer, Josef and Jan Keil (2012). State-of-the-art electricity storage systems: Indispensable elements of the energy revolution. Deutsche Bank Research. Current Issues. Frankfurt am Main. In 2012 renewables accounted for 22% of all electricity generated in Germany, a new record. In 2005 the figure was just 10%.

[4] See RWE Innogy (2010). Fact Book Renewable Energy. RWE Innogy (2012). Fact Book Renewable Energy.

[5] In the Alps many of the locations suitable for hydropower plants are not used for landscape conservation reasons. Nevertheless, Austria and Switzerland already have high hydropower shares in electricity generation of more than 50% each.

81% of global energy consumption in 2010 was accounted for by fossil fuels 7

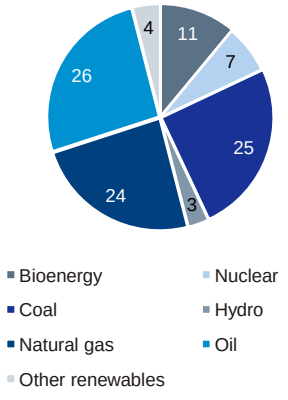
Share of energy demand, %, 2010



Source: IEA

75% of global energy consumption in 2035 was accounted for by fossil fuels 8

Share of energy demand, %, 2035



Source IEA

In future, however, we will also see an increase in the importance of green sources of electricity such as photovoltaics, biomass or renewables-based, efficient combined heat and power systems, which promote the trends towards decentralisation and smart grids. At the same time, however, there are new trends in renewables that ultimately point more towards centralised power generation. One only needs to think of the construction of large offshore wind farms whose electricity subsequently has to be transported to customers over long distances. Or of the ambitious Desertec initiative that could speed up the convergence of the electricity markets of North Africa and Europe in a few years. Large volumes of desert electricity are then to be offered to energy-hungry, solvent clients in Europe at low prices.

Renewables complement the established electricity generation mix

Renewables are unquestionably becoming increasingly important for the global power supply. All the same, the continued global increase in demand for electricity during the coming decades will still open up sufficient revenue potential – both for renewables and fossil fuels. Should, however, there be fundamental or unexpected changes in not only the overriding drivers such as demographics and, linked to this, the demand for electricity, but also additional factors such as technological progress, energy efficiency or also consumption patterns, then of course new forecasts and if necessary also policy adjustments will be necessary. In the meantime it is thus by no means a matter of crowding out or replacing individual sources of energy, but rather of supplementing and enhancing established input patterns.

3. Gas posing an ever increasing challenge to coal

For a long time the contest between the fossil fuels appeared to be mapped out and the outcome inevitable. On account of the increasingly tight resource situation and the prospect of rising prices for power plants in the future oil was attributed with at best a chance of being used to flexibly offset demand peaks. Although the prospects for natural gas were seen to be more favourable because its resource base is better than that of oil, ultimately the less favourable medium and long-term resource situation – compared with coal – and the relative increase in the natural gas price – because it is tied to the oil price – would show their effects and thus diminish the prospects of gas being able to compete with coal.

By contrast, the triumph of coal on account of the large and cheap deposits in many parts of the world was regarded as unstoppable and simply a matter of time, and this despite its environmental impact being more unfavourable than that of natural gas. In fact, the world's second most important source of energy, coal, contributed nearly half and thus the lion's share to satisfying the 55% increase in global demand for energy between 2000 and 2010.

Coal remains on an uptrend, …

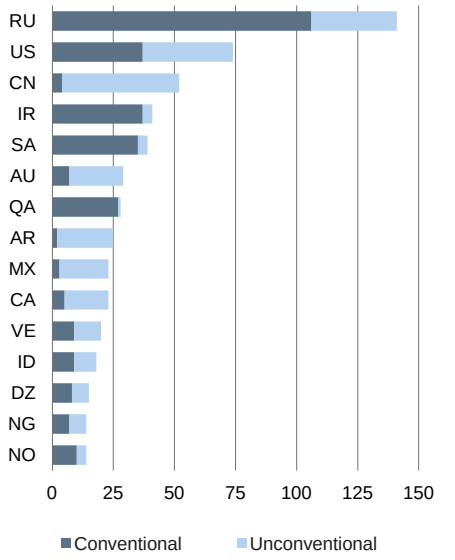
The IEA expects a further expansion in coal demand of nearly 60% by 2035 – admittedly based on the premise of a constant energy policy framework. This would make coal the new number one global primary energy source with a 30% share of global energy consumption, i.e. ahead of oil (27%) and natural gas (23%). But even in the IEA's new central scenario based on the new energy policy framework, which gives a slightly higher weighting to environmental targets, there is still a 21% increase in global coal consumption. The biggest drivers of the increase in demand are probably the emerging markets, especially China and India. India's economic ascent will be accompanied by its coal

consumption more than doubling by 2035. This will see India overtake the US in the statistics to become the second largest consumer of coal even before 2025 and probably also become the biggest importer of coal before the current decade has even come to an end.

All the same, China, which has only been a net importer of coal since 2009, will remain the dominant force in the world coal market. China already absorbs around half of the world's coal output. It is no small matter that the outlook for the global coal market is dependent on the centrally planned targets of China. China's future energy policy, presented in its current five-year plan, is aimed at reducing the energy and CO_2 intensity of the Chinese economy. Its implementation as planned would support the global coal central scenario of a gradual slowing of the increase in absolute coal consumption. The coal share in global primary energy consumption would thus already start to decline slightly once again at the end of the decade.

Natural gas: Recoverable resources 9

Top 15 countries, tr m^3, end-2011



Global total: 752 tr m^3

Sources: IEA, BP

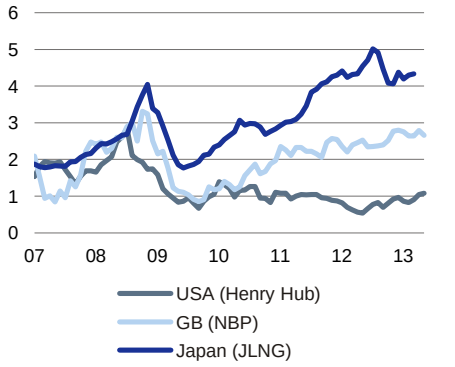
… but the gas glut raises questions

Natural gas is one main reason for the faltering dynamics in coal consumption. In the last few years coal has surprisingly been confronted with new competition. And in the meantime the battle between coal and gas has well and truly begun. One reason for this is the new discoveries of conventional gas deposits and another is the technological advances: firstly in extraction and production of unconventional natural gas. Secondly, however, advances have also been made in the long-distance transportation of natural gas using alternatives to expensive and geographically inflexible gas pipelines. The successful exploration and exploitation of major shale gas fields and the long-distance transportation of liquefied natural gas (LNG) make natural gas cheaper internationally and give the energy source fresh momentum in the energy contest, not least vis-à-vis coal.

Just a few years ago the rise of natural gas was seen as highly unlikely by many market observers, and if at all then certainly not for a sustained period.[6] Today, by contrast, there is a very broad consensus that the gas glut is set to last for several years. So it will probably not only impact on the direct competition between fossil fuels, but what is also relevant for all energy usage levels, on electricity generation and the heating market right through to mobility. It is no wonder that the auto industry is now trying out all the options and is also increasingly making use of them, ranging from compressed natural gas (CNG) and liquefied natural gas (LNG) right through to gas-to-liquids (GTL) technologies.

Wide international variation in natural gas prices due to gas glut 10

Euro cents per kWh



Sources: Commodity Research Bureau, National Balancing Point, Bank of Japan, DB Research

Maturity of gas market still lags behind that of the coal market

It is ultimately prices and the respective markets that will be important for the competition between gas and coal. They have differing levels of maturity:

— The coal market is already highly mature, with a global market that has been functioning for years. Supply and demand determine prices, which in turn bring volumes into equilibrium via the time component. Ultimately it is the state and the performance of the global economy that determine the respective volume and price adjustments.

— By contrast, a fully functioning global market for natural gas has failed to develop up until now. One main reason for this is that transportation facilities used to be limited and/or very expensive. In the startup phase it

[6] See for example Auer, Josef and Thu-Lan Nguyen (2010). Gas glut reaches Europe. Deutsche Bank Research. EU Monitor 75. Frankfurt am Main.

therefore certainly made economic sense to finance the costly pipeline investments via long-term take-or-pay contracts.[7] The contracts reduced the sales risk for investors and in turn guaranteed customers their gas supplies with predictable price risks. This is an important reason why even today regional markets with differing price mechanisms and natural gas prices are the most common.

Thanks to the new gas production technologies, the rising global volumes of shale gas and modern, flexible transportation facilities the gas market has been maturing gradually for several years. Admittedly the global gas market is currently still divided into at least two strands with regard to pricing mechanisms:

— North America, the UK and Australia have open gas markets. So natural gas is a commodity that is traded on exchanges, just like many other raw materials. Pricing occurs in North America at Henry Hub and in the UK at the virtual National Balancing Point (NBP). In the US, gas-to-gas competition began with the liberalisation of pipeline access in the 1970s, while in the UK it was not until deregulation occurred in 1986 that more competition was made possible.

— The gas price link with the oil price, by contrast, can still be found across vast areas of continental Europe and in Asia. In Europe the primary linkage is to the price of Brent crude in Rotterdam. In Japan, by contrast, the norm is for the gas price to be linked to the Japanese oil quotation JCC.

— There is no single pattern in South America. Both price mechanisms can be found there; on the one hand hub-linked gas prices (NBP), and on the other also oil-linked gas prices (Brent).

The question is what the future holds. There are indeed still considerable variations in global natural gas prices, which means that distinctions can be drawn between different price zones. In the US natural gas costs are the lowest because of the gas glut there. In 2012 the US gas price temporarily fell to a 10-year low. Although gas is more expensive in the UK than in North America, it is still very cheap compared with continental Europe where it is still linked with the oil price in some places. The highest prices are achieved in Asia; the gas price there is sometimes many times higher than in the US. Recently, the abrupt turnaround in energy policy in Japan following Fukushima resulted in particularly high prices. However, there is a lot to suggest that also the regional markets typical of the natural gas sector with hitherto largely unconnected price zones will in future gradually converge.

US the biggest beneficiary of the gas glut, …

The gas glut started in the US. And that is where its impact is being felt most clearly. Many small, local US companies have developed and tested the technology. One of the first energy companies to correctly gauge the onset of a totally new era was ExxonMobil. The then biggest private oil company seized the opportunity and via vigorous takeover activity also became a leading gas producer.

In the US natural gas now costs just one-quarter to one-third of the price of oil. Thanks to the new and inexpensive gas supplies the one-time threat of dependency on imported oil has lost a considerable amount of its political relevance – and this quite regardless of the large amounts of unconventional oil that can still be tapped in North America in future. President Obama's vision that the US could be largely independent of imported energy in a decade is therefore

US industry is not at risk from “Dutch disease” despite the shale gas boom – in fact it is benefiting from it 11

Given the boom in unconventional natural gas the US is by no means at risk of contracting so-called Dutch disease. This is the name given to the phenomenon in which the discovery of raw material deposits (in the case of the Netherlands it was natural gas in the 1960s) can also harm a small country, because appreciation of the local currency reduces the international competitiveness of the other export sectors and at worst can cause them to collapse. In the end this means that what is actually a welcome boom in a small country can have seriously negative repercussions.

The complete opposite is the case for the US industrial sector which is actually flourishing for several reasons: firstly the gas glut is squeezing energy prices in the US, which in turn provides the domestic industry with a comparative advantage in international competition. Secondly, US industrial output is less susceptible to exchange rate movements than that of small countries with a high export share. One reason is the imported feedstocks and intermediates that are made cheaper by a stronger US dollar. This in turn has a positive impact on US industrial productivity and competitiveness. Thirdly, the typically negative macroeconomic effects that small countries experience due to a commodities boom will probably not materialise in the US because, on the one hand, the US's very geographical and economic size makes it a special case, that is a relatively “closed economy”. And on the other, there is the fact that industry now only generates a comparatively small share of US GDP. It is therefore unlikely that the US will contract Dutch disease given the boom in unconventional energy sources.

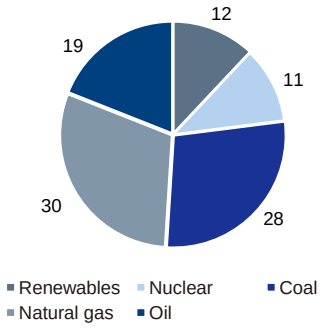
For details see also Hooper, Peter et al. (2013). US Shale Shock and Dutch Disease, Deutsche Bank Markets Research, Global Economics Perspectives, 11. April 2013.

[7] The seller receives a payment guarantee as the buyer pledges to pay for a fixed volume of gas regardless of whether he actually takes delivery of this volume.

certainly not unrealistic. Shale gas, which currently contributes one-third to the US gas supply, could already account for 50% in 2035.

US power generation covers 80% of domestic energy requirements 12

Share of US energy output, %, 2011



Source: US Energy Information Administration

Cheap gas prices allow the US to also charge low electricity prices, not only for households but also for industrial clients. While power generation in the US was based primarily on coal as recently as 2008, natural gas has grown to become the most important source of electricity in recent times. Market observers believe that thanks to the cheap gas prices and thus also electricity prices the stage is set for a re-industrialisation of the US. The hoped-for resurgence of the US petrochemicals sector would provide a range of business sectors with the important advantage of being able to source their essential raw materials from more secure domestic producers at attractive prices. The range of beneficiaries would stretch from the agricultural sector (e.g. inexpensive fertilisers) and the construction industry, chemicals and steel right through to the auto industry and household items. On balance additional annual growth in US GDP of 0.5 pp would appear to be possible. In accordance with the logic of economic inter-dependencies the consequence would be an at least small jobs miracle.

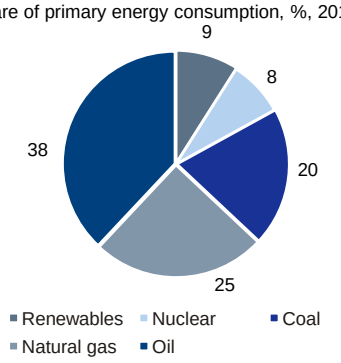
… but higher gas prices abroad make the case for US gas exports

The other side of low US natural gas prices is, though, that the high production, infrastructure and thus investment costs associated with unconventional natural gas are less economical than during the period preceding the gas glut. In addition, much higher gas prices can be charged in Europe and Asia. The gas glut has therefore resulted in the US, which – partly for energy supply security reasons – once built very expensive infrastructure for LNG imports from overseas, now investing in transportation in the other direction. Construction of the first LNG export terminal will be completed in the Gulf of Mexico by 2015 at a cost of USD 10 bn.

Consumers in Europe and Asia would welcome US gas

Oil, gas and coal dominate primary energy consumption in the US 13

Share of primary energy consumption, %, 2011



Source: US Energy Information Administration

For Europe and Asia liquefied natural gas from North America would represent a major alternative to imports from traditional suppliers such as Russia, Norway, Qatar (with increasing frequency of late) and in future also many other countries in Africa. In continental Europe the markets for natural gas are already in upheaval. Long-term contracts, for example with Russia, which also used to appear to be particularly interesting commercially, are now regarded as being far less appealing. The very inexpensively priced open supply of gas has in the meantime had an effect that appeared to be utopian just a few years ago. Following protracted negotiations – some of which lasted several years – even Russia has recently shown that it is prepared to make concessions on the conditions of its long-term contracts (with E.ON and RWE, for example). Currently the particularly important gas suppliers for continental Europe from Norway and Russia are now accepting spot price components in their gas contracts. Norway is already much further ahead in the open gas market.

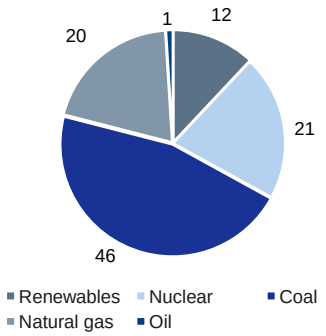
More competition in the European gas market, ...

The venerable European gas segment is in a state of upheaval. Old structures are becoming less restrictive and are increasingly breaking up. A gradual trans-formation into more open competitive markets with a fundamental readjustment of market participants is taking place. Asia, by comparison, still lags some way behind. One reason for this is that Asia's gas infrastructure is still under-developed, since in populous countries for example long distances and thus higher costs hold back expansion.

The new global power plant order

Coal, nuclear and gas dominate power generation in the US 14

Share of US power generated, %, 2011



Source: US Energy Information Administration

A clear illustration that the longstanding gas suppliers with hitherto hefty market clout are also embracing the fundamental shift in the sector is the gradual construction by Russia's biggest gas supplier, Gazprom, of its own large trading and marketing department in London, which already commenced operations years ago, but has generated more momentum of late. In future Russia would thus like to be a major player in the open gas market as well. This strategic reorientation should not be underestimated. After all, the open market provides the opportunity to manage supply volumes in such a way that is most appropriate for the suppliers. As such, the expanding open gas market in Europe is currently exerting very welcome price pressure that is generating options for all customer groups to make savings.

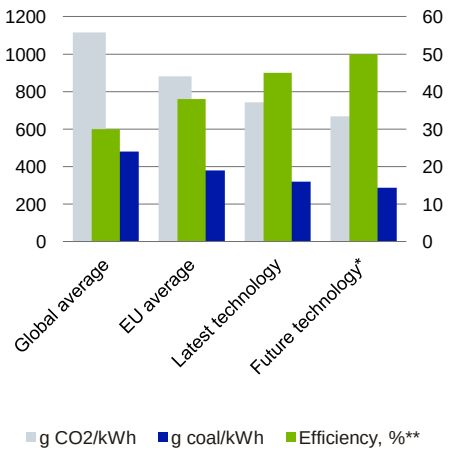
… but open market also brings risks

In the medium and long term, however, it cannot by any means be ruled out that the internationally relevant gas producers will coordinate their supplies more closely and use their supply volumes to influence pricing to their own advantage. The prospects for a “gas OPEC” (even operating at the global level) are undoubtedly less favourable than those for the real OPEC because gas deposit locations are dispersed relatively widely around the world, whereas major conventional oil deposits are more heavily concentrated in particular regions. For those reasons alone, the gradual merging of the hitherto typically regional markets for gas, especially North America with Europe, should not be prematurely declared a “triumph”. After all, it is possible that following a certain learning phase concerning the permanent conflict between market power and economic law there will be another renaissance for long-term contracts; these contracts will, however, probably then be a great deal more flexibly structured than in the preceding half-century.

The conflict between gas and coal is currently characterised by many solutions

Considerable potential for boosting efficiency of coal-fired power plants 15

2010, g (left), % (right)



*700° steam power plant technology
**Average values for hard coal plants

Source: VGB Powertech

Numerous parameters are relevant for power plant investments. Regions with brown coal deposits typically use them to cover the baseload. The most advanced brown coal power stations can achieve an efficiency level of 43%. In locations where there are customers for both electricity and heat, energy producers can use efficient combined heat and power, which enables considerably higher levels of efficiency; all input energies are basically suitable for this. All over the world there is constant competition between hard coal and gas-fired power plants, which can typically also be operated very flexibly. Huge technical advances are being made with both types of plant and they have by no means come to an end.

Modern coal-fired power stations already achieve efficiency levels of around 45%. This makes them far more efficient than the average of all coal-fired power stations worldwide (30%) or even the average of only those plants operating in Europe (38%). Next-generation coal-fired power plants with better steam parameters and materials, so-called 700°C plants (steam power plants), will probably be the first to achieve efficiency levels of 50% and more. And if innovative eco-friendly coal-fired power stations with carbon capture and storage (CCS) technology can be successfully developed at a reasonable cost, then the outlook for coal would be even better. As things stand at the moment, “clean” CCS technology is capable of delivering a 90% reduction in CO_2 emissions per kWh generated compared with the current global average (1,116 g CO_2/kWh).[8]

[8] RWE (2011). Facts & Figures. VGB Powertech (2010/2011). Electricity Generation. Page 18.

Advanced gas-and-steam power plants represent a major technological leap forward by using natural gas particularly efficiently. If only electricity is generated, efficiency of up to 58% is feasible. With downstream combined heat and power these gas-and-steam plants can even achieve efficiency levels of up to 80%.[9] One welcome additional benefit is that the CO_2 emissions are substantially lower than from traditional coal-fired power stations. Depending on the emission price this environmental advantage of electricity from gas can be of great economic relevance for investors. This and the fact that gas-fired power plants can also be operated relatively flexibly – unlike lignite or nuclear plants – make them additionally interesting. Their flexibility means that they are basically well suited for smoothing out fluctuating markets, i.e. where the electricity supply tends to be unstable from time to time due to the expansion of renewable sources of electricity such as windpower or solar power (see also page 12 regarding this topic).

The gas vs. coal contest will be decided on a regional basis

For the time being there will be no "global champion"

Over the medium term there will be no clear "global champion" in the race between natural gas and coal. There are several reasons for this. Firstly, in the coming years the prices charged for gas will still differ from one continent to another – despite the gradual convergence of regional markets. The level of the gas price is, however, an important determinant in the contest with competing energies. Secondly, the relevant factors for power plant investors are not only the current environmental standards but also the expectations for the coming decades. The uncertainties regarding how the climate debate will develop as well as – linked to this – the level of future emissions prices provide a great deal of scope for a variety of assessments and decisions. Even in the case of emissions and/or environmental prices that are higher than at present this will not by any means always automatically benefit gas-fired power stations. There are certainly investors and population groups who argue for example that gas-fired power plants "still" emit half the amount of CO_2 of traditional coal-fired power stations. This means that leaving aside economic considerations there are other factors to be weighed up especially to the extent that they also have a regulatory influence on market events via policymaking. Thirdly, many more parameters need to be taken into account: for example, the financing environment or the respective regulatory framework, which in turn reflects the degree of liberalisation and ultimately determines the achievable electricity prices.

Different winners depending on the region: The US trend is towards gas, …

Different trends are materialising depending on the region

In the US and the rest of North America the gas glut has probably been the most important energy topic in the past few years. It is no surprise that the very low gas prices of late have prompted investors to prefer gas power plants. As we believe that gas prices in North America will remain squeezed for the foreseeable future, investors there will continue to favour gas-fired power plants in future.

It is not uncommon in this connection for the multifarious international interconnections to receive insufficient recognition or attention. It is frequently overlooked that the gas glut in North America will ultimately lead to an oversupply of coal. If US utilities burn less coal than previously planned, then the mounting oversupply of coal will seek new demand abroad over time. This road also leads to Europe, and partly also to Asia. The additional supply will

[9] RWE (2012). Innovation.

then squeeze coal prices in the new markets and improve – all things being equal – their competitiveness in relation to natural gas for example.

... in Asia the trend is towards coal

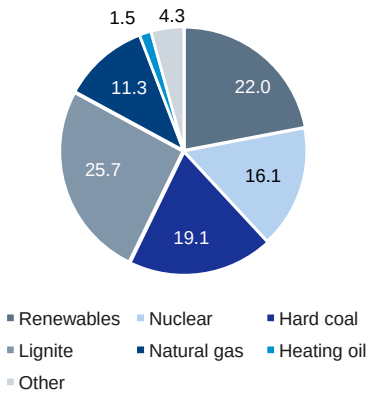
Coal also has a future

In Asia the outlook for natural gas is less rosy. With gas prices remaining relatively high for the foreseeable future this provides more of an argument for coal. On top of this, the expansion of gas there still has to contend with inadequate gas infrastructure, not least the lack of LNG capacity and pipelines. The outlook is brighter however in Japan, which will probably rely primarily on gas and renewables in future. The prospects for gas in China are not to be dismissed either: firstly, China would like to reduce pollution in the coming years. Secondly, the level of gas prices is not the most important determinant of the planned economy. For China as a country that is relatively poorly endowed with energy sources, topics such as the security of supply are certainly at least just as important. Moreover, China is pursuing a quite aggressive global purchasing policy concerning energy deposits. Its increasing gas output in future – in Africa for example – will probably never find its way onto "the world market" but will ultimately land in China. In fact we will probably see all energy sources – that is natural gas and (!) coal – being used even more for generating electricity than up until now. In India the topic of electrification is still regarded as being of very much greater importance than is the case in more advanced emerging markets. The deciding factors remain the traditional investment and fuel costs, leaving aside environmental considerations. The beneficiary of this will be coal, whose price on account of the weakening of the global economy has recently been a great deal lower than before.

The European situation is mixed

22% of German electricity generated from renewables 16

Share of gross power output, %, 2012



Source: AGEB

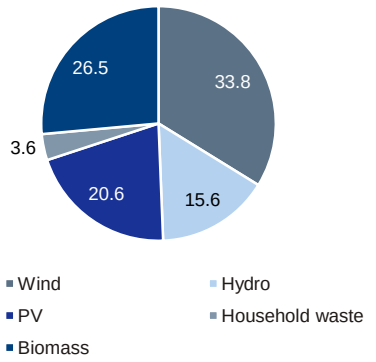
Europe presents a diversely sparkling picture. In 2011 Europe consumed 3% more coal than in 2010. The main drivers were of course the lower coal prices. One reason is the tide of cheap coal from the US (see above). This could increase further over the medium term as currently coal export capacities are being expanded in order to supply overseas markets. On top of this there are coal supplies from Australia and South Africa priced at multi-year lows. The positive impact of low prices on the competitiveness of coal will secondly be bolstered by the also very low prices in European emissions trading; their low level further reduces the appeal of gas-fired power plants. A third factor is that several European countries have access to cheap coal deposits; Poland and Ukraine continue to produce hard coal and use it to generate electricity. By contrast, Germany is increasingly giving up the mining of hard coal, but it still has ample deposits of brown coal that it uses to generate very competitive baseload. On the other hand in Europe there are the countries that have their own large gas deposits or – also independently of this – low gas prices. In Norway, above all, the prospects for gas-fired power plants appear very favourable at first glance. However, nearly all electricity demand is met in Norway using hydropower. And gas has no chance against hydropower. In the UK the open market has led to low gas prices and stabilised the prospects of gas compared with coal. The same also applies to other European countries with an existing (or planned) LNG link.

Germany the exception: Gloomy outlook for natural gas & hard coal

On balance, as far as investors are concerned Germany is a very big exceptional case – similar to Norway, but very different nevertheless. In the end the energy policy turnaround with the decision to exit nuclear power generation

Wind dominates renewable energy output in DE 17

Share of renewable power generation, %, 2012



Source: BDEW

and heavily expand renewable sources of energy will have a considerable impact on the power generation mix. In 2012 renewables already contributed 22% towards electricity production. In 2020 the figure should already have risen to 35% and in 2050 then be 80%. The preferential feeding into the grid of "green electricity" stipulated in the Renewable Energy Sources Act (EEG) leads to gas and hard coal power plants generating electricity for ever shorter periods. This reduces their profitability. Ultimately the consequence is that investments in gas and hard coal power plants are of little interest – at least as long as the political framework remains unchanged. Coal-fired power plant projects have been political hot potatoes in Germany for years already. Investing in gas-fired power plants is less attractive due to the EEG.

In the last few months major German utilities have threatened to shut down existing gas-fired power stations as they are jeopardising their profitability targets. Since this would increase the challenges arising from the nuclear power exit a rekindling of the debate is likely at this time. The realisation is dawning that the construction and expansion of electricity storage facilities and/or the faith in future import options may not suffice on its own. Europe's biggest industrial nation still requires a continuous and uninterrupted supply of electricity at a reasonable cost. Ultimately the energy turnaround requires an electricity supply system in which the fluctuating wind power and solar energy inputs are evened out using flexible back-up capacity. Systemically relevant gas and coal power plants need additional incentives in the "new power environment".

4. Summary

The traditional, global power plant landscape is in a state of flux for a myriad of reasons. There is no doubt that in the days following Fukushima it was premature to predict a rapid end to the peaceful use of nuclear energy. Over the next 20 years the newly erupted gas vs. coal contest in the electricity market will not produce a lone "global winner". Whereas in the US gas continues to assert its dominance, in Asia coal remains the no. 1 source of fuel. The power generation landscape is becoming more colourful: while Germany is banking on renewables, France is sticking with nuclear power generation and other nations retain their preference for coal. The continuing increase in the thirst for electricity over the next 20 years provides sufficient scope for the coexistence of the most diverse power generation alternatives. Unconventional energies, such as shale gas, and green energies thus represent a challenge to the existing global power plant order. They will certainly not bring about any revolutionary change to this order for the foreseeable future, though. The energy landscape would have to undergo even more far-reaching developments for such change to materialise.

Josef Auer (+49 69 910-31878, josef.auer@db.com)

Printed by: HST Offsetdruck Schadt & Tetzlaff GbR, Dieburg

Print: ISSN 1612-314X / Internet/E-mail: ISSN 1612-3158