ENERGYWATCHGROUP

The EU's dependency on Russia for natural gas can only be reversed with a rapid expansion of renewable energy sources.

Due to insufficient resources, a natural gas diversification strategy with other source countries is doomed to fail.

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Both at EU level and in Germany, there are calls for independence from Russian energy deliveries, and justifiably so. This really is an urgent need, as otherwise the EU, including Germany as the largest buyer of natural gas from Russia, will become ever more politically dependent on Russia.

The recent inability of the Ukraine and the EU to take action demonstrates the problems energy dependencies can cause. In spite of many warnings of ever increasing dependency on Russian energy deliveries through the years, all Ukrainian governments in the past decades have continued to increase the country's reliance, with some even lining their own pockets as they did so.

With its skilful manipulation of price increases, price reductions and gas disconnections, Gazprom, as an extension of the Kremlin, hit all the right notes to apply political pressure on entire nations as gas customers.

Russia will not automatically remain a reliable energy supplier for Europe, and certainly not forever.

The entire EU has already reached this level of dependency on Russia. The depth of dependency on Russia for energy is evident in the many warnings by the German private sector not to impose stricter economic sanctions on Russia. Even after annexing Crimea, and in light of the danger of further annexations of parts of Eastern Ukraine, the fear of Russian countermeasures affecting energy deliveries is so great that none of the EU's economic sanctions have seriously affected Russia. In fact, today, all other major political principles and values are already being sacrificed to the need to procure raw materials.

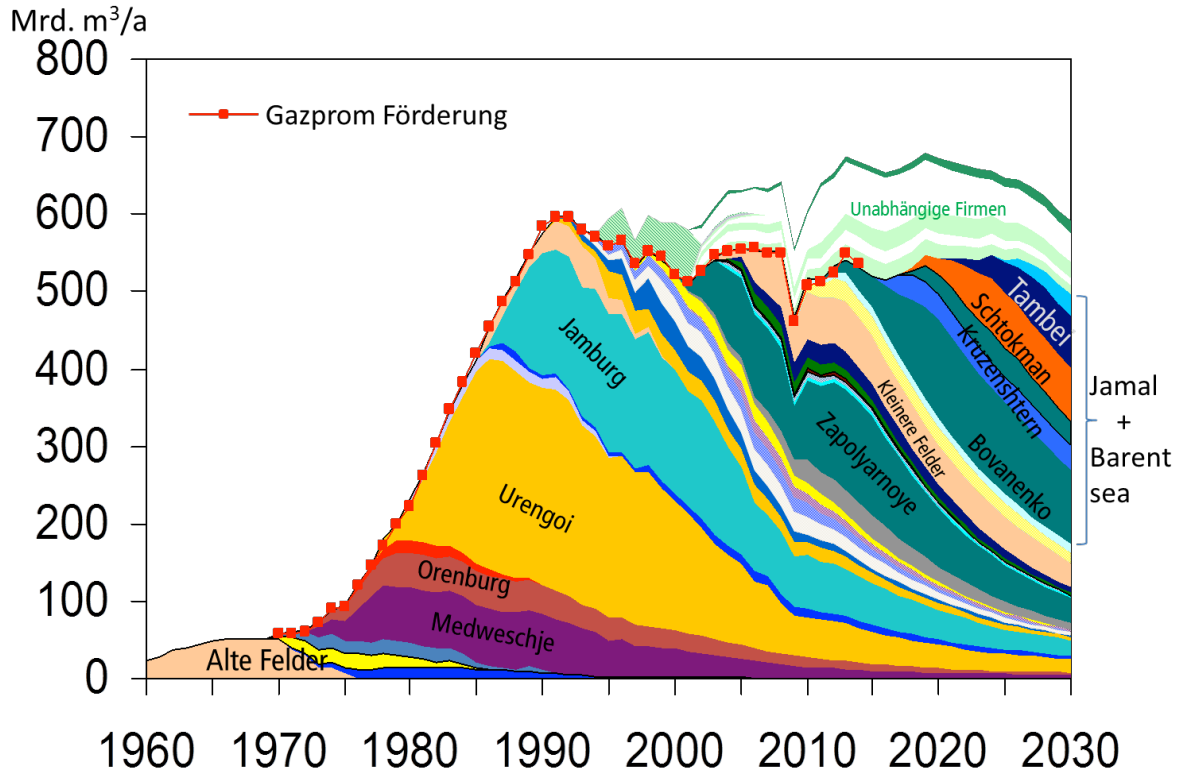
Many are very sure that Russia will not abuse the energy dependence in future and will remain a reliable energy provider, as was the case even during the Cold War. However, that will not necessarily be the case, and there are many indications that the future will be different.

However, Russia will not be able to fulfil the customers' energy demands in the decades to come. Russia has reached peak production, both in oil and natural gas, and therefore cannot deliver additional total oil and gas quantities to new and old customers in the years to come.

Instead, it is to be expected that in the years to come, Russian oil and natural gas production will decline, with major and significant declines to begin in the next decade.

We will illustrate this based on natural gas:

The two largest gas fields, Yamburg and Urengoi, which still delivered roughly 60 percent of the Russian gas production, or approx. 330 bn m³ annually, at the start of the last decade, have long since started to decline in production, and now only deliver slightly over 100 bn m³ with significant drops in productivity. This decrease was compensated by developing many new fields, which all provide a far lower gas volume, and some of which are already declining. In the years to come, Russia will find it very difficult to compensate declining production of existing gas fields by developing new gas fields. It is more likely that Russia will be unsuccessful in its attempts. One indicator of this is that the development of the former great hope for future gas production in Russia, the Shtokman gas fields in the Barents Sea, once announced to a great media response and initiated in cooperation with Norway, has now been postponed indefinitely due to the high investments and major technical difficulties.



Datenquellen: Gazprom 2008, 2013; J. Stern The Future of Russian Gas and Gazprom 2005; BP 2012
Campbell, Perrodon, Laherrere: The world's gas Potential 1995; LBST Feb 2009

Russia will not be able to expand its gas production in the years to come. In order to ensure its ability to meet existing delivery obligations, it concluded a gas purchase contract with Turkmenistan as early as 2007. In 2012, Russia imported roughly 30 bn m³, 12 bn m³ of which came from Kazakhstan and 10 bn m³ from Turkmenistan. However, at the same time, Russia, Turkmenistan and Kazakhstan are expanding new large-scale gas production delivery structures to the Far East. In 2012, Turkmenistan supplied Japan in particular, but also China and Korea, with a total of 15 bn m³ of liquid natural gas. Turkmenistan has already delivered 20 bn m³ to China by pipeline. In the past year, a framework agreement was concluded with China for the delivery of 38 bn m³/a from 2018 on, with an expansion of up to 60 bn m³.

The new delivery routes and volumes are significant compared with the deliveries to the EU. For example, Russia has already concluded gas contracts with China equivalent to roughly 50% of the annual deliveries to Europe. Russia will not be able to fulfil this with new gas quantities on top of its current production. Gazprom will attempt to play the most solvent customers against one another to earn the highest prices, using the gas price strategies exhibited in the Ukraine. Those who are unwilling to play along will no longer receive deliveries, or will receive reduced deliveries. And it is a well-known fact that the Chinese are solvent energy customers.

In summary, we must re-evaluate whether Russia will remain a reliable energy provider in future. Russia is diversifying its new sales markets significantly, and is struggling with declines in its own gas production. Long-term reliable gas deliveries do not appear feasible. At the very least, import prices can be expected to increase due to the rising transport costs and new customers.

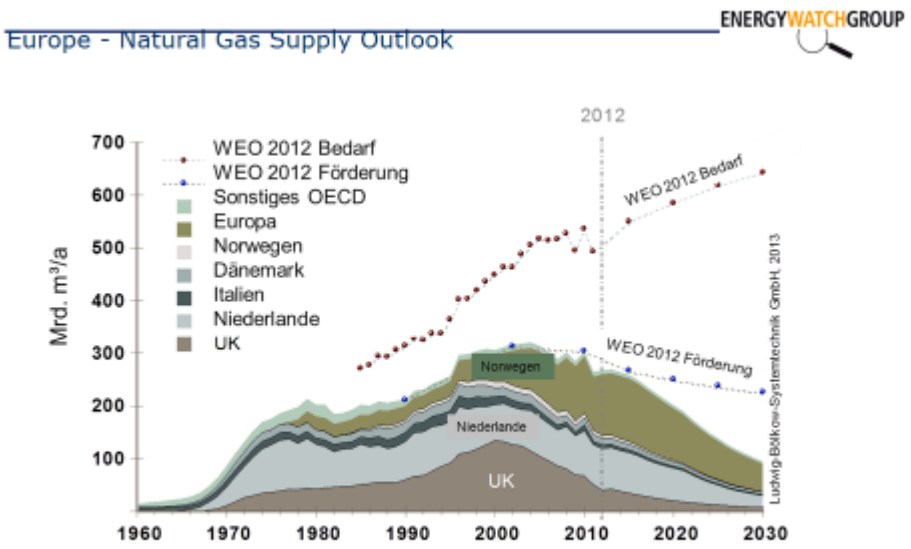
There are also similar analyses for future oil deliveries to Europe which will not be described in detail here.

What options remain to increase the gas procurement sources within Europe?

In 2012, the EU consumed roughly 450 bn m³ of natural gas. Many believe that the energy transition requires new large-scale natural gas power plants. While there are enough other natural gas-free alternatives to implement the energy transition, political initiatives, such as capacity markets, are focusing on the construction of new gas-fired power plants. In addition to this, there are also political efforts to advance natural gas as a fuel. We must consider that to completely replace crude oil for road traffic in the EU with natural gas would roughly double the European gas demand. This estimate should illustrate how unrealistic the proposals for more natural gas in transportation actually are. Industrial natural gas demand is also increasing constantly, without looking for alternatives to natural gas.

The International Energy Agency (IEA) estimates the EU's annual natural gas demand in 2030 at roughly 540 bn m³, an increase of roughly 20% over the current demand.

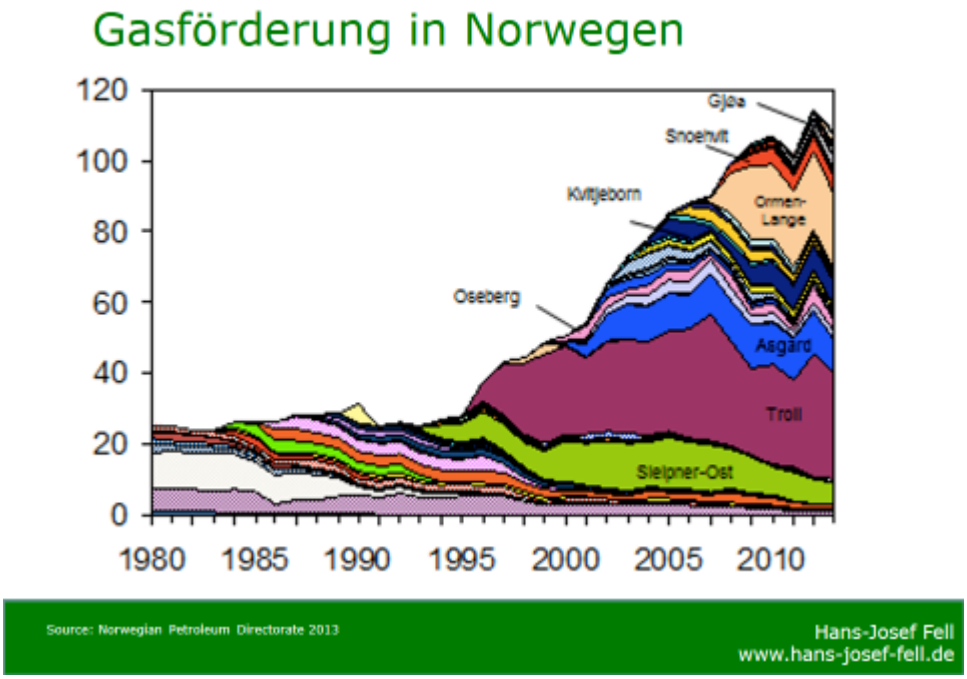
Development of European gas production



There have been repeated proposals to replace the Russian natural gas deliveries to Europe by increasing deliveries from other European countries, in particular Norway.

Anyone who examines the development of European gas production precisely will quickly see that this is impossible. With the exception of Norway, gas production in all European countries is in decline, drastically in some cases. For example, while Great Britain built new gas export pipelines just a decade ago, the pipelines must now be used for import, as the British gas production did not develop as predicted by analysts. German gas production has also been decreasing steadily for years. While a few years ago, domestic gas production was roughly 20% of demand, it is now less than 10 percent, with a significant downward trend. And that is despite the fact that the gas consumption in Germany decreased from 87 bn m³ in 2006 to 75 bn m³ in 2012 (BP statistics).

In recent years, Norway has succeeded in increasing its gas production significantly to a level of 110 bn m³/a of natural gas. However, our analyses indicate that Norwegian gas production is reaching its peak, and cannot be increased significantly in the years to come.



In order to replace the Russian gas deliveries not only must the imports totalling approx. 130 bn m³ be compensated. It must also be accounted for the decline in gas production in the EU, estimated at approx. 100-150 bn m³ by 2030, and additional natural gas quantities must also be procured to cope with the increasing gas consumption in the EU by 2030, which IEA estimates at roughly 50-100 bn m³ per annum.

Thus, if the current energy policy of slowing down the development of renewable energy sources and disregard of potential energy savings persists, the EU would have to replace annual natural gas quantities of 280-380 m³ if Russian deliveries are stopped.

Fracking gas in the EU

Much could be written about the causes, success and problems of the fracking boom in the USA. However, the fact is that fracking activities there are now starting to abate. In the past five years, the major increases in expenditure by oil and gas companies for exploration and production contrasted with falling natural gas and stagnating or slightly reduced oil prices. The lack of success in the oil drilling sector made this situation more difficult. Shareholders – in particular pension funds – which require appropriate yields, have forced a drastic reduction in expenditure on unprofitable shale gas (and light tight oil [LTO]) deposits in 2014. That will lead to a decrease in production, which will also affect shale gas and LTO quantities in the USA.

Against this background, it must be noted that the geological, geographic, economic, financial, technical and infrastructural circumstances in Europe are far less favourable than in the USA: The shale gas potential – that is, the potential of a generous upper limit for conceivable production quantities – is far lower than in the USA (in Poland alone it has already been reduced by a factor of 10 on several occasions), the population density in Europe is far higher than in the US regions where intensive fracking is performed, many of which have less than 2-3 inhabitants per km². Land use

competition in Europe is also far higher, while environmental standards play a more important role, delaying production planning and increasing costs. The connections to the banking sector, which are driving forces in the USA, are less significant in Europe, and the gas infrastructure in Europe is far less comprehensive than in the USA, leading to far higher infrastructure costs and major restrictions in potentially profitable regions. Finally, the number of active drilling systems is already at full capacity now. Any attempt to increase related activities will raise drilling costs further.

In spite of this, rather optimistic assumptions by the International Energy Agency in the World Energy Outlook 2012 assume that the quantity produced in Europe in 2035 will be approx. 20 bn m³/a. **Even if demand for natural gas in the EU remains constant until 2035, that is less than 5% of the natural gas required.** The gas industry itself has also announced a slight increase in the quantity of unconventional gas production by 2035 based on industry forecasts by Schlumberger et al. However even there, it is considered far too low to stabilise the decrease in production or even to increase it again. That those who stand to profit from this sector tell the public another, more optimistic story should not be a surprise. This is more likely due to the companies' desperate situation and desire to keep up their old business as long as possible in spite of growing problems (increasing prices, exhaustion of resources).

One example of the problem with fracking is that in the German state of North Rhine-Westphalia alone, roughly 17,000 km² have been assigned to companies for prospecting licenses. That is half of the territory of North Rhine-Westphalia. However, it is also roughly the same size as Barnet Shales in Texas, where over 17,000 wells have been drilled in the last 10 years. If fracking was to be implemented here even half as intensively, it would cause proportional problems (water, chemicals, sand, wastewater disposal, steel use, piping infrastructure and treatment systems, extreme increases of heavy vehicle traffic in rural areas, use competition etc.). And at this scale, the level of activities would have to be very high to produce a contribution significant to the energy sector. The lack of drilling systems alone prevents an equivalent volume. The number of drilling rigs in all of Europe is over one order of magnitude lower than in the USA. Germany has no more than one to two dozen systems. This cannot be changed in the short-term, particularly given the current prices, and without a long-term perspective.

Additional LNG terminals in Europe to import more natural gas?

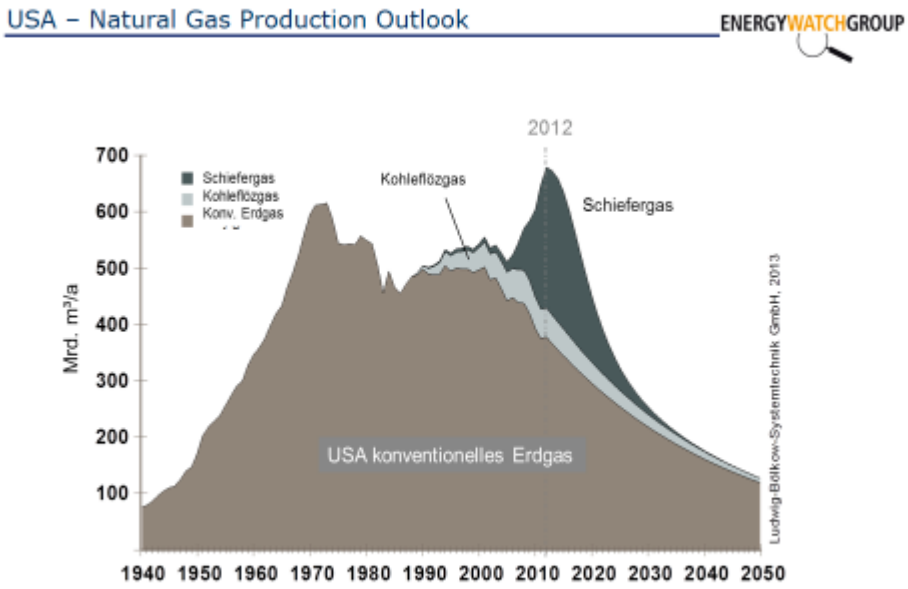
Many argue that the EU should add more regasification capacity to permit higher LNG imports. First, we must note that the EU's import capacity for LNG has risen rapidly in recent years. It is currently almost 200 bn m³/a, whereby the actual LNG imports have dropped from 90 bn m³ (2011) to 45 bn m³ (2013). That means that 150 bn m³/a of LNG import capacity is currently unused. Therefore, building new LNG import capacities will not make a significant contribution to replacing Russian natural gas deliveries, unless the LNG export capacities from natural gas producing countries are increased. However, that seems unlikely, as the following overview of the development of natural gas production in other global regions would indicate.

What other delivery options are available to the EU from outside the EU?

USA; Canada

The goal of independence from Russian energy resources cannot be achieved via deliveries of natural gas from the USA. Many analyses – not only those by the Energy Watch Group (EWG) – indicate that American natural gas production cannot be maintained in the next 20 years. On the

contrary, in spite of the increase in unconventional gas production (shale gas), American natural gas production will decline overall, in particular due to the decreases of conventional gas production which have persisted for years. As gas demand in the USA is higher than domestic production, the USA remains a net gas importer. In the years to come, the USA's import ratio will increase further, as conventional gas production in the USA decreases further and there are many indicators that the expansion of unconventional gas production has passed its peak.



Accordingly, the USA will not be in a position to deliver significant quantities of natural gas to the EU, much less compensate the overall European natural gas sourcing from Russia.

The following figures illustrate this: Europe currently sources roughly 130 bn m^3 from Russia. If we add the Ukraine to this, the total annual natural gas imports from Russia are 160 billion m^3. This quantity of natural gas would have to be largely replaced if the goal of independence from natural gas deliveries from Russia in Europe and the Ukraine is actually to be reached.

Let us assume the US gas production from 2012, a total gas production of 681 billion m^3. However, consumption in the USA is 722 bn m^3, making the USA a net gas importer, in particular from Canada. In addition to this, the EWG expects gas production in the USA to decrease significantly to just 400 to 500 billion m^3 by 2020.

As most of the gas produced in Canada is exported to the USA, and the USA is facing decreasing gas production, no significant natural gas deliveries can be expected from North America in the years to come.

South and Central America are not suitable as natural gas suppliers, as South America is currently struggling to compensate for the declining gas production from Argentina. The calls for a new natural gas pipeline from Venezuela to Argentina prove this. Not least the nationalisation of YPF due to the accusations against the former owner, Repsol, of not having invested enough in new production sites, and the current efforts to develop shale gas in the "Vaca muerta" basin – an area

with a serious lack of water – shows the desperate struggle against the decrease in production. In summary, South and Central America will not export significant quantities of natural gas to Europe, if we ignore the existing minor export capacities in Trinidad and Tobago.

North Africa

Total natural gas production in North Africa is currently roughly 150 bn m^3. The sales markets have not changed in years. Most of them are in Europe, which means that no sales can be shifted to supply more to Europe. Comparing this with the additional natural gas quantities of several hundred bn m^3 annually, which Europe require in total if the Russian gas deliveries stop reveals that not much new natural gas can be sourced from North Africa. While the regions south of the Sahara, in particular Nigeria, have a certain, but very restricted volume potential, at several bn m^3/a, North America in particular will also need this gas in a few years.

Middle East

The only region which could be able to increase its natural gas production significantly in the years to come is the Middle East. Currently, natural gas cannot be transported from there to Europe via pipelines. Any transport will be implemented via liquefaction (LNG) and ocean shipping. In recent years, the liquefaction capacities in the country of generation and regasification capacities in potential target markets have been expanded considerably. At the end of 2013, the liquefaction capacity in the Middle East was 100 million tonnes per annum, or 35% of the global capacity of 290 million tonnes per annum, equivalent to slightly less than 400 bn Nm^3/a of natural gas. By contrast, the global regasification capacity for receiving LNG and feeding it into the regional natural gas network is almost twice as great, at almost 1 bn Nm^3/a.

The situation in Europe is similar. Even though the regasification capacities in Europe have been expanded, reaching almost 200 bn m^3/a by the end of 2013 – almost double the figure in 2005 – and only one quarter of this capacity was utilised, the increasing competition for this gas remains. In recent years, the regasification capacity worldwide has been developed far faster than the liquefaction capacity. This also gives an idea of the increasing competition among consumers for this gas, or conversely, the decreasing willingness of the producing countries to invest in new liquefaction capacities. In 2013, Chinese LNG imports were already half the quantity of the LNG imports to Europe.

It is remarkable that the USA, with the exception of a small, old terminal in Alaska, currently has no LNG export capacity, but has almost the same import capacity as Europe, at 186 bn m^3/a.

In short, natural gas consumer countries worldwide already have significant LNG demand, which is not fulfilled by the natural gas producing countries. For the EU, this means that construction of new LNG terminals probably will not lead to significant new additional LNG imports.

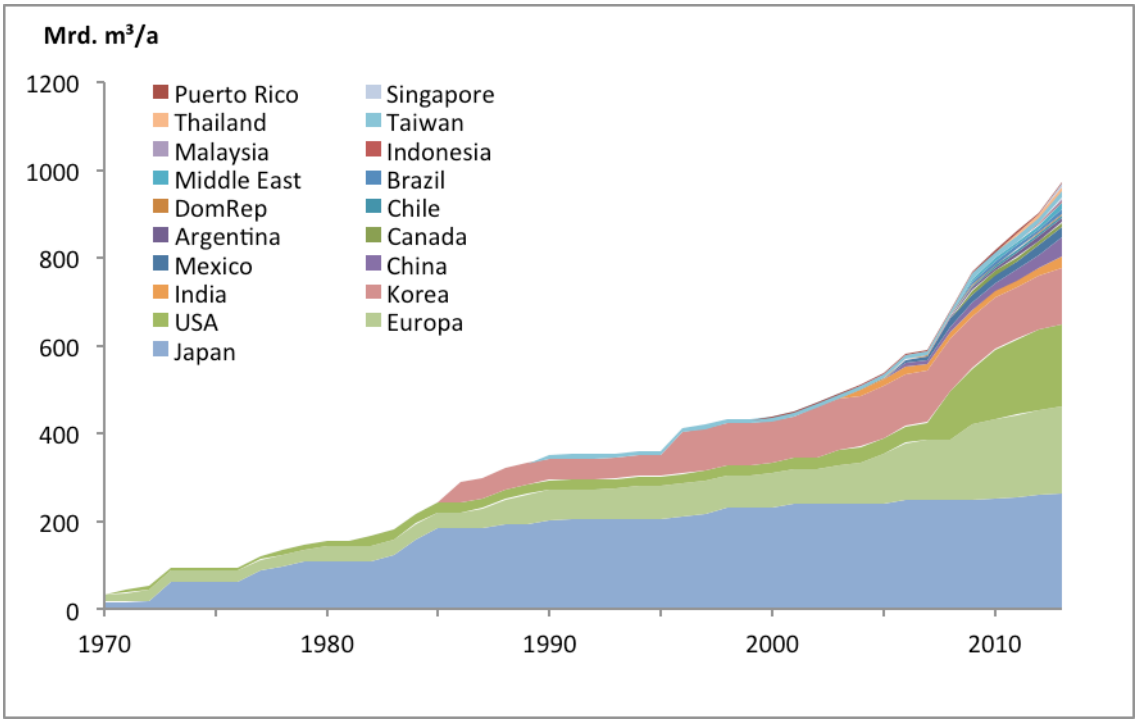


Figure: Global regasification capacity

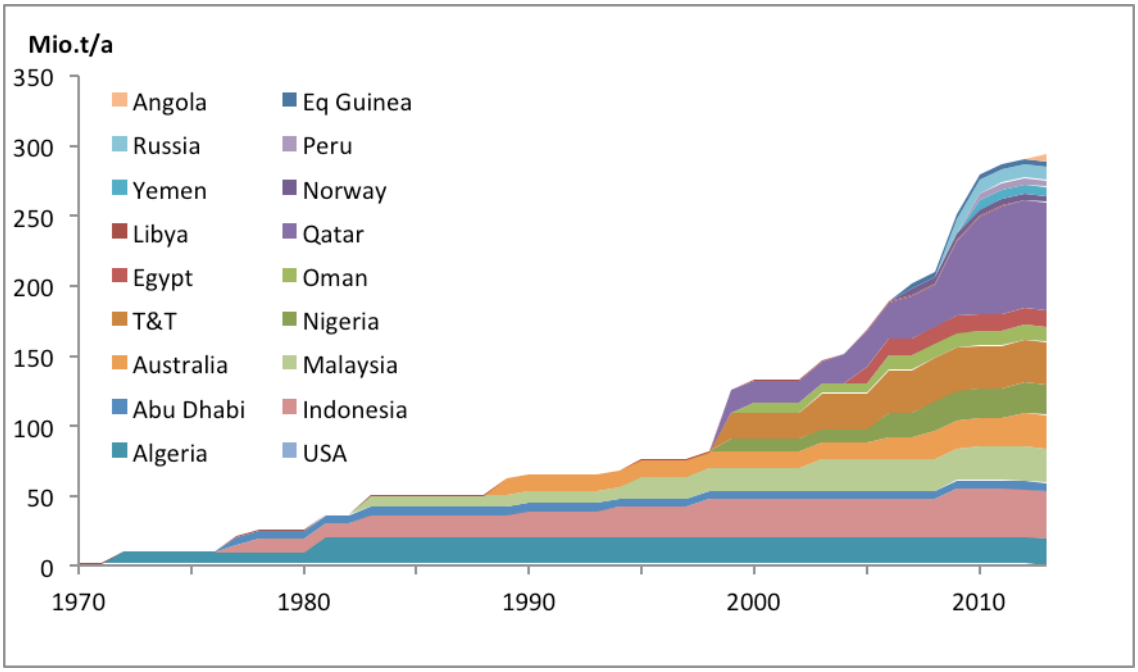


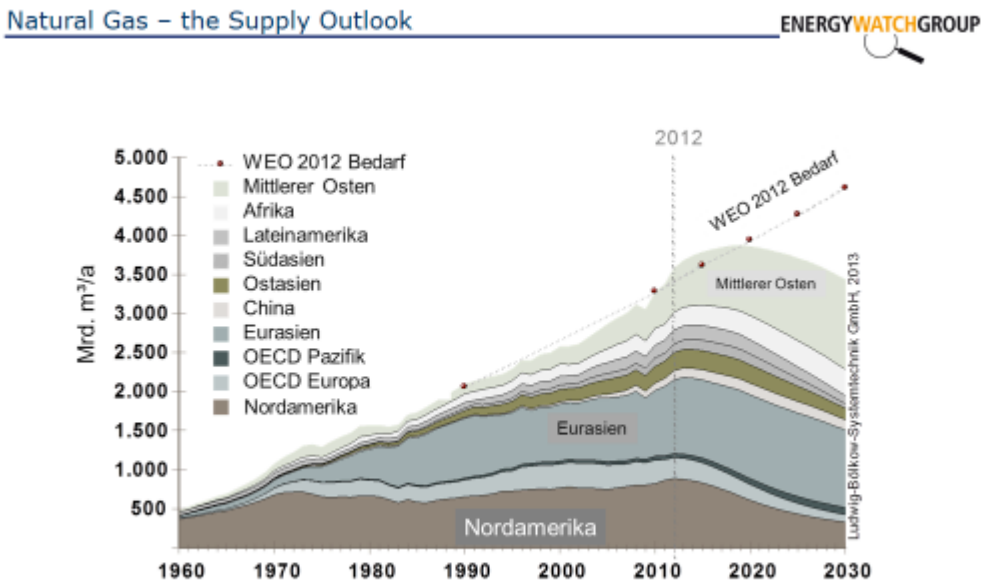
Figure: Global LNG liquefaction capacity; 300 mill. tonnes of LNG is roughly equal to 370 bn standard cubic metres of natural gas

In order to secure natural gas deliveries in a long term the political stability of import countries plays a significant role. The political dependence is precisely what triggered the renewed discussion on the replacement of Russian gas deliveries. The natural gas production sites with growth potential are primarily in Iran, Qatar and Iraq. However, this region is known as a political powder keg. Replacing unpredictable natural gas deliveries from Russia with far more unreliable deliveries from Iran or Iraq would be paradox. This revenue would bolster Iran, rendering it capable of implementing its nuclear programme. The transport routes for LNG tankers are highly unsafe: the Strait of Hormuz, which is controlled by Iran, and the Suez Canal in Egypt, another political powder keg. It would be absurd to believe that replacing Russian gas deliveries with LNG from Iran or Iraq would make the European gas supply more reliable.

Kazakh region

This only leaves the Kazakh region, i.e. from Azerbaijan and Uzbekistan to Kazakhstan. The autocratic regimes in this region are not good indicators of a politically stable situation, which could supply natural gas reliably to the EU for decades. Also, increases of gas production in this region can hardly be expected. It is noteworthy that the Nabucco project failed, as there were not enough delivery countries willing to supply the gas quantities required reliably for decades. And that is in spite of the fact that the Nabucco pipeline was only planned to deliver roughly 12 bn m³/a of gas. That would have been a modest contribution to the challenge of replacing the decline in European gas production, including the Russian deliveries.

An overview of the expected gas production of the individual regions reveals that the only region in the world where gas production could be increased is the politically unstable Middle East. No other region could make a significant contribution to replacing Russian gas deliveries to Europe.



That makes a diversification of natural gas supply countries for the EU a pipe-dream. It is difficult to envision finding a replacement for the Russian gas deliveries in the global natural gas industry without driving the price level upwards significantly. Without going into further detail, the EWG analyses indicate that this will not be possible in the oil sector either.

It is impossible to reach independence from Russian energy deliveries within the fossil energy system. However, a rapid expansion of renewable energy in the EU would be a viable alternative.

The expansion of renewable energy in the EU, in conjunction with energy efficiency, is the only way to reach independence from Russian energy deliveries.

In its impact assessment accompanying the Communication "A policy framework for climate and energy in the period from 2020 up to 2030" from January 2014, the EU Commission describes the context between climate protection and the reduction of the EU's dependence on energy imports. It clearly demonstrates that the EU's energy dependency will be reduced all the more, the stronger the targets of greenhouse gas reduction and the expansion of renewable energy are.

That is not surprising at all. All renewable energies – except bioenergies – do not require fuels, and the bioenergies can also be generated at a high level within the EU. At the same time, all efficiency measures in energy use and energy transport reduce the total energy demand, which can also reduce the energy imports. Accordingly, the switch to an energy supply with 100% renewable energies in conjunction with energy efficiency and energy storage is the key way to end the EU's high dependency on energy imports of currently roughly 60%.

Because, as shown above, the EU cannot free itself from Russian energy deliveries by diversifying to other supply countries, the only remaining option is to switch energy supply to renewable energy. European resources, such as hydroelectricity, marine energy, geothermal energy, solar radiation, wind and biomass are available in surplus in the EU, by contrast to fossil and nuclear fuels, and will be available permanently for millions of years.

A variety of technological, social and political measures are required to implement them. These measures include research and development, as well as education and training, political support and framework legislation for the necessary market introduction and penetration. Compared with the development status of renewable energy a decade ago, the chances of a rapid and cost-effective market penetration are very good today. Unlike the situation ten years ago, today many technologies from the solar, wind, biomass and hydroelectricity sectors are competitive, as are many efficiency technologies, from LED lighting to high-voltage lines. Now, a new wind farm and new solar park in a good location can produce electricity cheaper than a new natural gas, nuclear or coal-fired power station.

A rapid and cost-effective transition to a renewable energy supply is possible. As early as 2009, the Californian universities Stanford and Davis drew up a global plan to switch to a full supply with 100% renewable energy in 20 years. They prove that this is industrially and technologically feasible, and even economically advantageous compared with retaining conventional energy supplies. According to the Stanford/Davis Plan, the global investments would be roughly 100 trillion US dollars, or half of the global fuel costs in 20 years at roughly 200 trillion US dollars, if the transition to renewable energy were not made. This was documented by the Energy Watch Group based on fossil energy prices in 2008.

The variety of measures required can only be presented at a superficial level and specifically for the natural gas sector here. To go into further detail would exceed the remit of this analysis.

In the EU, natural gas is used in the heating sector, in the industry and in the power supply in particular. To a limited extent, it is also used in the transport sector. The most important measure for saving natural gas, is refurbishing buildings to reduce energy consumption. Optimal thermal insulation is just as important as switching the heating systems to renewable energy. Solar hot water and solar air collectors, together with seasonal heat storage facilities, provide solar heating even in winter, especially with the high-efficiency ice storage tanks. First solar power systems combined with geothermal heat pumps and electrochemical storage systems are already in use today. Biomass heating systems supplement renewable heating options.

In housing estates, medium-sized and industrial production companies, local and district heating systems will form the connection to the electricity sector. Renewable energy heating sources feed local and district heating systems. In future, this will be implemented increasingly via heat pumps, which use the excess electricity from wind and solar power, which the electricity system does not require when wind and solar power are abundant. Solar and wind power can also provide the process heat required in the industry in conjunction with combined heat and power (CHP). In times of low solar and wind supply, rapid-start decentralised CHP systems are triggered to provide additional heat and the necessary electricity compensation. Biogas motors, fuel cells as well as plant-based oil motors are ideal for CHP systems. In future, wood and green coal gasification units will also be used.

With a combination of the abovementioned measures, the gas demand in the EU can be reduced rapidly and sustainably. The gas quantities required then can be generated renewably from biogas. Surplus electricity from wind and solar power can be converted to hydrogen via electrolysis which is added to the biogas, and even transformed to methane. These power-to-gas technologies supplement the power-to-heat strategies, and primarily use the existing natural gas infrastructure, which provides a very large storage volume. In particular, this can store surplus solar energy from the summer for the cold winters in northern EU countries. In the southern EU countries, the solar power generated will cover the high summer cooling demand simultaneously, and thus replace a lot of natural gas directly.

For the abovementioned associated strategies, no large new gas power plants are required for electricity supply security, especially because, in addition to bioenergy, hydroelectric power and geothermal heat provide highly flexible additional electricity generation technologies, which help compensate the volatilities of sun and wind.

The potential of biogas is often severely underestimated. As early as eight years ago, the German Parliament discussed a motion by the Green Party for a European biogas strategy. The basis for this motion was a scientific study by the Institute for Energy and the Environment from Leipzig. This study showed that in Europe, particularly in Eastern Europe, enough biogas can be produced to replace the entire European natural gas demand.

As described above, the full current European natural gas demand does not have to be replaced with biogas. All options mentioned above and others, which were not mentioned, will facilitate replacement of the current natural gas demand of the EU with renewable energy. With appropriate political support, this can be implemented in a few years to replace the Russian natural gas deliveries. A look to the Far East provides evidence for the enormous growth potential of renewable energies. China succeeded in increasing its expansion of photovoltaics sevenfold in just one year, from roughly 2 gigawatts of new investments in 2012 to an estimated 14 gigawatts in 2013.

By contrast to a strategy of diversification of natural gas supply countries, a strategy based on rapid expansion of the renewable energy sources certainly could bring about independence from Russian energy deliveries to the EU in a few years.

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The **Energy Watch Group (EWG)** is an international network of scientists and parlamentarians. The EWG project is supported by Ludwig Bölkow foundation and Reiner Lemoine foundation. The Energy Watch Group commissions scientists with studies free from political or economic influence. Topics are: Increasing scarcity of fossil and nuclear energy resources, possibilities for expansion of renewable energy sources and strategies of securing a reliable and affordable energy supply in the long term.
The scientists collect and analyze ecologic and especially economic and technologic data. The results of these studies are to be presented not only to experts but also to the politically interested public.

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