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Shale Gas for a Better Climate?

The US Fracking Revolution Challenges European and International Climate Policy

Susanne Dröge and Kirsten Westphal

Since natural gas surpassed coal in US energy consumption, the country's carbon dioxide (CO_2) emissions have been declining. The United States hopes that this will lead to a long-term improvement of its emissions performance. Yet the shale gas boom has not spread beyond the United States. It is indeed questionable whether shale gas will be able to bring about a turnaround in global emissions as long as the worldwide demand for coal continues to rise. From the current perspective, shale gas can be expected to produce at most a mixed overall impact on the climate since its future consumption depends on the environmental and energy policy decisions of the United States and other countries. International market developments are also ridden with uncertainties. The potentially sweeping political consequences of the natural gas boom in the United States confront European and international climate policy makers with entirely new and unexpected challenges.

The growing share of unconventional (shale) gas in the global energy mix has an impact on the environmental and climate performance of the countries that extract and use it. The extraction of shale gas by means of hydraulic fracturing ("fracking") differs from conventional gas production: A mixture of chemicals and large quantities of water are injected into underground rock formations through horizontally drilled wells, which sets free the trapped gas reserves. This energy-intensive process also releases methane gas, which has many times the greenhouse gas effect of CO_2. Fracking technology carries with it other environmental risks as well, ranging from surface and water contamination to noise pollution. Under unfavorable geological conditions, earthquakes may also be triggered. On the other hand, the combustion of natural gas has a significantly lower climate impact than the burning of hard or lignite coal.

In the United States, the energy sector has responded rapidly to the potential of natural gas-fired power generation. According to the *BP Statistical Review of World Energy 2013*, natural gas-fired power production increased in 2012 by 21 percent, while coal-fired power generation fell during the same period to its lowest level since 1987, with corresponding reductions in CO_2 emissions.

A comparable effect on global emissions, however, has not yet emerged. The coal that

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is no longer needed in the United States is being exported to countries with a high demand for coal, such as China and India. Germany, too, has increased the use of coal in power generation: Whereas the share of natural gas in Germany's power production declined from 2011 to 2012, the share of lignite coal increased by 6 percent. This stands in stark contrast to Germany's climate policy goals and its planned transition to renewable energy ("*Energiewende*").

The US Energy Transition and its climate impacts

Under the Copenhagen Accord, the concluding document of UNFCCC (United Nations Framework Convention on Climate Change) climate negotiations from 2009, the United States pledged to cut greenhouse gas emissions by 17 percent of 2005 levels by the year 2020. In 2011, the United States produced 6.9 percent lower greenhouse gas emissions than in 2005, and in 2012, emissions from the US electricity and transport sector declined as well. This was due in large part to three factors: the lagging economy, new standards for motor vehicles, and the increased use of shale gas.

Between 2005 and 2012, total natural gas production in the United States increased from 511 billion cubic meters to around 681 billion cubic meters. Shale gas production increased tenfold up to 2011. Over the same period, natural gas prices fell – despite the increased demand – from 13 to around 2 US dollars per million British thermal units (MBtu) by 2012.

Electricity companies have reduced coal-fired power production substantially due to the availability of cheap natural gas. Whereas in 2005 coal made up nearly 50 percent and natural gas barely 19 percent of total US electricity production, in 2012 the shares of coal and gas were 37.4 and 30.4 percent, respectively. Since natural gas emits only about half as much CO_2 on average as coal in the process of energy generation, this shift to gas translates into a positive effect on CO_2 emissions.

The Environment Protection Agency's (EPA) attention lies not only on the emissions produced in energy generation but also on other greenhouse gases that accompany shale gas production. The greenhouse gas methane has fifty times the greenhouse gas impact of CO_2 in a 20-year comparison. Its comparative effect is only reduced by half when viewed over a 100-year time-frame. Furthermore, substances are emitted in the process of shale gas extraction that have a negative impact on regional ozone and smog levels. To regulate these substances, the EPA introduced standards for the oil and natural gas sector in 2012. A side effect of these standards is a reduction in methane emissions. Nevertheless, a specific regulation for methane remains to be created.

The methane gas released in shale gas extraction can contribute to a worse net emissions balance of shale gas compared to coal. According to calculations by US institutions, fugitive methane emissions from shale gas extraction would have to be reduced to less than 3 percent of total gas production in order to render shale gas more environmentally friendly than coal, no matter what time period is used as the basis for calculations. Calculations for the transport sector estimate that methane emissions must be reduced below 1 percent of total gas production to result in a net climate advantage of natural gas over diesel. For this reason as well, the EPA has focused attention on reducing methane gas emissions further.

In his June 2013 Climate Action Plan, President Obama announced a comprehensive strategy to curb methane emissions. In 2012, methane accounted for roughly 9 percent of domestic GHG emissions. Since methane gas is also released in activities such as agriculture and mining, one objective of the Action Plan is to develop an interagency methane strategy. For gas producers methane capture may be more profitable than flaring or no action, once they invest in capturing devices. If the United States succeeds in reducing methane emissions in the transport sector and industry and in moving forward on developing renewable energies, shale gas use can help the United States to achieve the international climate goal they announced in 2009.

A competitive edge for US manufacturing

It remains difficult to forecast how additional regulatory measures for methane emissions will affect the costs of US companies. Up to now, the low price of natural gas in the United States has increased US competitiveness in the energy-intensive sectors. Industries in these sectors such as steel, cement, and basic chemicals are responsible for large parts of global industrial CO_2 emissions, and they have been under immense pressure to reduce costs for a number of years. The availability of cheap energy has thus increased the attractiveness of the United States as a location for manufacturing. Both European chemicals and steel producers have announced to invest in the United States. After years of the most energy-intensive industries moving mainly from Europe to the Middle East and China, the shale gas boom has created a new pull for manufacturing migration from the Old World to the New. However, the low price of natural gas in the United States is not the only reason for "onshoring" manufacturing. Other factors include the increased wage costs in Asia, the negative impact of outsourcing on innovation by US companies, and the lack of intellectual property protection in Asian countries. Locating as close as possible to customers also plays an important role for many manufacturers.

Companies are faced with new uncertainties, however, due to the regulatory interventions under consideration to curb environmental impacts of fracking. Up to now, the US administration has supported shale gas extraction: Fracking was explicitly exempted from the Clean Water Act by the "Halliburton Loophole" in the Energy Policy Act of 2005. Changes in the legal framework could therefore have substantial effects on the production costs and the available supply of shale gas.

The future of shale gas in the United States

There are some indicators that the threefold trend in the United States – increasing gas supply, increasing demand, and falling prices – has been halted, at least for the time being.

First, the low price level has made unconventional gas extraction unprofitable to some extent: In the last three years, the spot price for natural gas at Henry Hub – the main distribution hub on the natural gas pipeline system in Erath, Louisiana – was below most companies' extraction costs. The break-even point with the current technology is around 5 to 8 US dollars/MBtu, whereas the gas price at Henry Hub in Summer 2013 was approximately 4 US dollars/MBtu. The number of rigs drilling for gas has significantly decreased, and the equipment has been reallocated to oil drilling. This shift has further intensified the price pressure, since natural gas is a by-product of far more profitable oil and gas condensate extraction. Future natural gas supplies and prices will depend on how much "dry gas" is produced as a by-product, or how much "associated gas" can be extracted in the process of oil and gas condensate extraction.

Second, shale gas reserves have a number of characteristics that set them apart from conventional gas fields. Production rates drop off sharply and rapidly over time, and exploitation rates are relatively low. For the companies involved, but also for the industry as a whole, these are the factors that drive costs. A large number of new wells are needed to maintain production volume.

Third, despite the boom, many companies themselves are in crisis. Even pioneering companies such as *Chesapeake* have been forced to sell part of their assets to meet their financial obligations. This has raised concerns of a “shale gas bubble,” particularly since drilling companies had significant incentives to overrate their own gas reserves in order to raise capital. Also, around the middle of the last decade, companies invested in expensive liquid natural gas (LNG) import infrastructures in response to 2006 predictions by the US Energy Information Agency (EIA) of an over 70 percent increase in the demand for LNG imports within the coming decade. The LNG terminals proved to be an expensive and ill-advised investment. This infrastructure can be used for shale gas exports, but it will have to be converted. Moreover, the process surrounding export approvals is tedious and its outcomes are uncertain.

Fourth, with the consolidation of the shale gas market, the large International Oil Companies (IOCs) are moving into the business as well. They have both an interest in the technology as well as the financial power to endure the low price phase. They are working towards tapping into new market segments and want to develop their long-term export potential. Two export terminals with a total export capacity of 30 billion cubic meters per annum have the official licenses. First exports are expected in 2015/2016. As natural gas will also likely play an increasing role in the US transport sector if the price difference between natural gas and oil remains, natural gas prices are likely to increase in the medium term.

Can the US shale gas boom be exported?

The shale gas boom in the United States raises the issue of whether such developments could also take place in other countries, thereby globalizing the positive effect on greenhouse gas emissions. Over 80 percent of global energy consumption is met by fossil fuels, which in turn are responsible for over two-thirds of greenhouse gas emissions. As natural gas is relatively low in emissions compared to coal or petroleum, it often hailed as a bridge to a sustainable global energy system. Since 2012 at the latest, when the International Energy Agency (IEA) published its analysis highlighting the significance of shale gas extraction for US energy markets, the possible implications of the boom for international climate policy have been under serious consideration. Hopes of positive climate impacts have been further nourished by the falling natural gas prices and by favorable geological conditions providing relatively easy access to shale gas. Optimistic scenarios of the potential of unconventional natural gas extraction estimate that shale gas could contribute up to 30 percent of the global primary energy supply by 2015 and as much as 35 percent by 2040. The range in these estimates is enormous, however, since the actual quantities available for extraction can only be determined after resources have been explored.

Many countries with high energy consumption have national shale gas reserves, which would make extraction appear attractive: In June 2013, the US Energy Information Administration (EIA) raised its estimates of global shale gas reserves by 10 percent over its first report from 2011. China and Argentina’s shale gas reserves are larger than or approximately comparable to those of the United States. Traditional gas and coal producing countries like Russia, Algeria, Libya, South Africa, and Mexico have significant shale gas reserves as well. Since most of these already have an (export) infrastructure, they could also consider shale gas extraction, which would tend to sustain the global energy market and price structures.

According to the EIA, there are 17.36 trillion cubic meters of technically recoverable shale gas in Europe. Up to now, the United Kingdom, Poland, Romania, and the Ukraine have shown an interest in extraction. Whereas France has banned fracking, the United Kingdom wants to intensify its use of the technology. In Poland, some companies have withdrawn their engagement after encountering disappointing results in early shale gas exploration. Since large gas reserves have been discovered in the countries on Europe's borders – in the Eastern Mediterranean, for instance – a significant *potential* gas supply exists. The question is whether it can be extracted.

According to EIA estimates, China has almost twice the volume of unconventional resources as the United States, especially (but not only) in the arid western and Northern parts of the country. Yet China still lacks the technical resources needed for rapid development of its shale gas reserves. Furthermore, the water requirements for current fracking methods are extremely high – a problem which, along with the lack of both infrastructure and service companies could impede shale gas extraction.

None of these countries has a market environment so ideally positioned for a gas boom as United States – with the possible exception of the United Kingdom. The constellation of factors favoring the US market includes the political and legal framework, investment security, the availability of equipment and services, a developed infrastructure, an established gas market, and proximity to consumers, but above all the US-specific land ownership rights.

Despite the uniqueness of the US market, the IEA nonetheless predicts the advent of a "golden age" for natural gas, forecasting that global demand will increase by almost 50 percent by 2035. For this demand to be met, annual natural gas production will have to increase to a level corresponding to roughly three times Russia's annual natural gas production. More than two thirds of this additional demand would have to be met by unconventional gas.

In order for this scenario to become a reality, North America would have to export significant quantities of natural gas to international markets. This would reinforce global and flexible LNG trade. Whereas the main obstacle in Canada is a still inadequate transport and export infrastructure, it is apparently strategic economic concerns in the United States that hinder gas export promotion. Washington's traditional advocation of free energy markets and largely unrestricted trade flows is confronted with the competitive advantages of low energy costs. These two considerations have sparked heated debate over exporting natural gas. On the one hand, a stronger US economy provides the basis for a strong US dollar and a declining trade deficit. On the other hand, exporting natural gas also offers economic advantages, but it would create higher prices on the domestic market and thus disadvantages for some sectors of the economy. Political discussion of these issues in Washington has just begun.

Threefold division of the international gas market will delay price effects

A further impediment to the international gas boom is the division of the international gas market into three distinct regional markets: North America, the Eurasian trade area, and the Asia-Pacific region. Japan, South Korea, and China together consume two-thirds of globally traded LNG. The threefold division of the market has resulted in distinct price structures that have been affected only indirectly by the shale gas boom, with LNG originally intended for the United States being diverted to international markets. From 2008 to 2012, LNG imports to the United States dropped by almost half. Since early 2010, the price trend in North America has been moving in the opposite direction of other regional gas markets. The United States, thanks to its highly liquid spot market and pricing and trading hubs, with Henry Hub as the principle hub, is profiting from wholesale trade prices that were around one third of the average spot price in the United Kingdom. As a result, the US boom has tended to intensify the division of the global gas market up to now. Gas exports would reduce the price differences between the United States and Europe but would not eliminate them. In the Pacific LNG market, however, high risk premiums are paid on oil-price-indexed long-term contracts, resulting in a 45 to 60 percent higher average LNG price in Korea and Japan than in the EU.

A significant decline in gas prices can therefore not be expected in Europe despite the US shale gas boom. Gas is supplied to the continent mainly through pipelines, and is tied – through a hybrid contractual and price structure – to suppliers in Russia, Norway, and Algeria. Nevertheless, pressure is increasing to abandon the principle of oil price indexing, which the Russian gas company Gazprom in particular wants to maintain. As a result, Gazprom has been forced to make price concessions, and the Norwegian company Statoil has changed to spot market indexing and also reduced transport fees.

All this suggests that the price and volume pressure on traditional suppliers will continue, at least in the short to medium term, as companies diversify their portfolios – for instance, with import contracts for LNG from Canada. In addition, the EU has accused Gazprom of "unfair pricing" and launched an antitrust probe in September 2012. It remains uncertain, however, how the price formulae used in long-term contracts will develop. LNG from North America could be an attractive option for the European market. But since it would not trigger a steep drop in prices, the overall price effects would be too weak in the short term to substantially increase the use of gas compared to coal.

Coal consumption has a decisive impact on the climate

Even if the gas price outside the United States does drop significantly in the near term, and if this is followed by an increase in the gas supply, positive climate effects would still only occur if natural gas replaced coal in power production on a large scale. Natural gas could be used to an increased degree in the transport sector as well, especially in shipping and freight transport, and could gradually replace petroleum.

It has been emphasized repeatedly in the international climate debate that a dramatic turnaround in emissions trends is needed by 2020 to prevent dangerous levels of global warming. In 2013, the IEA outlined four proven measures that could be taken using currently available technology to reduce global warming at no net economic cost. Along with measures to increase energy efficiency in buildings, phase out fossil fuel subsidies, and reduce methane releases from the oil and gas industry, measures to curb the use of coal are of key importance: According to the IEA, the construction and use of inefficient coal-fired power plants in particular should be phased out.

As reported in the *BP Statistical Energy Review 2013*, the international consumption of coal has continued to grow in the brief period since the beginning of the shale gas boom in the United States, but at a slower rate. The increased use of gas in the United States manifested itself in a 12 percent reduction in coal use in the year 2012, although coal production declined by just 7.5 percent. In Asia and Europe, both the consumption and production of coal continued to rise. China leads the world with almost 48 percent of global coal production, and in 2012 was also responsible for more than half of the world's coal consumption for the first time ever. India's demand for coal increased by almost 10 percent in 2012. The United States and Europe (including the Ukraine) held approximately equal shares in global coal production at 13.4 and 12.2 percent, respectively. Germany is the EU's largest coal consumer: Whereas the rate of coal consumption declined in almost all other EU countries in 2012, it rose in Germany by 3.9 percent.

In the longer term, global total energy demand will continue to grow. If climate and energy policy is not designed to counter this trend, coal will hold its position as the leading fuel source worldwide. If there is not a global shift from oil and coal to natural gas, these three fuel sources will maintain their approximately equal shares in the global energy mix, at around 26 to

28 percent each, leading up to 2030. This will have severe consequences for climate change, since global energy demand is expected to increase nearly 40 percent by that time.

In the short term, global coal consumption will depend crucially on economic development in China. Economic downturns like the current one have a direct impact on energy demand and provide short-term alleviation of the problem.

From a longer-term perspective, according to IEA forecasts, even in the United States, gas could fall to around 27 percent of total energy production and coal could remain above 40 percent unless coal consumption is reduced in line with the Obama administration's regulation plans. If China shifted to shale gas, this would have a substantial influence on the global energy mix. However, the country is currently missing the basic conditions that would allow for such a change of course. It still lacks the decisive incentives to invest more in low-carbon energy sources. The Chinese government is promoting the expansion of renewable energies and is testing emissions trading in some of its major economic zones, but the question remains how strongly this will affect the energy sector and whether it will be compatible with Chinese growth ambitions.

Effects on European policy and climate negotiations

The dawning of a new "golden age" of gas – and thus the use of gas as a "bridge" to a low-emissions energy system – will not come about automatically in Europe (or the rest of the world) even if more natural gas becomes available at lower prices. For this to happen, political decisions and regulatory interventions will be needed to make natural gas a more viable alternative to coal. Up to now, German and European energy and climate policy have not given natural gas a key role in the transformation of national energy systems or in climate protection. The downward trend in CO_2 prices, the rapid expansion of renewable energies, and existing power capacities have favored coal-fired power generation.

The shale gas boom has raised issues that place additional strain on the energy and climate policies of the EU and its Member States. First, Member States are split over the risks and opportunities of fracking technology. Second, increasing domestic energy costs are inducing parts of European industry to oppose further EU climate policy ambitions that could affect their competitiveness.

In addition, the EU's most important climate policy instrument – the European Emissions Trading Scheme (EU ETS) – has lost most of its vigor. In late 2012, the price of CO_2 emissions allowances reached its lowest level to date and no longer has an impact on the use of fossil fuels. The two-digit CO_2 prices that were originally envisaged would create clear advantages for the use of renewable energies and natural gas compared to coal. Basing calculations on coal and gas prices from spring 2013, the CO_2 price would have to be approximately €40 to €45 per ton to make natural gas commercially viable compared to coal. In order to achieve such a price, the supply of carbon certificates would have to be reduced substantially.

The European energy market structures have shifted further as a consequence of the German energy transformation ("Energiewende"). Gas-fired power plants could make a more flexible contribution than the existing coal-fired power plants to stabilizing the fluctuating German electricity generation from renewable energies. But the price of power on the energy exchange has fallen significantly since 2011, due to the guaranteed feed-in for wind and solar energy and the need to keep coal and nuclear power plants running at a certain level, but especially to the principle of the "energy only" market and its so-called merit order effect: the share of renewable energy on many days is so high that this brings about low or even negative energy prices on the energy exchange. In this event, it is only the cheap (coal-fired) conventional power plants that prove to be commercially viable. The actual price per megawatt hour is set by the power plant with the highest variable costs. A newly built and efficient gas power plant would operate on a higher cost level than the existing coal plants and would no longer pay off. Thus, investments are not made in new power plants, and the existing modern gas power plants are not economically efficient.

At the international level, the EU Commission and national European climate policy makers must continue to grapple with the implications of the US shale gas boom. After all, the United States will propagate this energy source together with the Obama Climate Action Plan in UN negotiations as a strategy for "clean" energy provision (which includes a mix of renewable, biomass, shale gas, and nuclear energy), with the goal of taking on a leadership role among the global economic powers. The EU is coming under increased pressure to take clear action, having by now essentially lost its claim to leadership. A potential area in which the EU could again take the lead, however, is in expanding renewable energies. Such an approach will only be credible, however, if the costs of energy supply are reduced and if Member States abandon their go-it-alone approaches. These weaknesses within the EU have undoubtedly come to the attention of other countries, and they endanger the credibility of the pioneering role that Europeans and in particular Germans have worked for years to establish.

The competitive advantages offered by the low price of natural gas in the United States has sparked a discussion that is influencing efforts to develop a new EU climate and energy strategy up to 2030 as well as the reform of EU ETS. If the Obama administration succeeds in implementing its climate strategy, the United States will be considered an international model for climate policy. The EU and Germany will only be able to meet this competition by promoting their own model for energy and climate policy, instead of compromising it in the light of an uncertain and perhaps temporary US shale gas boom.

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