THE IMPACT OF SHALE GAS ON THE COSTS OF CLIMATE POLICY

Jan Kersting, Fraunhofer Institute for Systems and Innovation Research ISI
Breslauer Straße 48, 76139 Karlsruhe, Germany
Phone: +49 (0)721 6809 474, e-mail: jan.kersting@isi.fraunhofer.de
Vicki Duscha, Fraunhofer Institute for Systems and Innovation Research ISI
Breslauer Straße 48, 76139 Karlsruhe, Germany
Phone: +49 (0)721 6809 226, e-mail: vicki.duscha@isi.fraunhofer.de

Overview

In recent years, the USA have experienced a significant boom in production of natural gas from shale formations. This has caused a surge in the share of natural gas in US electricity production from 20 to 30% between 2006 and 2012. As natural gas produces less CO_2 per unit of electricity than oil and coal, greenhouse gas (GHG) emissions decreased by 5% between 2010 and 2012. Consequently, the International Energy Agency claimed that the world economy might be entering a “Golden Age of Gas” (IEA 2011) and Moniz et al. (2011) suggest that natural gas could serve as a “bridge fuel” to a future low-carbon economy. While shale gas is having positive impacts on emissions in the short run, Jacoby et al. (2012) and Schrag (2012) caution that increased competition of natural gas creates obstacles for the development of mitigation and low-carbon technologies such as carbon capture and storage or renewable energy technologies. Levi (2013) finds that natural gas is of limited use in a GHG mitigation scenario compatible with the 2°C target, but could play a larger role in less ambitious mitigation scenarios.

In this paper, we investigate the effects of an increased exploitation of shale gas reserves around the globe and to what extent it can serve as a low-cost GHG mitigation option. Our analysis relies on the POLES model, a techno-economic model with a detailed representation of the energy sector. This allows us to compare a scenario of global shale gas exploitation with a scenario in which shale gas use is very limited. We compare the development in the baseline case with no climate policy, as well as for different GHG mitigation cases in line with the 2°C target.

Methods

For the baseline and policy simulations we employ POLES, a world simulation model for the energy sector. POLES is a techno-economic model with endogenous projection of energy prices, a complete accounting of demand and supply of energy carriers and associated technologies. The model includes, among others, 30 different power generation technologies for 57 different countries/regions, and accounts for CO_2 and other GHG emissions. This high level of regional disaggregation allows to a very large extent for a country-specific modeling of technology availability.

POLES has been employed to generate a *US only* scenario and a *Global Shale Gas* scenario. In the *US only* scenario only the USA are allowed to exploit their shale gas reserves, while in the *Global Shale Gas* scenario there are no restrictions on shale gas development for any country. In addition, the *Global Shale Gas* scenario uses more optimistic assumptions about available shale gas reserves than the *US only* scenario and therefore paints a more optimistic view on the availability and use of shale gas in the future than the *US only* scenario.

The two scenarios are compared in the baseline case with no climate policy and in cases with GHG mitigation targets for 2030 and 2050. In 2030, these climate targets are based on the effort sharing principle of Contraction & Convergence, which calls for each country to bring its per capita GHG emissions to a level equal for all countries. For 2050, we use targets of 80% below 1990 emission levels for Annex I countries and 65% below baseline emission levels for non-Annex I countries. These targets are considered to be consistent with the 2°C target and fall in the range of different effort sharing principles, as presented in the IPCC Fifth Assessment Report (IPCC 2014).

Results

The additional shale gas in the *Global Shale Gas* scenario causes multiple effects. On the one hand, the use of natural gas as a replacement for coal and oil lowers GHG emissions and presents a cheap mitigation option. On the other hand, the availability of additional natural gas lowers prices for all fossil fuels, causing replacement of low-carbon technologies and an overall increase in energy demand. The size of these effects varies significantly between countries: In the long-term up to 2050, India uses 68% of its additional gas in electricity production to replace coal or oil, while Argentina only uses 7% for this purpose. Consequently, GHG emissions in Argentina in the baseline are 3% higher in the *Global Shale Gas* scenario compared to the *US only* scenario, while the change in India's emissions is negligible. No country experiences a significant decline in GHG emissions in the *Global Shale Gas* scenario.

On the costs of compliance with climate targets, we find that the costs of reducing one tone of CO_2-equivalent are smaller in the *Global Shale Gas* scenario for most countries. However, this mitigation cost effect is overshadowed by the increase in baseline GHG emissions mentioned above, as this leads to an increase in the GHG reductions needed to meet a specific climate target.

In the short-to-medium-term up to 2030, the same effects apply, but the scale is much smaller. The USA still account for three quarters of global shale gas production in the *Global Shale Gas* scenario and the difference in global production of natural gas to the baseline is less than 2%. Consequently, the difference in baseline GHG emissions and in the costs of climate policy is modest.

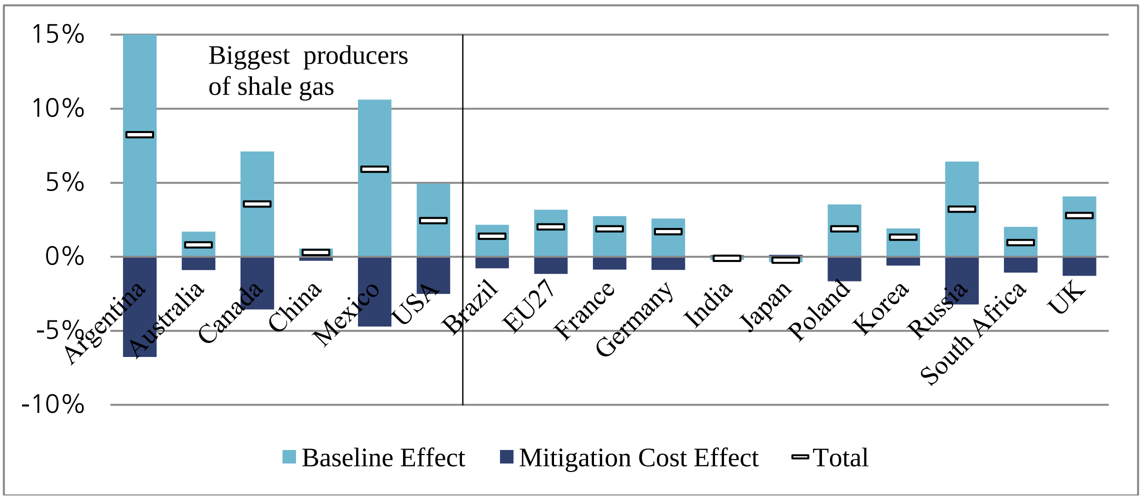

Figure 1: Change in costs of compliance with climate targets in 2050, induced by additional shale gas.

Conclusions

Our analysis suggest that shale gas should not be considered a cheap option to reduce global GHG emissions due to three reasons: the effects of a global shale gas boom (a) are small in the short-term, (b) lead to higher baseline GHG emissions for most countries in the long-term and (c) result in higher costs of compliance with climate targets. In addition, the degree to which shale gas is used as a replacement for coal or oil in electricity production differs considerably between countries, suggesting that country-specific circumstances need to be taken into account when trying to replicate the recent experience in the USA in other countries. Our analysis does not take into account the environmental impacts or the additional methane emissions during the extraction process of shale gas. Taking those into account might even further strengthen that picture.

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