Phasing out coal for global electricity production – effects on Arctic gas deliveries

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Overview

In an earlier study of arctic petroleum extraction towards 2050 (Lindholt and Glomsrød, 2012), the future coal scenarios were to a large extent based on expectations in the late 2000s. Compared to these scenarios coal demand in the global power sector is now expected to be around 20 per cent lower already in 2020. When mitigating climate change coal stands out as a major target due to its high emissions of CO_2 per unit thermal energy. Coal is also a dirty business in terms of high emissions of health damaging air pollution.

Coal has many alternatives in the power sector as gas, renewables and nuclear. This paper examines to what extent downscaling of global coal based electricity generation encourages gas demand and affects regional activity in gas production, with emphasis on the arctic regions. We take the New Policy Scenario (NPS) in IEA (2014) as the starting point and calculate the effects on the gas markets and particularly the arctic supply. In addition, we assess the effect of phasing out coal for electricity production.

Some argue that due to the development of shale gas resources there will be less need for conventional gas projects in the future. As a consequence we have updated the shale gas production and reserves.

Methods

The FRISBEE-model is a recursive, dynamic partial equilibrium model for (oil) gas, coal and renewables in 15 regions worldwide. Demand is a function of end-user prices of energy, population, GDP per capita and AEEI-autonomous energy efficiency improvement. Each region has three end-users: Industry, households (incl. services) and power producers.

Supply: We have perfect competition on the gas and coal markets with endogenous prices. Regarding gas the model differs between fields in production, field not developed and undiscovered fields. Both production and investment decision are modelled explicitly and are based on profitability. At first investments target the most profitable areas and gradually shift to more remote and costly areas, leading to a geographically spread of the global gas production. We model low flexibility in the short term and full flexibility in the long term, and differ between capital and production costs. We also implement bilateral gas trade between regions through pipelines and as LNG. The gas supply side covers six arctic regions; Alaska, Arctic Canada, Arctic Norway, Greenland, East Arctic Russia and West Arctic Russia. Coal supply and supply of renewables (incl. nuclear) are based on more simple cost functions. Regional electricity production is a function of the electricity price, prices of energy inputs, fuel efficiency conversion rates and operating costs.

Coal, gas and renewables are substitutes in the global power sector. First we develop a reference scenario based on the New Policy Scenario (NPS) in IEA (2014) and calculate the effects on future arctic gas supply to 2050. Second, we assess the effects of phasing out coal.

Results

In the reference scenario coal for global electricity is reduced from 38 per cent in 2015 to 28 per cent in 2050. The share of non-fossil feedstock is increasing from 35 per cent in 2015 to 45 per cent in 2050. Global electricity production increases rapidly and this initiates a marked increase in arctic gas supply over the period.

Arctic supply of gas will slightly decline from 500 mtoe in 2013 to about 450 Mtoe by the early 2020s, when the supply starts to increase. In 2050 the level of arctic gas supply is more than double the level during the early 2020s. The increase in total Arctic gas production is primarily due to higher Russian volumes, but also partly a result of increases in gas supply from the other arctic regions, although from generally low levels.

Global gas production more than doubles over the period. The most important reason is abundant and cheap gas resources from the MENA region, above all Iran and Qatar. In the reference scenario the share of total Arctic in world supply of gas is reduced from 22 per cent in 2015 to 14 per cent by 2050. However, the Arctic sustains its share in production outside Middle East and North Africa at 27 per cent.

In 2050 coal is reducing its share in the global power sector from 28 per cent in the reference scenario to 18 per cent in phasing out coal scenario. However, the strong trend towards non-fossil electricity also reduce the market share of natural gas in the global power sector. For the Arctic as a whole the decline in accumulated production 2015-2050 is 9 per cent compared to the reference scenario, for Greenland and Alaska as much as 69 and 31 per cent respectively. Although Russia no longer see the rapid growth from 2035 the effect on accumulated production is as low as 6 per cent.

Conclusions

The Arctic has almost 30 per cent of the global undiscovered conventional gas resources. Around 22 per cent of the present global gas supply takes place in the Arctic. Less need for coal in the global power sector in our reference scenario leads to a steep increase in total Arctic gas production, primarily due to higher Russian volumes, but also partly a result of increases in gas supply from the other arctic regions, although from generally low levels. Because global production increases even relatively more, the arctic share of global gas production declines to 14 per cent in 2050.

Phasing out coal leads to an even stronger trend towards non-fossil electricity production. This reduces arctic natural gas production from around 2030 compared to our reference scenario.

References

IEA (2014): World energy outlook 2014, OECD/IEA Paris.

Lindholt, L. and S. Glomsrød (2012): The Arctic: No big bonanza for the global petroleum industry, *Energy Economics* 34.