PROMOTING CCS IN EUROPE: A CASE STUDY FOR STRATEGIC TRADE POLICY?

Rolf Golombek, Simen Gaure, Mads Greaker, Sverre A.C. Kittelsen and Knut Einar Rosendahl
Lead Author: Rolf Golombek, Frisch Centre, rolf.golombek@frisch.uio.no, +47 950 45 696

Overview

In the 2013 IEA report titled Technology Roadmap: Carbon Capture and Storage, it is predicted that CCS will contribute to one sixth of the required CO2 emission reductions by 2050. At the same time current CCS projects are having problems. The Norwegian government originally planned to have a full scale CCS operation in place at the gas power plant at Mongstad by 2015, but now the project is cancelled. The EU launched the Zero Emission Platform in 2007, and aimed to have 12 full scale CCS plants in operation by 2015. Today, it seems like at most one of the projects will be realized.

According to the IEA report, the largest challenge for CCS deployment is the integration of component technologies into large scale projects. IEA (2013) further holds that a key action is to introduce financial support mechanisms for early deployment of CCS. We have identified two business models by which this can happen. One option is to provide support to power plant investors by covering a part of their additional investment cost of CCS. This is the route that the Norwegian government aimed to follow. The alternative model is to focus on the CCS technology suppliers. Currently, there are only a few such firms of which some belong in the EU. Of course, the government can support research and development and demonstration by these firms. The government can also subsidize some of their costs of providing CCS technology to power plant investors.

To our knowledge, the literature has not yet compared the pros and cons of the two routes in a formal analysis. Thus, the first research question in this paper is to what extent promotion of CCS in Europe should be through by subsidising the purchasers of CCS technologies – a downstream subsidy - or by subsidising development and production of CCS technologies – an upstream subsidy. CCS technology can be applied both to gas power and to coal power. These two technologies are likely substitutes in demand. Thus, the other research question is to what extent the EU should give priority to one of the CCS technologies.

Methods

We study the research questions both theoretically in a stylized model and numerically by using a well known economic model of the European energy market. Furthermore, we explicitly take into account that competition between CCS technology suppliers is likely imperfect as there are only a few potential suppliers in the world.
Based on standard economic theory one may wonder whether the distribution between an upstream and downstream subsidy is of any importance: In a closed economy, it is of no importance whether a (positive or negative) tax is imposed on supply or demand, and this is the case both with competitive markets and under imperfect competition. This reasoning is based on the assumption that either all producers face the tax or all consumers face the tax. In our model we assume that some CCS technology suppliers – those located in the EU – are offered an upstream subsidy, whereas the remaining producers – those located outside the EU – do not receive the upstream subsidy. Once some agents in a group do not receive the subsidy, the equivalence between an upstream and a downstream subsidy/tax no longer holds.

Taking all the welfare components of the EU into account, that is, its producer surplus, consumer surplus and the tax revenue of the EU government, we show that it is optimal to offer an upstream subsidy to the EU producers, but no downstream subsidy. Both subsidies increase the use of CCS, which is desirable due to imperfect competition in the market for CCS technology. However, by prioritizing an upstream subsidy to the EU producers, production and profits are shifted from the non-EU producers to the EU producers. In contrast, one effect of a downstream subsidy is to stimulate production from non-EU producers, which, all else equal, hampers the welfare of the EU.

While the theory models in Section 2 give rules of thumb of how to design upstream and downstream subsidies, we apply a numerical model of the Western European energy markets – LIBEMOD - to illustrate the magnitudes of the optimal subsidies and their impacts on the energy markets. In order to establish a model with endogenous price formation of CCS plants, we develop a new approach which to our knowledge has not been used before.
First, we run the LIBEMOD model to find demand for CCS plants. That is, we specify costs of investment for CCS technologies, and run the model for a future year (2030 with a uniform tax at USD 90/tCO2). Then we change the cost assumptions and run the model again. For each model run we find how much of each CCS

technology that is purchased. From the resulting set of model runs we estimate demand for CCS technologies as a function of the costs of CCS investments.
Second, we combine this demand block, extended by downstream subsidies, with a supply block that specifies production of CCS technologies under Cournot competition and upstream subsidies. In the model there are both EU and non-EU producers of CCS technologies, but only the first group receives upstream subsidies. This model determines, for a given set of subsidies, the price of each CCS technology. By running the CCS model under alternative assumptions about the upstream and downstream subsidies, we find the corresponding prices of CCS technologies.

Third, we implement the set of CCS prices in LIBEMOD as parameter values for costs of investment in CCS technologies. Each set of CCS prices gives an equilibrium in the energy markets in Western Europe, including how much of each CCS technology that has been purchased. Because we can calculate welfare of different groups in LIBEMOD, we can identify which combination of upstream and downstream CCS subsidies that maximizes the welfare of Western Europe.

Results
Even if the price on CO2 is set optimally, CCS should be subsidized due to imperfect competition in the markets for CCS technologies. Furthermore, the numerical simulations confirm that upstream subsidies should be preferred over downstream subsidies. If only downstream subsidies are used, CCS coal power plants should receive a 25% investment subsidy while CCS gas power plant should receive no subsidy. On the other hand, if only upstream subsidies are used, suppliers of CCS technology should receive a 95% coal power construction costs subsidy and 45% gas power construction costs subsidy.

The numerical simulations cover effects that are not included in the theoretical model. Western Europe is a major importer of natural gas and coal from abroad. Policies that increase the price on imported gas and coal have a negative terms-of-trade effect, and should, all else equal, be avoided. In the numerical model LIBEMOD, increased demand for natural gas in Western Europe tends to increase the price of gas significantly, whereas the effect of increased demand for coal on the price of coal is moderate due to the coal market being global and supply elasticities of coal are large. Thus, one reason for why CCS coal power should be prioritized over CCS gas power is the terms-of-trade effect. The other reason is that a subsidy to construction of coal power CCS plants on the margin affects consumer surplus in the power market relatively more than a subsidy to gas power CCS. This aspect of a subsidy is also pointed out in the theoretical analysis.

Conclusions
If Europe wants to promote CCS power technologies, one should primarily offer subsidies to development and production of the technology, not to those acquiring the technology. Further, subsidies should be higher for CCS coal power than for CCS gas power.