Promoting CCS in Europe: A Case for Green Strategic Trade Policy?

Finn Roar Aune,[a] Simen Gaure,[b] Rolf Golombek,[c] Mads Greaker,[d] Sverre A.C. Kittelsen,[e] and Lin Ma[f]

According to IEA study *World Energy Outlook* from 2018, there is a huge gap between the optimal utilization of Carbon Capture and Storage (CCS) technologies to lower global CO_2 emissions and the current, negligible diffusion of this technology. A number of factors may explain this big mismatch, for example, the price of carbon may be by far too low; costs of renewables may have decreased more rapidly than expected; and there might be market imperfections in the CCS value chain of capture, transport and storage that slow down the speed in CCS development. Because of impediments, the IEA study *Technology Roadmap: Carbon Capture and Storage* from 2013 argues that a key action to kick off innovation and diffusion of CCS is to introduce financial CCS support mechanisms.

There are two business models to spur CCS. One option is to support purchasers of CCS technologies by covering a part of the additional investment cost of CCS. The alternative model is to focus on the CCS technology suppliers by supporting their research, development and production costs. Our first research question is to what extent promotion of CCS in Europe should be through subsidising development and production of CCS technologies—an upstream subsidy—or by subsidising the purchasers of CCS technologies—a downstream subsidy.

In the electricity sector, the CCS technology can be applied both to coal power and gas power. These two technologies are likely substitutes in demand. Our second research question is therefore to what extent the EU should give priority to one of the CCS technologies, that is, whether the subsidy to CCS coal power should exceed the subsidy to CCS gas power.

We study the two research questions both with simple theory models and within a framework where a numerical version the theory model is soft-linked with LIBEMOD, a large-scale numerical model of the European energy markets. The link between the two models is the prices of CCS plants: In LIBEMOD, these are (exogenous) cost parameters, whereas in the theory model, prices of CCS plants are (endogenous) model-determined variables. In the analyses, we take into account that competition between CCS technology suppliers is imperfect as there is only a few potential suppliers in the world.

Both the theory models and application of the numerical framework suggest that from an EU perspective, the upstream subsidy should exceed by far the downstream subsidy. The main reason is simply that an upstream subsidy shifts production and profits from non-EU CCS suppliers to EU suppliers, thereby increasing EU welfare. In addition, both upstream and downstream subsidies stimulate total production, thereby lowering the initial economic welfare loss due to product prices exceeding their marginal costs.

a Statistics Norway, finn.roar.aune@ssb.no
b Frisch Centre, simen.gaure@frisch.uio.no
c Frisch Centre, corresponding author, rolf.golombek@frisch.uio.no
d OsloMet, madsg@oslomet.no
e Frisch Centre, Sverre.kittelsen@frisch.uio.no
f CICERO, lin.ma@cicero.oslo.no

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Furthermore, we find that subsidies to CCS coal power plants should (from an EU perspective) exceed subsidies to CCS gas power plants. The reason is partly that the pure economic value of CCS coal power plants exceeds the pure economic value of CCS gas power plants. This is reinforced by the fact that coal has a higher CO_2 emissions coefficient that natural gas, and hence it is more valuable to replace conventional coal power with CCS coal power than to replace conventional gas power with CCS gas power. In addition, suppose demand for natural gas and demand for coal increase equally much. Then the price of natural gas tends to increase more than the price of coal. Combining this empirical result with the fact that the EU is a net import of both natural gas and coal, provides another reason for why CCS coal power plants should receive a higher subsidy than CCS gas power plants.