HOW CARBON TAXATION CAN HELP DEPLOY CCS IN NATURAL GAS PRODUCTION

Framework Step:

STEP 4. Support and contribute to innovation leading to new products and services
4. A What can host governments do?
Support research and development efforts to identify, adapt, and transfer technology, making sure that these efforts are responsive to private sector demands. In doing so, develop ties with local universities, public research institutions, and participate in collaborative initiatives.

Identify changing trends in global consumption and production patterns (progressive ore grades decline and increasing labour, transport, energy, processing, capital/ equipment costs), changes to end uses for minerals (innovation in final products), and carbon emissions trading.

4. B What can extractives industries do?
Invest in specialised technologies for planning, handling, processing, maintenance, operational monitoring and recycling (excavation, concentration, ore prospecting, monitoring of the state of the environment) that reduce environmental impact.

Tags:

- ☐ local employment
- ☐ local supplier participation and development, including SMEs
- ☐ marginalised groups (women, indigenous people)
- ☐ skills development and upgrading
- ☐ access to credit
- ☐ shared infrastructure (transport, water, power)
- ☐ technology transfer
- ☒ innovation
- ☐ economic diversification
- ☒ Other: decarbonisation

Problem Statement:

Norway is one of the global top 7 exporters of crude oil. The oil and gas sector constitutes around 18% of Norwegian GDP and 62% of Norwegian exports in 2018. Recognising the ambitious targets to reduce carbon emissions, the government of Norway has supported the use of Carbon Capture and Storage (CCS) technology in its climate plans to help the deployment of CCS technology at scale, which increases the possibility of meeting ambitious climate targets by preventing large amounts of CO_2 from entering the atmosphere. The government is also aware that CCS deployment cannot be possible without public funding. While providing financial support for CCS projects, in 1991, the government has introduced a CO_2 tax to ensure that Norway would be able to meet its climate targets by increasing efficiency and achieving emission reduction in upstream operations.

Natural gas produced at the Sleipner West field in Norway naturally contains about 9% CO_2, which has to be removed to meet the gas sales requirement in the European market (<2.5% CO_2). Instead of venting the separated CO_2 to the atmosphere, thus adding to global emissions, Equinor and the other owners of the field decided to inject the CO_2 using a 3-km long well and store it in a reservoir formation called the Utsira Sandstone. The CO_2 storage activity is driven by the Norwegian CO_2 emissions tax, which was introduced five years before gas production started at Sleipner.

Parties Involved:

- Equinor ASA: is the field operator.
- ExxonMobil, LOTOS, and KUFPEC: are production license partners
- Ministry of Finance: more than 80 per cent of domestic emissions is subject to mandatory emissions trading, a CO_2 tax, or both.
- The Ministry of Petroleum and Energy is responsible for energy, including petroleum and natural gas production in the North Sea.
- Gassnova: is the Norwegian state enterprise for CCS, it works on disseminating CCS learnings from Norway.
- The British Geological Survey (BGS) and SINTEF (Norway): are involved in geophysical monitoring and reservoir modelling of the distribution of the injected CO_2 in the Utsira Sand to improve understanding of storage processes.

Common ground:

Many gas markets have regulations and norms in place concerning the quality of natural gas, including the share of CO_2, in order to enable access to the transportation grid and meet customer safety requirements. In 1990, during the planning phase of the Sleipner project located in the Norwegian part of the North Sea, it became clear that the natural gas contained about 9% of CO_2, exceeding gas market specifications of a maximum share of 2.5% CO_2. Therefore, the CO_2 content had to be reduced before the natural gas could be sold. Rather than venting the separated CO_2, Equinor, the operator of the field, decided to invest in Carbon Storage and Capture (CCS) technology.

In 1991, the Norwegian government introduced an offshore CO_2 tax in an effort to reduce emissions from upstream oil and gas operations. The Norwegian government opted for an economic measure to make fossil fuel production more efficient and to lower emissions. This tax applies to all CO_2 emissions in the offshore sector, including any CO_2 released from gas extracted from Sleipner. The CO_2 tax was one of the main business drivers for Equinor to separate CO_2 offshore and inject it into deeper geological layers. Due to the Norwegian CO_2 emissions tax, it was more economical to store the CO_2, once captured, than venting it. Had this process not been adopted and the CO_2 produced been allowed to escape to the atmosphere the licensees of the Sleipner West field would have had to pay around NOK 1 million/day in Norwegian CO_2 taxes.

Actions taken*:*

Sleipner is the world's first platform-based CO_2 capture facility located 250km offshore in southern Norway. The CO_2 is being separated from the natural gas and reinjected into a saline formation,

which lies 1.000m below the sea bottom. The layers contain porous sandstone filled with water, keeping CO_2 under a 700m thick layer of sealing rock. The CO_2 is removed from the produced hydrocarbons at an offshore platform before being pumped back into the ground and the hydrocarbons piped to land. Equinor has been injecting one million tonnes of CO_2 per year since 1996. There is no evidence of CO_2 leakage and the CO_2 remains in situ. The project is an important demonstration of safe and secure CO_2 storage in deep saline aquifers. With the CCS technology about a million tonnes of CO_2 per year is prevented from being released into the atmosphere and more than 11 million tonnes has been stored so far.

More recently, the Sleipner CCS project has also handled and stored CO_2 capture streams from neighbouring gas fields, giving it an incipient CCS hub status. In 2016, the Norwegian government initiated plans to develop a new full scale CO_2 capture, transport and storage project, linking onshore industrial CO_2 sources to offshore storage.

Obstacles:

- Public concerns and safety issues around carbon dioxide capture and underground storage offshore: over the last decades, the viability and safety of CO_2 storage has been debated in Norway, including its deployment in the Sleipner project. Time-lapse 3D seismic data was acquired in 1994, prior to injection, and again in 1999, and every 2-3 years following. Using these seismic images, the plume of injected CO_2 can be identified as a number of bright sub-horizontal reflections above and around the injection point. The reflections are interpreted as wavelets from thin layers of CO_2 trapped beneath intra-reservoir beds of shale. The data shows the precise subsurface location of the CO_2 plume and confirms that, so far, the CO_2 is stored securely within the storage reservoir. Based on these monitoring surveys, current work by the British Geological Survey and by SINTEF is focused on understanding detailed migration processes within the plume, by relating the seismic signals directly to CO_2 distributions in the reservoir and history matching numerical flow simulations with the observed data.

Enabling factors:

- Given the economic importance of the gas sector for the Norwegian economy, there is broad political support for Norway to commit to CCS. Out of the 163 parties that have submitted nationally determined contributions (NDCs) to the UNFCCC, Norway is amongst the 13 countries (plus the European Union on behalf of its 28 member states) that explicitly recognise the importance of carbon capture and storage technology for decarbonisation efforts in the low-carbon transition.
- The petroleum sector is subject to the CO_2 tax, and the current tax rate is about NOK 500 per tonne CO_2. Since 1991, the CO_2 tax level has been increased and extended from offshore to other onshore industry sectors.
- Gassnova is in charge of supporting R&D projects through its CLIMIT programme. It is a programme for research, development and demonstration of CCS technologies. Gassnova carries out the programme in cooperation with the Research Council of Norway and Gassnova. CLIMIT has supported development of CCS technology in Norway for more than ten years. The knowledge and solutions created during this time have laid the technological foundation for work on CO_2 full-scale projects in Norway, including the industry and transport sectors.

Lessons Learned

- Started in 1996, the Sleipner project was the world's first demonstration of carbon dioxide capture and underground storage offshore. Prior to that some onshore projects linked to CO_2 EOR were in operation only in the USA. Since Sleipner started, around 20 more large-scale CCS plants have become operational.
- The CCS post-combustion capture method used at Sleipner can be potentially applied to power stations and other industrial emissions sites, thus holding out the promise of making deep cuts in global CO_2 emissions.
- According to the International Energy Agency and the Intergovernmental Panel on Climate Change, the Sleipner project is a valuable demonstration of industrial-scale CCS, and can help pave the way for other CO_2 storage offshore projects.
- The development of industrial-scale CCS in Norway, starting with the Sleipner project in 1996, gives a uniquely long track record of experience with CCS and provides valuable insights for the potential deployment of CCS at global scale. The successful deployment of CCS operation for over 20 years shows that CO_2 storage can be feasible and safe. Geophysical monitoring has proven essential for site management and time-lapse seismic imaging of CO_2 plume development gives much improved understanding of flow processes. Finally, a clear policy and regulatory framework has created a stable and predictable environment conducive to the successful deployment of CCS technology in offshore upstream operations.

Validated on 25 November 2019

13th Plenary Meeting of the Policy Dialogue on Natural Resource-based Development, OECD, Paris