VIRTUOUS CLIMATE AMBITIONS: VIRTUAL SOLUTIONS

Precarious delivery of industrial CO_2 capture & storage projects in Norway

26th March 2018

BELLONA

Capturing the climate, industrial and commercial opportunities of CCS in Norway requires more than the beleaguered EU CO_2 price

This policy brief looks at the role of Norway's CCS projects and their possible effects on roll-out of CCS projects in Northern and Western Europe. The brief is partly a response to a report by consultancy Atkins [link] on the costs and benefits of the Norwegian CCS project. Said report has several major shortcomings and is therefore not suitable as a basis for a Norwegian government or parliament decision on investment in a full-scale CCS value chain. The main points of this brief can be summarised as follows:

1) The EU's Emissions Trading System (ETS) for CO_2 emissions is not the main driver for climate action in Europe
2) There is a very high societal cost of failure to deliver CCS
3) Without CCS, Norway will not reach its climate targets
4) The Norwegian CCS project is likely to have considerable benefits for Norway's economy

Norway: Virtuous climate ambitions with virtual solutions

Norway has statutory climate targets in line with commitments of the EU and the UN

According to the climate settlement, by 2020, Norway must reduce greenhouse gas emissions by 47% (from 32 to 17 million tonnes). Norway is now set to miss its climate settlement goals. The new lawmakers' climate targets for 2030 entail a 40% reduction and come under what we call nationally agreed contributions to the Paris Agreement. Norway has furthermore chosen to follow the EU's emission commitment and is in the process of entering into an agreement on a common fulfilment of emission reduction by 2030.

Norway's way of sidestepping international obligations and national laws

According to the Climate Act, Norway has a two-pronged strategy to fulfil the climate target for 2030. First and foremost, through cooperation with the EU in delivering tangible emissions reduction and alternatively, to purchase offset quotas to virtually meet the target – a creative accounting solution that allows Norway to offshore CO_2 reductions with reduced investment at home.

The Government writes in the Climate Act - Prop. 77 L (2016-2017): "The law fully agrees that Norway meets the climate target for 2030 in cooperation with the EU. If a joint solution does not occur, the goal of at least 40 percent reduction in emissions by 2030 compared with 1990 will be conditional upon the availability of flexible mechanisms in the Paris Agreement and a crediting of our participation in the EU quota system as a contribution to fulfilling the obligation. "

The Atkins report, commissioned by the Ministry of Finance to quality assure the plans for demonstration of full scale capture, transport and storage of CO_2 limits the measurement of the socio-economic gain of Norwegian full-scale projects solely to the context of the EU ETS. However, the government's obligation is, first and foremost, to fulfil its climate commitments through cooperation with the EU. A quality assurance report that looks at the profit stabilisation of full-scale projects cannot be based on as narrow a measure as the EU ETS has proven to be. On the contrary, we must first look at what happens in the EU and then all opportunities and pitfalls for the realisation of the project in a Norwegian, Nordic and wider European perspective.

Norway: Clean image but surprisingly dirty

Norway already enjoys almost 100% low carbon renewable electricity generation yet simultaneously has among the highest per capita CO2 emissions in Europe. Norway's per capita climate impact is far worse than its neighbour Sweden and even exceeding heavily coal-based Poland.

Of total Norwegian greenhouse gas emissions (GHG), oil and gas extraction is the largest (28%) followed by manufacturing industries and mining (22%), Road traffic (19%), Aviation, navigation and fishing (12%). These three final major contributions in addition to hydrocarbon extraction need to be simultaneously addressed in reducing emissions in line with the Paris agreement.

Table 1: CO_2 per capita intensity comparison of Sweden, Poland and Norway

	CO_2 emissions per capita	CO_2 emissions per capital (1990 – 2013)	Electricity supply	Total CO_2 Emissions pa[1] (million tonnes)
Sweden	**4.6**		Low Carbon 99.4% Fossil 1.6%	44.3
Poland	**7.9**		Low Carbon 5% Fossil 95%	298
Norway	**8** *(ex oil & gas)*[2] **11.7** *(incl. oil & gas)*		Low Carbon 98% Fossil 2%	44.3

Cutting Norwegian CO_2, not jobs: the case for CCS

The Norwegian Process Industry's own roadmap shows how CCS is indispensable to reaching the industry's climate target: around 9.2 million tonnes of CO_2 must be captured each year by 2050.

[1] http://edgar.jrc.ec.europa.eu/overview.php?v=CO2ts1990-2014&sort=des9

[2] Oil and gas activities subtracted to allow direct comparisons with European counters without a hydrocarbon extraction sector. Norwegian of oil and gas activities ~32% of total Norwegian CO2 emissions.

Furthermore, Norway is very well positioned to receive and store EU CO_2 emissions in the North Sea. A huge storage capacity resource, advanced geological understanding and existing infrastructure could be used to entrench Norway as leading CO_2 storage service provided to Europe and technology export globally.

As the manufacturing industries are such a significant contributor to Norwegian emissions, no viable decarbonisation strategy can disregard their emissions. Manufacturing industries require CCS to deeply decarbonise. The 2016 Norsk Indusri Zero Emission 2050 Roadmap for Processing Industry[3] relies very heavily on the delivery of CCS (in particular CO_2 transport and storage infrastructure) to deeply decarbonise many sectors including cement, aluminium, fertilisers, hydrogen and achieve negative emissions. The central decarbonisation scenario of Norwegian industries relies on CCS for ≈ 55% of the CO_2 reduction, preventing 9.2 million tonnes of CO_2 from entering the atmosphere every year in 2050. With current technologies, it would be a reckless gamble on the future of the climate and our livelihood to fail to timely develop a viable CO_2 transport and storage network in Norway. The absence of CCS to reduce the emissions from these sectors results in one of two outcomes. Firstly, that Norway will not meet, and does not intend to meet its obligations under the Paris Climate Agreement, which it has ratified, and which commits keeping warming below two degrees. Alternatively, Norway will meet its climate targets through the closure and/or offshoring of industrial production with the resulting loss of jobs and economic welfare creation. If either outcome is intended, this should be clearly stated by the government and/or parliament when taking this decision.

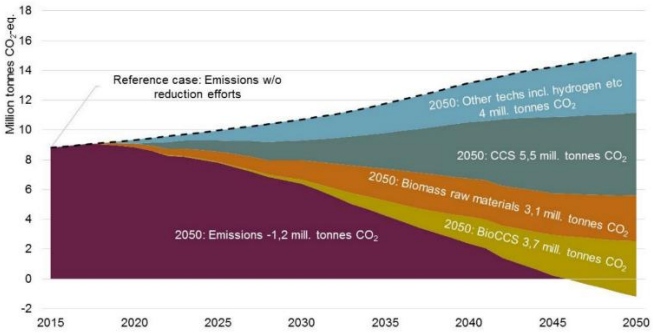

Figure 1: Emissions reductions by type (Norsk Industry 2016)[3]

Global requirement – less CCS will lead to more irreversible, disastrous climate change

Through the 2015 Paris Agreement, almost 200 nations agreed to limiting a rise in the world's average surface temperatures to "well below" 2 degrees Celsius above pre-industrial times, as well as to "pursue efforts" to keep temperature increases at 1.5 degrees. According to a recently leaked draft report of the IPCC on reaching the 1.5-degree target of the Paris Agreement, this effort is going to require far more extensive action at a much faster pace than currently planned for.[4] Indeed, the emission reductions pledged by countries under the Paris Agreement as Nationally-Determined Contributions (NDCs) are insufficient by far to keep temperature rises at 1.5.

The IPPC scenario for 1.5 degrees requires global economies to emit less than 580 billion tonnes of GHGs in the future. However, under current projections this budget will be exhausted within the next 12-16 years.[5] It may therefore be inevitable to also remove CO_2 emitted from the atmosphere in the future through Carbon Dioxide Removal (CDR).

To retain a chance of reaching the 1.5-degree target, Carbon Capture and Storage (CCS) and Bio (energy) CCS (Bio-CCS/BECCS) take central roles in the IPPC scenarios. CCS is needed particularly for industry emissions and for power generation in countries unable to completely phase out fossil fuels by 2050. The IPPC estimates that globally industry CCS will need to abate approx. 1.5GtCO2/yr by 2050. Bio-CCS (BECCS) is considered one of the primary ways to remove CO_2 from the atmosphere and therefore should already be deployed at scale by 2030, which requires access to large-scale CO_2 transport and storage. Overall, the IPPC draft report stresses that

[3] https://www.norskindustri.no/siteassets/dokumenter/rapporter-og-brosjyrer/veikart-for-prosessindustrien_web.pdf

[4] https://www.scribd.com/document/371415321/IPCC-special-report-on-1-5C-draft-summary-for-policymakers?secret_password=xlexc6JWYfplQn1LVaDe#from_embed

[5] https://www.scribd.com/document/371415321/IPCC-special-report-on-1-5C-draft-summary-for-policymakers?secret_password=xlexc6JWYfplQn1LVaDe#from_embed

"any initial delay in emission reductions requires faster subsequent reductions to meet the same temperature ambition".[6]

Greens and industry alike agree on need for CO2 storage

In February 2018 the Greens in the European Parliament published their "Vision Scenario for the European Union 2017 Update for the EU-28". The report states that hydrogen technologies and/or CCS belongs to the enabling strategies needed on the way to a fully decarbonized economy. The most important emissions reduction in industry are provided by CCS in sectors such as steel and cement. The work estimates that "*CO_2 emissions from non-energy sources drop significantly, by about 240 Mt CO_2 from 2015 to 2050. This is mainly due to the increase of resource efficiency (regarding steel, cement, etc.) and the introduction of CCS for process-related emissions in the steel and cement industry*."[7] The publication is notable given the Greens' former reluctance to endorse CCS, which contributed to the limited public support in Europe in the past decade.

The trend is to supplement the EU ETS, not bow to its call for inaction

Atkins suggests that the development of the ETS EUA price will "probably be the most important driver for further spread of the technology". A comprehensive SSB study from 2016 revealed that the EU ETS does not have a significant impact on environmental and economic performance at Norwegian production facilities. The low incentives for emission cuts in the EU ETS are something that applies to industrial plants in general and not to CCS full-scalability in particular. Therefore, the EU ETS should not be used as the sole basis for an assessment of methods for Norway to reach its climate commitments and investment in CCS full-scale deployment in particular.[8]

Due to a lack of incentive from the ETS to decarbonise, many countries have chosen to set an independent CO_2 tax or pricing mechanisms. Sweden, France, the Netherlands and the United Kingdom have supplemented the price of CO_2 to ensure their climate mitigation strategies render substantive results. Implicit or explicit carbon pricing throughout society that is far ahead of the ETS has become common practice in Europe: France has a floor price for transport and heating fuels of €44.6/tCO2[9], the UK floor price of £18/tCO2[10]has been added on top of the ETS price[11], the Dutch are looking to set a floor price of €18/tCO_2 in 2020 and Sweden has set the bar high with a tax of equivalent to €120/tCO_2 on fossil fuels as of 2018.

Overall, these policies imply that the ETS will not deliver the change in an economical way / or at all.[12] According to a study for the Nordic Council of Ministers, it remains to be seen whether the reform of the ETS will make it efficient enough to fulfil its purpose; hence, they suggest a Nordic floor carbon price to ensure stronger incentives in the region[13]. With such initiatives in the region, Norway should not stay behind and count on said reform, the effects of which are highly uncertain. Another example of the need for setting higher standards than the ETS CO_2 price is the shadow pricing for cars. According to the International Council of Clean Transport, to reach the target imposed on carmakers as of 2021 of 95grams/km, the CO_2 price would need to be set at approximately €370/tCO_2[14].

One does not need to look outside of Norway to see long run carbon pricing far in excess of the current ETS. The Norwegian offshore CO_2 tax applied to CO_2 emissions from the hydrocarbon production sector directly imposes carbon pricing on approximately 50% of Norwegian exports.[15] The offshore CO_2 tax has been in place for 27 years, being among the first in the world. Even this early CO_2 tax, the initial price of 210 NOK would still be higher than the existing ETS emissions allowance cost. The current CO2-tax level

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[6] https://www.scribd.com/document/371415321/IPCC-special-report-on-1-5C-draft-summary-for-policymakers?secret_password=xlexc6JWYfplQn1LVaDe#from_embed

[7] https://stopclimatechange.net/fileadmin/content/documents/O__ko-Institut_-_Vision_Scenario_2017_v3.pptx

[8] https://www.ssb.no/en/forskning/discussion-papers/the-impacts-of-the-eu-ets-on-norwegian-plants-environmental-and-economic-performance

[9] Reuters. 2018. https://www.reuters.com/article/us-france-budget-carbon/france-raises-carbon-taxes-to-repay-edf-renewables-debt-idUSKCN1C21DL

[10] Hirst, D. 2018. http://researchbriefings.parliament.uk/ResearchBriefing/Summary/SN05927

[11] Carbon Market Watch. 2018. https://carbonmarketwatch.org/2018/02/06/floor-prices-necessary-support-weak-carbon-market/

[12] Carbon Market Watch. 2018. https://carbonmarketwatch.org/2018/02/06/floor-prices-necessary-support-weak-carbon-market/

[13] Ollila and Skov-Spilling. 2017. http://norden.diva-portal.org/smash/get/diva2:1106010/FULLTEXT01.pdf

[14] Mock et al. 2014 https://www.theicct.org/sites/default/files/publications/ICCT_EU-ETS-perspective_20141204.pdf

[15] https://brage.bibsys.no/xmlui/bitstream/handle/11250/302267/masterthesis.pdf?sequence=1

for oil and gas production is 410 NOK, more the four times the current ETS price of €10.5. The offshore tax comes in addition to the EU ETS regulation, meaning that the oil and gas industry in Norway pays both CO_2-tax and EU ETS price.[16]

The Norwegian Ministry of climate and environment, the CO_2- tax is likely to have caused the separation and underground storage of the CO_2 content in the gas extracted at the Sleipner field since 1996. The operator of Sleipner, Statoil has estimated the operational cost of CO_2 storage at the site to be in the region of 54 MNOK per annum.[17] In its 22nd year of operation and continuing to store approximately 0.9 million tonnes of CO_2 per year the CO_2 storage project avoids offshore CO_2 tax & ETS liabilities in the region of 400 MNOK per year.[18]

When reviewing the expected cost of CO_2 pricing mechanisms, it is rational to look at the alternative for non-compliance with meeting CO_2 mitigation goals, i.e. the unavoidable cost of climate adaption. The UNEP has consistently revised upward the anticipated cost, rising to between $280 and $500 billion per year by 2050 in developing countries alone.[19] The national studies informing the analysis demonstrated that cost estimates rise strongly when a global warming scenario above 2°C is considered. It is highlighted that the adaptation cost for more sever warming scenarios could diverge as early as the 2030s. It follows that enhanced mitigation ambition and pre-2020 action is central for limiting adaptation costs.

EU countries work beyond ETS to secure tangible climate action

Sweden has adopted a goal of having net zero greenhouse gas emissions by 2045. In addition to industries such as steel, cement and refineries, Sweden also has an advanced industry for products and services such as biofuels, energy generation from biomass, and district heating from waste-to-energy plants. CO_2 capture could be applied to a number of these industries, and the CO_2 could easily be transported to a storage site on the Norwegian coast. When CO_2 is captured from biomass, e.g. in waste incinerators with high shares of biogenic CO_2, this would even allow for removal of carbon from the atmosphere. Crucially, Sweden has even set a 2030 goal of 63% GHG reduction for its industrial sector by 2030, a level which cannot be achieved in sectors such as e.g. cement production without CCS.

"Norway and Sweden are neighbours. It is therefore especially efficient and important to work together on such large-scale projects"
Elisabeth Undén, Gothenburg Environmental Party.

In **The Netherlands** following a landmark court case where NGO Urgenda successfully challenged the climate ambition of the Dutch Government,[20] recent elections in the Netherlands led to the new coalition government significantly increasing ambition on CO_2 targets. The coalition agreement established a new 49% CO_2 reduction target, in no small part set to be delivered through industrial CCS.

Whilst a new energy accord (policy) is currently under development, initial ambitions contained in the Dutch coalition agreement set out an ambition for 18 million tonnes of CO_2 stored per annum from industrial emitters, with a further 2 million tonnes per annum being stored from energy from waste facilities. The Port of Rotterdam is currently progressing with plans to develop a multi-emitter CCS cluster in the port region, which could alone see emissions reductions of up to 10 million tonnes a year. Building on a strong relationship between Fortum's Klemetsrud (Oslo) waste incinerator and similar Dutch operators, Bellona has been meeting with energy from waste facilities in the Netherlands, who also harbour ambitions to capture 800,000 tonnes of emissions reductions from CCS within the next few years. The sector recently made an announcement stating ambition in this space in late 2017.[21]

France also plans to invest into the development of industries compatible with both development and climate goals. According to president Emmanuel Macron, France will establish a €10 billion fund to bolster the development of the 'Industry of the Future'. These investments will ''support the industrial

[16] http://www.ssb.no/en/forskning/discussion-papers/_attachment/225118

[17] http://faculty.jsd.claremont.edu/emorhardt/159/pdfs/2006/Torp.pdf

[18] 0.9 MtCO2 *(Offshore tax of 410NOK/tCO2 + ETS of 101 NOK/tCO2) - Annual operational cost of 54 MNOK

[19] http://web.unep.org/adaptationgapreport/sites/unep.org.adaptationgapreport/files/documents/agr2016.pdf

[20] https://www.politico.eu/article/paris-climate-urgenda-courts-lawsuits-cop21/

[21] https://www.verenigingafvalbedrijven.nl/nieuws/nieuwsbericht/duurzame-route-voor-co2-afvangen-en-hergebruiken.html

transition and help in tackling the key challenges of the environmental transition"[22].

Germany has set a 55% emission reduction target for 2030, and an 80-95% target for 2050 compared to 1990 levels.[23] According to the BDI Climate Paths study, CCS will be essential for this.[24] Without it, at least 47Mt CO2 from industrial processes would remain unabated. Through CCS these and additional energy-related emissions can be reduced with total savings of 73Mt CO2e/year (p.153). Also, the German Academy of Science and Engineering (Acatech) is currently assessing the potential for industry CCS in Germany, with a report expected later in 2018.[25]

EU funding pots can aid the creation of new Norwegian offshore sector

EUROPEAN COMMISSION	DEPLOYMENT	European Energy Programme for Recovery (EERP) **~4 billion EUR** European Structural and Investment Fund **~454 billion EUR** ERA-NET Accelerating CCS Technologies (ACT) - Horizon 2020 (FP8) + ERA-NET ACT Research Fund for Coal and Steel Innovation Fund (NER 400) **~1-5 billion EUR** NER 300 (bridge) **~1 billion EUR** Connecting Europe Facility (Projects of Common Interest-PCIs) **~33 billion EUR**
	INNOVATION	Horizon 2020 (FP8) + ERA-NET ACT SET Plan (EERA, EII, KIC InnoEnergy)
EUROPEAN INVESTMENT BANK		Modernisation Fund **~1-4 billion EUR** European Fund for Strategic Investments **~21 billion EUR**

Table 2: EU funding for CCS projects (Bellona 2016)

By acting now, Norway will be well placed to benefit from a wide variety of EU funding opportunities for CCS projects. The European Commission's Communication to Leaders in February 2018 proposed a range of options, including doubling funding for the future Research and Innovation Framework Programme to €160 billion. Ahead of decisions on the future of the Multi-annual Financial Framework (MFF), Members of the European Parliament have called for an increase in the proportion of EU funds made available for climate finance from 20 to 30%, whilst the Green Growth Group of EU Member States has called for the remainder of the funds to be spent to help achieve the Paris Agreement, thereby greatly increasing prospects for CCS project funding.

Near-term funding opportunities for CCS projects also include the forthcoming ETS Innovation Fund, the successor to the much-maligned NER300 programme. The final amount of funding on offer under the Innovation Fund will be determined by the price of emissions allowances but with 450 million ETS allowances set to make up the Fund CCS, projects could be eligible for a share of upwards of €7.5 billion.

"The Innovation Fund, endowed with at least 450 million allowances. The fund will provide support to a wide range of innovative, commercial-scale, low-carbon technologies in the renewable energy, industry and CCS areas." Speech by EU Energy & Climate Action Commissioner Miguel Arias Cañete to the "Wirtschaftsrat" Berlin

Whilst the NER300 largely failed to deliver any project, there are encouraging signs that the Commission has learnt from the experiences of the NER300 programme and is set to develop a set of rules governing the Fund that yield significantly better prospects to both renewables and CCS project developers. The revised ETS Directive introduces new provisions to allow for a broader range of financial instruments to be used and could enable projects to receive a proportion of awarded funds as 'pre-financing' to support project development. The pre-financing provisions put in place by the Commission could allow CCS project developers to receive much more tailored support, specific to the unique challenges that CCS projects face. This could include funding for storage appraisal and development, funds for infrastructure development and potentially funding for part-chain CCS projects. The rules governing the Innovation Fund are set to be developed by the end of 2018. The progress of real-world projects in Norway will no doubt influence this decision process.

[22] Mesures. 2017. http://www.mesures.com/instrumentation/mesure-physique/item/14252-10-milliards-d-euros-pour-l-industrie-du-futur

[23] Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB), 2016, https://www.bmub.bund.de/fileadmin/Daten_BMU/Pools/Broschueren/klimaschutzplan_2050_en_bf.pdf

[24] BDI, 2018, Klimapfade fur Deutschland, https://bdi.eu/publikation/news/klimapfade-fuer-deutschland/

[25] Acatech, 2016, http://www.acatech.de/de/aktuelles-presse/presseinformationen-news/news-detail/artikel/aufruf-von-forschung-verbaenden-und-ngos-deutschland-braucht-eine-neue-debatte-ueber-ccu-und-ccs.html

Norwegian CO2 stores at the heart of European Projects of Common Interest

In addition to Research & Innovation Funding and the ETS Innovation Fund, the European Commission has also, for the first time, initiated opportunities for CO_2 transport Projects of Common Interest (PCIs) to access significant funds streams available for infrastructure development. The Connecting Europe Facility (CEF) is a €30 billion fund for boosting energy, transport, and digital infrastructure with a total budget of €5.35 billion for the 2014-2020 period. The goal is the development of key energy infrastructure projects including gas infrastructure & cross-border carbon dioxide transportation infrastructure.

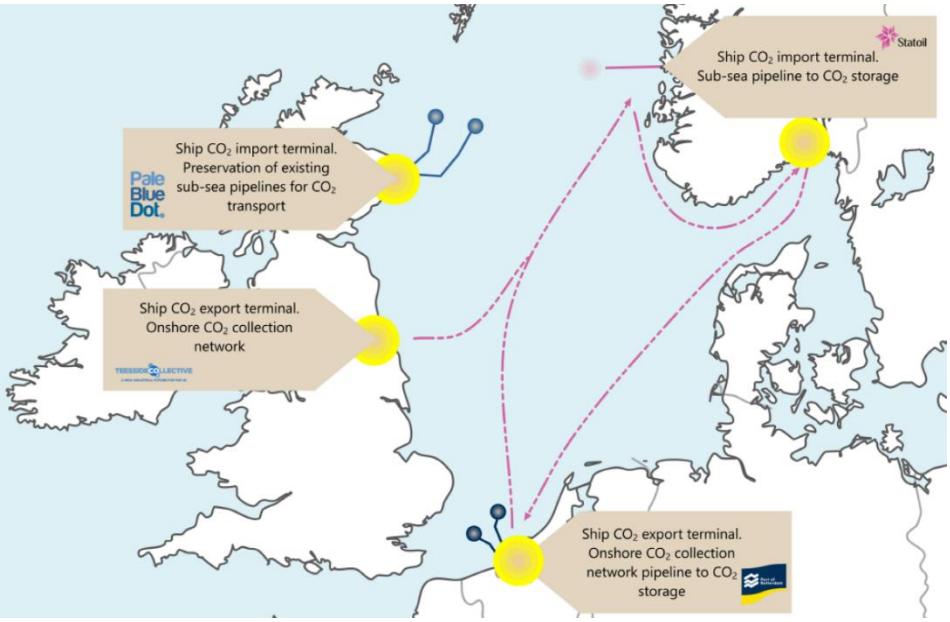

Figure 2: PCIs included on the list of eligible projects

In 2017, four CO_2 PCI projects were included on the list of eligible projects, with three of these directly linked or reliant on the anticipated Norwegian CO_2 storage (see map below). The PCIs have shown that when mature CO_2 storage is available the potential for linking to diverse CO_2 capture projects is greatly increased. The delivery of CCS in Norway can aid the unlocking of EU funds to link the North Sea in a CO_2 network, accelerating the development of the Norwegian CO_2 storage sector.[26]

Industrial regions drive new CCS projects in a new push prepare for CO_2 constrained world

Rotterdam CO_2 Network

Dutch CO_2 emissions are set to drop by 49 percent by 2030 under a new government coalition agreement. The Port of Rotterdam, hosting many energy-intensive industries is a nucleus of emissions in the country and not exempt from emissions reductions. Accelerating emissions reduction and increasing competitiveness at the port is set to include a suite of techniques and low-carbon infrastructure including regional heat network, a CO_2 transport and storage network, conversion of plastic waste into chemicals (waste-to-chemicals), bio-based fuels and chemistry. The energy and climate transition for the port will take time, but the planners are aware that the first requirement on that pathway is to start projects.

The required contribution of CCS is large, the goal by 2020 is for Rotterdam to store 2 million tonnes of CO_2, growing to at least 5 million tonnes a year by 2030. Efforts now focus on the development of strategic infrastructure to serve the port. The backbone CO_2 pipeline will provide the port access to offshore CO_2 storage and extra capacity to expand and scale over time. The port authority describes CO_2 transport as a service to attract new low carbon investment and retain emitters in a deeply decarbonising world. The CEO of the Port of Rotterdam Authority, Allard Castelein, aims to reduce the complexity and accelerate decarbonisation of companies at the port: "They have to deliver it at the gate, we do the rest".[27]

[26] https://ec.europa.eu/energy/en/consultations/consultation-list-proposed-projects-common-interest-cross-border-carbon-dioxide

[27] https://www.trouw.nl/groen/rotterdamse-haven-slaat-co2-op-in-zee~ab1e64f9/

Mr Castelein has clearly stated that companies who are not prepared to participate in the outlined low-carbon transition will soon have no place in the Port.[28]

The CO_2 transport and storage network will be delivered by a coalition of state backed companiesthat have an interest in the provision, planning and reuse of existing suitable infrastructure. The Port of Rotterdam leading overall coordinating development, EBN, the national offshore licensing authority will coordinate offshore CO_2 storage development and Gasunie the gas network operator will develop and expand CO_2 transport onshore.[29]

Rotterdam is also aware of its role as the gateway for emissions intensive region to North Sea storage, including Norwegian CO_2 storage. This can be achieved by beginning the development of CO_2 transport to the Rhine/Ruhr area of heavily industrialised North-Rhine Westphalia (NRW) in Germany, transporting captured CO_2 via the Rhine to the port of Rotterdam, and then to a storage site in the North Sea. According to Europipe[30], up to 35MtCO_2/year could be abated this way. German offshore storage potential is relatively small. Large-scale industry CCS in Germany is therefore dependent on the availability of storage in other exclusive economic zones in the North Sea, first and foremost in Norway and the UK (see map).

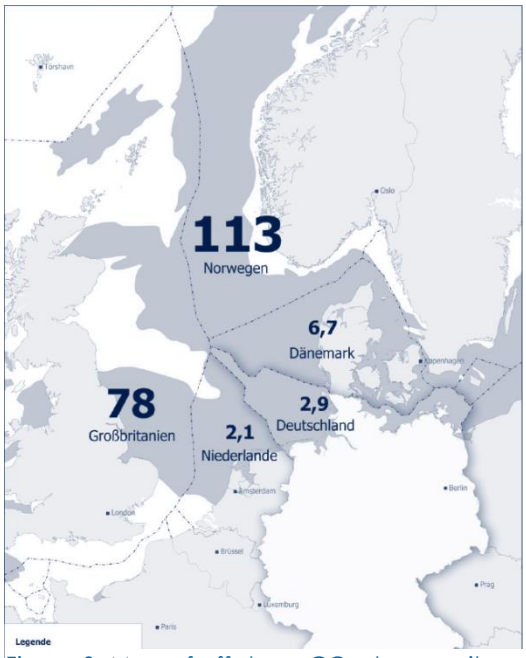

Figure 3: Map of off-shore CO_2 storage sites

Hydrogen: removing the CO_2 from fossil gas

Statoil, Vattenfall, the Swedish electricity generator and Gasunie, a European gas infrastructure company are pursuing Europe's first large scale low carbon hydrogen production in Eemshaven the Netherlands.

The Magnum project aims to remove climate damaging carbon from methane (natural gas), creating clean hydrogen.[31] The hydrogen will at first be used for zero carbon power generation and can grow over time as a flexible and powerful decarbonisation tool for industrial, companies and homes. The project would be the first-time Norwegian fossil exports would be consumed in a climate friendly manner, giving Norwegian export a pathway to relevance in the deeply decarbonised future. Upgrading Norwegian methane to hydrogen is also a strategy to insulate Norwegian gas exports from low cost competitors, creating a new higher value product reliant on CO_2 transport and storage for its production. Norwegian gas now has one of the highest production costs in the world. The production cost is over twice that of Russia, at around $1.04/MMBtu compared to Gazprom of just $0.40/MMBtu in 2015.[32]

The Magnum project envisions hydrogen production in the Netherlands with the CO_2 returning to the Norwegian CO_2 storage site currently under development. The project is an early example of the potential for accessible CO_2 storage sites to stimulate new commercial low carbon opportunities for the Norwegian economy.

CCS to aid deep emissions cuts and renewable integration in Ireland

Ervia, the Irish state-owned operator of water and gas infrastructure has proposed CO_2 capture from two gas-fired power plants in Cork Ireland with offshore CO_2 storage at the soon to be depleted Kinsale gas field.[33] Equivalent to Norway, Ireland has to date failed to cut CO_2 emissions in line with EU 2020 targets requiring a rapid acceleration in renewable deployment, renovation of the built environment,

[28] https://nltimes.nl/2017/03/23/rotterdam-port-looks-capture-co2-ambitious-emissions-reduction-plan

[29] https://www.duurzaambedrijfsleven.nl/industrie/25657/co2-van-rotterdamse-raffinaderij-en-chemie-opslaan-haalbaar

[30] Europipe, 2011, http://www.co2europipe.eu/Publications/D4.2.2%20-%20Making%20CO2%20transport%20feasible%20-%20the%20German%20case.pdf

[31] http://www.powerengineeringint.com/articles/2017/07/dutch-gas-power-plant-to-undergo-hydrogen-power-conversion.html

[32] http://www.platts.com/latest-news/natural-gas/london/analysis-doubts-stack-over-norways-gas-export-26390853

[33] http://www.powerengineeringint.com/articles/2017/10/cork-for-carbon-capture-and-storage.html

electricity interconnectors, electro mobility and coal phaseout. The CCS project will reuse existing gas transport networks for CO_2 transport and aims to provide low carbon electricity to compliment rapidly expanding but variable renewable wind generation. The combination of smart grids, widespread wind generation and low carbon dispatchable gas CCS generation would deeply decarbonise the Irish grid.

Nordic cooperation reliant on Norwegian CO_2 storage development

Sweden has set in law national carbon neutrality by 2045 and negative emissions after this.[34] Finland is on a similar path.[35] Swedish industrialists acknowledge that CCS is necessary for large-scale decarbonisation, and it provides pathways for carbon negativity through the usage of sustainable biomass. Due to the lack of a CCS infrastructure in Sweden, cooperation with Norway is essential. This has been highlighted at various seminars in Sweden and Norway in the past year.[36] In addition to other waste incinerators owned the Klemetsrud operator Fortum, one of the most advanced prospects is a pilot study for capture of CO_2 from the Preem refinery in Lysekil, Sweden, and the storage thereof on the Norwegian continental shelf.[37]

We cannot ignore CCS if we are to cope with the climate crisis. It's a major investment, but more countries can share the bill," Member of parliament for Nya Moderaterna and co-author of the Swedish climate framework, Johan Hultberg.

''**Because the Nordic countries are too small to deploy and finance the development and deployment of CCS on their own, Nordic cooperation on this is important. I believe that we in the Nordic countries, and I am then considering both private and public actors, have to come together and work to make large-scale CCS installations a reality**'' Johan Hultberg, Swedish Member of Parliament

A new approach to CCS in the UK

The UK's Clean Growth Strategy sets out an ambition to deploy CCS at scale by 2030; an ambition that has seen a resurgence of private sector interest underpinned by at least six large-scale projects (see Annex). The projects span a range of industrial sectors including decarbonised gas (a flagship investment for the Oil and Gas Climate Initiative, OGCI), clean hydrogen production for heating homes in Leeds, Manchester and Liverpool, and a range of industrial sectors in both Teesside and Grangemouth (Scotland).

Climate Minister, Claire Perry MP, has been clear that the pursuit of CCS is potential matter of economic opportunities available to the UK from taking a leadership position. The Minister has identified economic opportunities not just from the potential storage of CO_2 in the North Sea but also through the development of innovative CO_2 capture technologies and the future competitiveness of UK industry in a carbon-constrained economy.

Bellona has strong relationships with the CCS community in the UK, which has been unequivocal about the importance of the Norwegian CCS programme to future ambition and investment in CCS in the UK. Whilst the UK government sees great opportunities arising from investment in CCS, it faces the same political challenges associated with significant initial investment costs. In that sense, complimentary CCS policies in neighbouring countries (Norway and the Netherlands) have helped to create a more-positive political environment within which the UK has been able to reaffirm its interest in CCS. If Norway was to back-out of investing in full-scale CCS a second time, the international consequences – both from a reputation perspective but also from a climate perspective – will be very harmful.

Employment opportunities due to Norwegian North Sea CO2 storage

In Norway in 2014 there were around 330,000 employees in petroleum-related activities, of which 186,000 in direct petroleum related businesses (operators and manufacturers) and 143,000 in indirect petroleum related sectors. This corresponds to almost 13% of all residents employed in Norway[38]

The combination or a reduced oil price, high costs and poor exploration results are putting many oilfield service companies under financial pressure.

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34 http://www.regeringen.se/artiklar/2017/06/det-klimatpolitiska-ramverket/

35 https://yle.fi/uutiset/osasto/news/environment_minister_finland_carbon_neutral_by_2045/9469850

36 http://bellona.org/news/ccs/2017-06-annual-public-workshop-2017-starting-the-swedish-norwegian-dialogue-on-bio-ccs

37 https://www.sintef.no/preem-ccs

38 RIS Industribyggerne 2015 [Report]. - Oslo : Rapport IRIS - 2015/031, 2015.

From 2014 to 2016 more than 43,300 oil industry-related jobs were lost in Norway as a result of an industry downturn, a reduction of more than 20 percent[39]. In Norway a report by Menon Business Economics and DNV GL, estimates that potentially 200,000 full time oil and jobs were at risk to 2020.[40] The offshore supply and service sector has been disproportionally affected by diminishing activity in the North Sea. The precarious situation for the sector continues, with only 11 companies applied for new blocks in the Arctic Barents Sea, with majors including Chevron, ConocoPhillips, Exxon Mobil and Total absent from bidding.[41]

Past and current reduced investments in exploration and development brings increased focus to the long-term sustainability of North Sea hydrocarbon activities. Jonathan Stern, analyst at the Oxford Institute for Energy Studies, said "We [the OEIS] are very unconfident about Norway's production".[42]

CO_2 storage will require the characterisation of storage sites, the drilling of appraisal and injection wells, the emplacement of CO_2 platforms, subsea CO_2 handling, along with engineering, fabrication and logistics. CO_2 storage requires many of the same skills and infrastructure now underemployed on the Norwegian shelf or set to be decommissioned.

Bellona has estimated that by 2030, 22,000 fulltime North Sea jobs could be maintained by rapid investment in in CO_2 storage development.[43]

CO_2 transport and storage development providing a decarbonisation service to Europe allows for Norway to build upon its existing offshore industrial expertise and supply chain. Most importantly it allows for a long term sustainable pathway for professionals in the oil and gas sector to migrate to new offshore activities, retaining expertise while continuing to contribute to Norwegian welfare and exports.

CCS is an evolving technology – a first step is required to unleash innovation

Industrial innovation in CCS requires CO_2 transport and storage development to be underway. The presence of CO_2 infrastructure opens opportunities for the emerging production of low carbon industrial goods such as steel, cement and chemicals along with new potential for low carbon energy. The growth of shared CO_2 networks has the short-term advantage in lowering the cost of CO_2 transport and storage. Over the longer term, the availability of CO_2 networks allows for the deployment of more diverse CO_2 capture techniques and even entirely new ways of making products that rely on CO_2 transport and storage. The first required step is now being considered in Norway, a shared CO_2 network with three diverse industrial capture projects showcasing where CCS can dramatically reduce emissions and allow followers to join, innovate and reduce cost.

New technologies for steel production such as TATA Europe developed “HISARNA” reduce the complexity of steel production, avoid the need for coking and sinter plants, avoid fossil waste gases and produce a high purity low cost capture CO_2. In Liege, Belgium, HeidelbergCement and Calix are demonstrating a reinvention of cement manufacture. The new process does away with the need for additional CO_2 capture altogether, production high purity low cost CO_2 for transport along with low carbon cement. Areas served CO_2 transport and storage will have access to the lowest cost pathways to decarbonisation and increasing competitiveness in a low carbon world. Producing hydrogen from methane is a low-cost form of CCS, the hydrogen product has diverse uses allowing deep emissions cuts in hard to abate sectors such as industry and homes. The availability of access to Norwegian CO_2 storage will be the driving force and key stone for this industrial value chain.

39 https://shippingwatch.com/Offshore/article9305281.ece

40 Taraldsen Lars Sjokkrapport advarer: 200.000 årsverk kan gå tapt [Online] // tu.no. - Teknisk Ukeblad , 2015. - http:// www.tu.no/petroleum/2015/11/03/sjokkrapport-advar - er-200.000-arsverk-kan-ga-tapt.

41 https://www.rigzone.com/news/oil_companies_limiting_risk_offshore_norway-22-jan-2018-153216-article/

42 http://www.platts.com/latest-news/natural-gas/london/analysis-doubts-stack-over-norways-gas-export-26390853

43 http://bellona.org/publication/north-sea-to-the-rescue-the-commercial-and-industrial-opportunities-of-co2-storage-in-the-north-sea

Basis for making long-term functional rational decisions

Delaying the deployment of technologies that can contribute to large-scale climate change mitigation will make action overwhelmingly difficult further down the line. Climate change is an issue that knows no borders and will wait for no country to get its head out of the sand. It's a problem that needs to be dealt with urgently and not set aside by setting baselines that do not recognise just how limited our remaining carbon budget is.

The one-dimensional perspective of the EU ETS presented in the Atkins report provides a narrow view on the issue of CCS in Norway and Europe. It makes the claim that little or nothing has changed in this respect since the last assessment in 2016, disregarding all developments outlined above, as well as the importance of CCS for reaching Norway's own climate targets and the high cost further delay would incur for future generations.

How Norway should assess the value of CCS

Climate change is not a short-term challenge. To minimise cost and maximise impact, the Norwegian government must take a long-term approach when considering which climate technologies to employ to reach its decarbonisation goals.

In delivering CCS, Norway is in a unique position to:

- Shift its offshore expertise and compensate job decline in fossil industries by building a CO2 storage, capture and transport industry that is fit for the decarbonised future
- Create a scalable, regional impact by leveraging existing and planned EU initiatives and support schemes, which in turn will help create a new export market for Norwegian industry
- Reach its climate goals and avoid substantially larger costs for meeting targets at a later point
- Enable existing industrial production to remain in Norway and make Norwegian industrial clusters attractive for investments into new innovative development, which will aid the country in diversifying its economy

The ETS is largely irrelevant as a driver for decarbonisation of any sector

As reflected in the various developments around Europe outlined above, Norway's peers are moving to supplement the ETS in order to make their economies fit for the emerging low carbon world.

Unless Norway's government assumes that the commitments and sector-specific targets set by its neighbours are entirely disingenuous, those, and not the prevailing feeble emission allowance price, should be the basis for investment plans in CO_2 storage and transport infrastructure.

If Norway, as well as other European countries, lack the tools for deep decarbonisation, the EU ETS will only serve as a tool for deindustrialisation.

A decision not to provide CO_2 transport and storage is an implicit decision to refuse Norwegian industry a pathway to a sustainable future.

The Dutch plans for decarbonising its industry states one very clear example of pragmatic action to prevent a clash between welfare creating jobs and climate action from being the outcome.

Norway, as a major hydrocarbon exporter, has even more to lose than most if decarbonisation infrastructure is absent. If the Norwegian government intends to retain a market for its major export product in the future, it has no time to lose.

Increasingly, capital investors look to climate performance and risk as a key factor in long term investment portfolios.

Should Norway fail to act in its own long-term interest, the government has an obligation to be clear to its electorate about the detrimental consequences for Norwegian welfare creation, and to be honest about what this means for its climate commitment.

Annex

Proposed CCS Project in Europe 2018

Project	Promoter	Country	Category	Stage of development
Sleipner	Statoil	Norway	Offshore gas production	Operating
Snovhit	Statoil	Norway	LNG processing	Operating
Full Chain CCS	Gassnova	Norway	Cement / Ammonia / Waste to Energy	FEED (pending)
Teesside Collective	Teesside Collective	UK	Industrial Cluster	FEED (pending)
Caledonia Clean Energy Project	Summit Power	UK	Power	FEED (pending)
Leeds H21	Northern Gas Networks	UK	Hydrogen / Heating	Feasibility
Liverpool-Manchester CCS	Cadent	UK	Hydrogen / Heating	Feasibility
ACORN	Pale Blue Dot	UK	Gas processing	Feasibility
UK Clean Gas Project	Oil & Gas Climate Initiative	UK	Power	Feasibility
Cork CCS	Ervia	Ireland	Power	Feasibility
Rotterdam CCS	Port of Rotterdam	Netherlands	Industrial Cluster	Feasibility
Magnum	Vattenfall, Statoil	Netherlands	Power / Hydrogen	Feasibility
Bio-refinery CCS Project	INA	Croatia	Biorefining / CO2-EOR	Pre-feasibility

Proposed CCS EU Projects of Common Interest (PCI)

CO_2 Cross Border Transport Connections project Participants: Statoil, *The Teesside Collective (UK), Vattenfall Magnum Project (Netherlands)* Countries: Norway, Netherlands, UK CO_2 Transport Infrastructure: new infrastructure for CO_2 transport by ship CO_2 Source: Hydrogen production via SMR for power generation + Teesside industrial collective Anticipated Operational Start Date -
Rotterdam Nucleus Participants: Port of Rotterdam, *TNO, TAQA, Progressive Energy, Swift Exploration, VOPAK, ROAD CCS Project, OCAP* Countries: Netherlands, UK CO_2 Transport Infrastructure: CO_2 Pipeline transport infrastructure that will connect the Rotterdam Harbour to storage reservoirs in the Dutch and UK sections of the North Sea CO_2 Source: Rotterdam industrial CO_2 sources, including refining, biorefining, chemicals, hydrogen Anticipated Operational Start Date *2023*
Teesside CO_2 Hub Participants: Tees Valley Combined Authority, *German Government, Belgian Government and the Port of Rotterdam* Countries: UK, Netherlands, Belgium, Germany CO_2 Transport Infrastructure: Development of existing CO2 shipping terminal, new pipelines and new shipping CO_2 Source: Industries located at Teesside, including 0% of the UK's energy intensive industry, produces 50% of the UK's hydrogen Anticipated Operational Start Date: *2025*
CO_2 SAPLING Participants: Pale Blue Dot, *SCCS, Costain, Summit Power, Bellona, Radboud University* Countries: UK, Netherlands, Norway CO_2 Transport Infrastructure: Existing pipeline infrastructure re-use, new infrastructure for CO_2 transport by ship CO_2 Source: Natural Gas processing plant, extension to industrial CO_2 sources including refining Anticipated Operational Start Date: *2022*

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