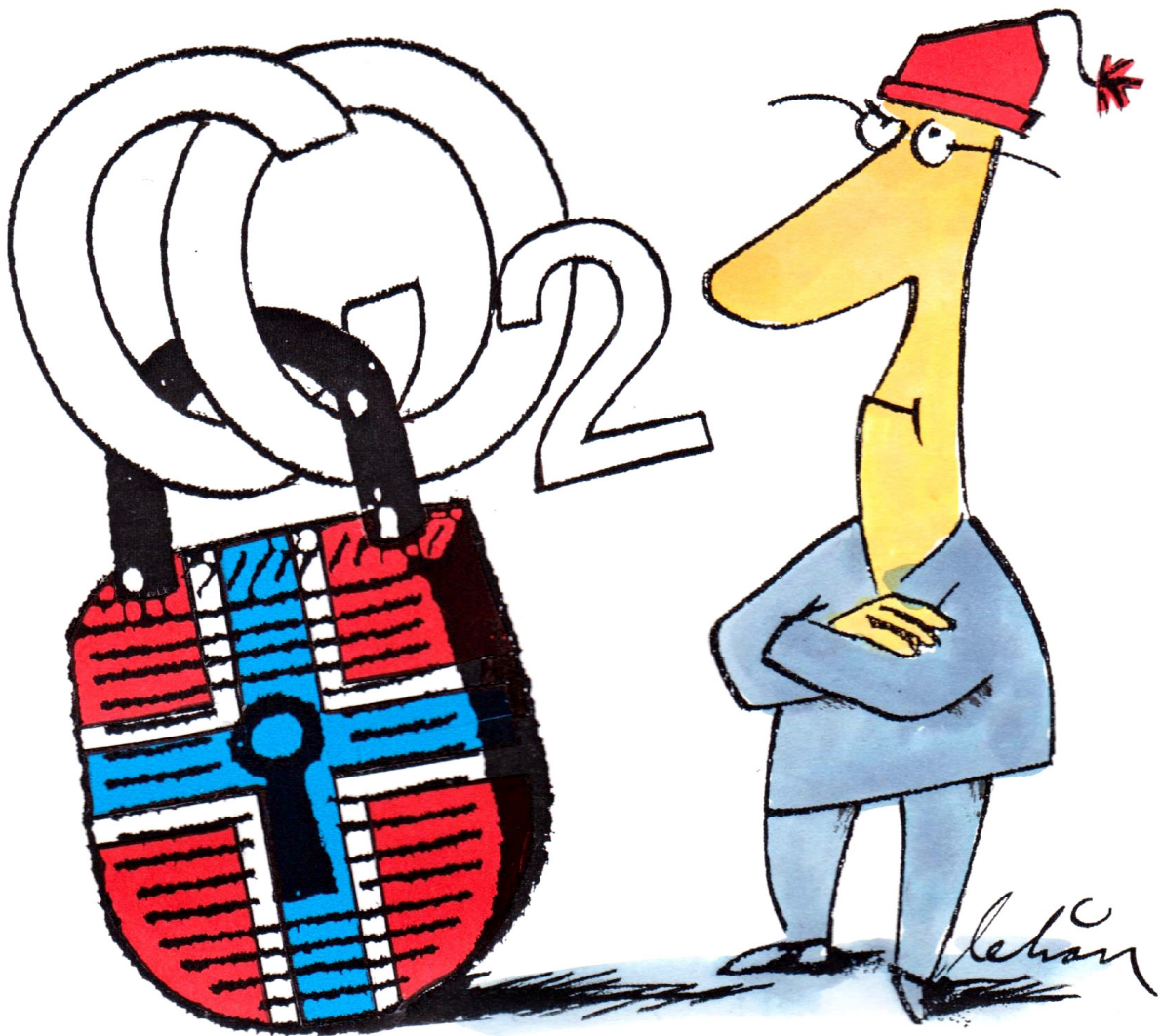


Carbon Capture and Storage in Norway

– The moon landing that failed

2nd Edition



AIR POLLUTION AND CLIMATE SERIES 33

Carbon Capture and Storage in Norway – The moon landing that failed

2nd Edition

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Executive Summary

The Norwegian interest in Carbon Capture Use and Storage – CCUS¹ – depends largely on the oil and gas sector. The assumed need for increased electricity generation based on natural gas from the 1990s onward has also been a strong driver. In the 1990s, oil companies operating in Norway began research and development. In 2005 the government took the lead. Prime minister Jens Stoltenberg announced the building of a full-scale CCS plant at Mongstad outside Bergen on the west coast of Norway in 2006, a project equivalent to the moon landing, in his own words. For a period the per capita investment in Carbon Capture and Storage (CCS) research and development was among the highest in the world. In 2013 the project to build a full-scale CCS plant at Mongstad in Norway was ended. Stoltenberg's government maintained that the calculated cost was too high to defend the project. The new government, led by Erna Solberg, has not reversed the decision. So far her government has shown more interest in contributing to CCS in Rotterdam in the Netherlands and in the Ukraine than starting the construction of a new CCS plant in Norway. Several test projects for the capture of CO₂ from industrial plants is under way. The oil producer Statoil has been given the task by the Norwegian government to investigate several possible sites for CO₂-storage in the North Sea. Earlier storage projects such as the Sleipner project has been hailed as successful examples of CO₂ storage. However, this project was started without any examination of the geological layers – caprock - over the CO₂ reservoir. According to the geology expert Professor Peter M. Haugan at the University of Bergen, Norway, it was only lucky coincidence that prevented a massive leak of CO₂ from the storage through deep rifts and numerous geological faults in the caprock . These were revealed by an EU-financed research project carried out many years after the pumping of CO₂ into the underground Utsira sandstone formation was begun in 1996. Finding suitable storage areas is a critical and under-communicated problem in the CCS-debate. According to Professor Haugan the search for safe CO₂-storage areas is expensive and may take anywhere from three years at the best and ten years at the longest .

Norway has many other options for reducing its CO₂ emissions, other than by CCS. Stopping further development of new oil fields is one, and particularly in the very vulnerable Arctic. Another option is reducing emissions from the transportation sector, which is otherwise going to expand. To the extent that CCS has overshadowed the other national mitigation potentials and reduced efforts in other sectors of the Norwegian economy, CCS may prove to have been a costly detour on the road to a climate-friendly Norway.

The Norwegian support for Carbon Capture and Storage – referred to from here on as CCS – may best be explained by pointing to Norway's status as the twelfth largest net exporter of oil in the world (2013). From around the

1 CCUS – Carbon Capture Use and Storage refers to both the use of captured CO₂ for different purposes, and the storage underground or by other means to prevent CO₂ in reaching the atmosphere. The Mongstad CCS project was designed for storage of CO₂ in underground geological formations out on the Continental Shelf.

mid-90s, the Norwegian oil industry was an initial driving force behind CCS in Norway. As the high cost of CCS became apparent, Statoil and the rest of the oil sector lobbied to persuade the government to shoulder the extra cost of CCS. They succeeded when the then prime minister, Jens Stoltenberg, pledged in 2006 to finance a full-scale CCS plant in Norway. He compared this project to the moon landing, and reaped much publicity and goodwill as a result of this pledge.

Statoil is by far the largest oil- and gas-producing company in Norway, and the Norwegian government has a 67 percent shareholding. Diminishing oil reserves and production in Norway reduce the future importance of Norwegian oil production as part of Statoil's total revenues. The oil and gas sector as a whole has a declining role in the Norwegian economy. This trend has been accelerated lately by a large fall in oil prices, from above 100 USD/barrel in 2014 to 30 USD/barrel in 2016. The assumed need for more electricity generation in Norway based on natural gas has also been greatly reduced since 2006, when preparations for CCS in connection with a gas-fired power plant started at Mongstad in Western Norway. All these factors have combined to reduce the importance of CCS in Norway. Both the oil industry and the government hoped in 2006 that CCS plants would become cheaper to build and operate as a result of new technology acquired from building a larger number of plants worldwide. Consequently, they would also be cheaper to build and operate in Norway. This was the explicit motivation for the moon-landing project of the Stoltenberg government.

The previous red-green (Social Democrat – Socialist Left – Centre/Agrarian) coalition government's great reliance on CCS in their climate mitigation plan was also the result of a political compromise at the time of the formation of the coalition. In 2005, the Social Democrats wanted to license two gas-fired power stations for general electricity supply. The Socialist Left party was against this because of the big increase in Norwegian CO₂ emissions that these plants would cause. A compromise was reached: the power stations could be built, provided that they were fitted with CCS as soon as this was technically and economically feasible. The compromise enabled the Socialist Left party to join the coalition government with a majority in parliament. CCS acted in this way as a "political glue". When the coalition left power in 2013, there was seemingly no more need for this "glue". The outgoing Stoltenberg government cleared the table for the new government by closing down the Mongstad CCS project, as one of its last decisions in power. The official reason for the decision was the high cost of building a full-scale CCS plant at Mongstad, with the likely result that it would not bring the average cost of CCS down. The wish to avoid criticism over the money spent on the unsuccessful project may also have been a contributing factor. But the criticism came anyway.

If you weigh the different Norwegian stakeholders and their relative interest in CCS against each other, between 2006 and 2013 the politicians in Norway probably had at least as great a need for CCS as the oil extraction business or the power sector, and maybe an even greater need. The red-green coalition

could not have achieved a government with a majority support in the Norwegian parliament without CCS.

The incoming conservative-populist government led by Erna Solberg upheld the decision to close the Mongstad CCS project. Officially the government's goal is to build a full-scale CCS plant before 2020. So far, it seems to be investigating possibilities for investing in CCS plants in other countries more eagerly. In 2014 the present government took two initiatives to help spread CCS technology to other countries. It has promised to finance part of the building of a CCS plant in one of the EU countries. Most likely, this will be a plant in Rotterdam in the Netherlands, but no final decision has been made for any project. The other initiative is to give economic support to a branch office of the Norwegian foundation Bellona, in Kiev, Ukraine, with the explicit purpose of assisting with the introduction of CCS in Ukraine.

A small pilot project to capture – and then release – CO₂ from a garbage incinerator in the capital Oslo has been started on 25 January 2016, and will run for 5 months. In the industrial hub around the cement industries in Brevik and the fertilizer production in Porsgrunn at the coast south-east of Oslo, possibility studies are being carried out. These studies are also supposed to be finished by 1 June 2016. A decision about which alternative to pursue in the future will be made in 2018. Incidentally, this will be made after the national elections in the same year. It is tempting to see this as an attempt by the government to postpone a possibly unpopular and/or expensive decision as long as possible.

In January 2015, the Norwegian government announced that it would seek to become a member of the EU Climate Bubble. Around 50 percent of Norwegian emissions already have to be covered by emission allowances from the ETS. Now, the Norwegian government wants to become a full participant in the EU climate reduction goals. If successful, this may possibly make it easier for Norway to take part in financing CCS plants in EU countries. It may also enable Norway to count the reduction in CO₂ emissions from CCS plants abroad as part of fulfilling the reductions targets under the EU Climate Bubble. The details in the agreement between Norway and the EU have not been concluded, as this has to wait until the EU has finished its own ETS (Emission Trading System) agreement in late 2016/early 2017.

There is a lack of critical debate about the shortcomings and unproven aspects of CCS technology in general in Norway. One reason is the lack of independent academic research into CCS technology. The Sleipner field in the North Sea has been hailed as an example of successful carbon capture and storage. This ignores the fact that the capture of CO₂ from the Sleipner field is not from a power station, but from natural gas extracted from underground. This is much easier than separating and capturing CO₂ from hot exhaust gases, and the methods cannot be directly compared.

A large research project has conducted extensive surveys of the Utsira sandstone formation, where the CO₂ from Sleipner has been stored. The researchers concluded that there were no signs of CO₂ leaking from storage.

Professor Peter M Haugan from the Geophysical Institute at the University of Bergen, Norway, says that this may be just a coincidence. No such research was conducted prior to the start of injection of CO₂ into the Utsira formation. The biggest crack that was found (up to 10 metres wide and 3 kilometres long) could well have been situated right above the injection site. His conclusion is that this proves the need for very expensive exploration of sites intended for storage of CO₂. Such exploration of potential CO₂ deposits might take anything between three years at best and up to 10 years in very difficult cases. There are no guarantees that these explorations will lead to a positive conclusion and declare that a specific site is safe for long term storage of CO₂.

The need for site specific investigations is also pointed out in a report about the possibilities for CO₂ storage in the British sector of the North Sea. The report underlines that it has estimated the probabilities and the rates of leakage based on the best available data and estimates. Even so, there are no absolute guarantees of permanent storage. The authors state that CO₂ from a storage facility in general is unlikely to leak because of the geological structures of the North Sea. However, the authors warn that there are site specific conditions that may cause a higher risk for leaks. One type of risk is boreholes with old oil- and natural gas wells. There are many different aspects of such old and unused wells that may cause a leak. One cause is the cement that has been used to seal old, unused wells. Under the influence of CO₂ mixed with saline water the cement may erode and start leaking. Another risk is geological faults and cracks. One must make sure that such faults do not extend all the way from the layer used to store CO₂ and up the seabed above. Even if this is not the case, fault-lines and cracks may be re-activated as a result of the injection of CO₂. A thorough examination of the cap layer for faults and old boreholes was not conducted before the Utsira formation was taken into use before the injection of CO₂ was started in 1996. It is highly possible that the use of the Utsira sandstone formation as a CO₂ storage facility would not have been allowed if the EU regulations for ensuring safe storage had been in place in 1996. This directive was finalized in 2009, which is a good 13 years after the CO₂ storage facility in the Utsira formation started its operation.

The Norwegian government announced in the beginning of January 2016 that it has given Statoil a contract of 35 mill NOK to look for suitable geological formations to store CO₂ underground on three different locations. The Utsira formation is one of these. The search shall be concluded by 1 June 2016. It is doubtful if it is possible to find a geological formation that is safe against CO₂-leakage in 5 months time, if one should follow professor Haugan's argument above.

Another reason for the lack of critical debate is that environmental organizations and the wider environmental movement in Norway have been divided on this issue. The environmental foundation Bellona has been the leading, permanent and very vocal advocate of CCS since 1996 in Norway and has also been active in the EU. Since the decision to stop the Mongstad project

in 2013, Bellona seems to be concentrating on the prospects for CCS in the EU countries. The environmental foundation Zero still has CCS high on its agenda. Environmental NGOs such as Friends of the Earth/Norges Naturvernforbund and Nature and Youth/Natur og Ungdom have supported Bellona to a varying degree in the past. They both demand in their policy papers that no gas-powered power plant should be built without CCS. Neither of them have CCS as a priority in their programmes for 2014. WWF Norway has been largely silent and does not have CCS as a priority, but it has CCS very low on a list of possible climate mitigation measures.

Two organizations, Greenpeace and Future in Our Hands (FIVH) have been openly critical. They still are, but in recent years both have also reduced their activities on CCS.

Economic and political motivations, combined with a lack of independent academic research and a partly positive and partly silent NGO community have all contributed to the present political commitment towards the use of CCS in Norway. The overall effect of this commitment has probably been negative for efforts to reduce GHG emissions in sectors other than oil and gas. In particular there is a lack of effort in the transport sector, where emissions are growing fastest. Emissions from the oil and gas sector are predicted to peak in 2020, after which they will be gradually reduced in the years to come, both in absolute and relative terms. This will happen even without the use of CCS, due to the rapid extraction and depletion of the Norwegian offshore oil reserves. The Norwegian oil production has diminished with 50 % since 2000, but has shown a slight increase during the last three years. The emissions from the existing oil- and gas fields in the longer term will continue to diminish anyway as the fields grow older and get depleted. A focus on CCS and emissions from the oil sector excluding other sectors with growing or stable emissions may therefore be a wrong priority.

The present government has opened several areas in the north for oil exploration. So far, very little oil has been found. There is no guarantee that the newly opened exploration blocks will lead to significant new, large finds of oil. All the same, further development of new offshore oilfields should be stopped. In this way, one can make sure that the oil- and gas resources remain in the ground and that there will no additional CO₂ emitted to the atmosphere from these fields. The Norwegian government's recent sales pitch to promote gas as a bridge to a sustainable energy system in the EU is therefore not in the best interest of the environment. Leaving oil and gas in the ground is best for the environment.

To the extent that CCS has overshadowed the other national mitigation potentials and reduced efforts in other sectors of the Norwegian economy, CCS may prove to have been a costly detour on the road to a climate-friendly Norway.

The Norwegian interest in CCS

The Norwegian support for Carbon Capture and Storage – referred to from here on as CCS – may best be explained by pointing to Norway's status as the twelfth largest net exporter of oil in the world (2013)², combined with an assumed need to use natural gas for electricity generation from the 1990s onward. From around the mid-90s, the Norwegian oil industry was the initial driving force behind CCS in Norway. As the high cost of CCS became apparent, Statoil and the rest of the oil sector lobbied to persuade the government to shoulder the extra cost of CCS. They succeeded when the then prime minister, Jens Stoltenberg, pledged in 2006 to finance a full-scale CCS plant in Norway. He compared this project to the moon landing, and reaped much publicity and goodwill as a result of this pledge.

Why is Norway investing heavily in CCS?

The coal industry and power generators in Germany and the United States were among the biggest and most important driving forces for CCS in their respective countries back in 2008, according to the Greenpeace report *False Hope*.³ These industries still play a significant role in the international debate in 2014. The coal extraction industry and the coal-based power producers want to prolong the useful lifetime of their respective resources and investments. However, they face increasing public and political pressure to reduce their emissions.⁴ International and national NGOs are for example co-operating in exposing the dangers and environmental problems caused by the coal industry, during extraction, transport and use for electricity generation worldwide. The aim is to put pressure on international financial institutions and banks to stop financing coal extraction and use.⁵ In this situation, CCS may seem to be a god-sent opportunity for coal producers and coal users to continue their present operations. Norway, on the other hand, does not have a big coal industry and no coal-fired electricity generation capacity connected to the grid. So the Norwegian support for CCS must have another explanation than the role of the coal industry or coal-based electricity generation in Norwegian society.

Hey, big spender!

Several questions arise when people from other countries look at the official Norwegian support of CCS as a climate mitigations option. One is connected to the fact that Norway has in the past been spending more on research and development of CCS per capita than many other nations. Norway, Canada and the Netherlands were among the top spenders relative to GDP

2 <http://www.eia.gov/countries/cab.cfm?fips=NO>

3 *False Hope. Why carbon capture and storage won't save the climate.* Greenpeace, May 2008

4 <http://www.smh.com.au/business/pressures-on-coal-show-no-signs-of-ending-20141228-12enrk.html#ixzz3NETWmMoj> Read 30.12.2014

5 <http://www.ran.org/banking-coal-undermining-our-climate> Read 30122014

in 2008.⁶ Why did the Norwegian government spend so much money per capita on CCS in the period up to 2008, when in comparison the US for example allocated far less relative to GDP to the same technology?⁷

The general aim of many R&D programs for capital-intensive technologies in Norway, including CCS, is to invest strategically in order to profit from cooperation with bigger nations. Norway has limited resources and therefore limited possibilities to finance very expensive technology research programs on their own. The goal is to get bigger nations to bear the brunt of the developing costs, and for Norway to participate enough to reap the benefits of a technological break-through. However, one may question if this strategy will work regarding CCS in light of the actual spending in other, bigger countries.

Research and development funding for CCS in the EU has also turned out to be far less than is probably needed, despite ambitions to build 12 large plants by 2015. This goal is definitely not going to be achieved. To date, no full-scale CCS plants have been built in the EU. The EU has supported six research projects through one programme, EEPR.⁸ Of these, three have been terminated. None of projects have led to a full-scale plant, and no decisions about building a full-scale version have been made so far. Another programme, NER 300, has financed another research project.⁹ In addition there are also national programmes, such as that in the UK. The British program to build a full-scale CCS plant has been cancelled because of the high cost.¹⁰ The EU has not succeeded in supporting the building of a single demonstration full-scale CCS plant so far.¹¹

The Norwegian programme needs to develop, in co-operation with the other, larger nations, CCS methods that can operate on a commercial basis within a timeframe that can give this technology a meaningful role. If development progresses too slowly it will not have much impact on emissions between now and 2050, when emissions of climate gases need to be reduced to zero if the world is to avoid catastrophic warming.

In 2006, the Norwegian government signalled an ambition to take the lead in the development of CCS, at least verbally. The prime minister, Jens Stoltenberg, started talking about establishing the first full-scale CCS plant

6 <http://www.cicero.uio.no/publications/detail.aspx?id=4078&lang=no#details> Read 15 April 2008

7 <http://www.cicero.uio.no/fulltext/index.aspx?id=3580&lang=no> Read 15 April 2008

8 http://ec.europa.eu/energy/eepr/projects/files/carbon-capture-and-storage/ccs-eepr-summary_en.pdf Read 30 December 2014

9 http://ec.europa.eu/clima/policies/lowcarbon/ner300/index_en.htm Read 30 December 2014

10 <http://www.theguardian.com/business/2016/jan/31/spending-watchdog-nao-george-osborne-carbon-capture-storage-scheme> Read 2 February 2016

11 <http://www.forskningradet.no/servlet/Satellite?c=Nyhet&pagename=climit%2FHovedsidemal&cid=1253998154912&lang=no> Read 30 December 2014

in Norway as the equivalent of the US landing on the moon.¹² Whether the actual funding and timeframe for the Norwegian development project was ever adequate to achieve this ambition is still an open question. Norway wants to be a big spender, but is Norway big enough? The project to build the only full-scale CCS plant in Norway was abandoned by the Stoltenberg government on the way out from office in 2013 because of the high cost. The new conservative-populist government of prime minister Solberg confirmed the ambition to build a full-scale CCS plant before 2020, but so far there has not been any concrete follow-up on this promise.

Big Oil, little coal

Statoil is by far the largest oil and gas producer in Norway, and the Norwegian government has a 67 percent shareholding. Diminishing oil reserves and oil production in Norway have reduced the importance of Norwegian production as part of Statoil's total revenues.¹³ The oil and gas sector as a whole has a declining role in the Norwegian economy. From 2014 to 2016 this trend has been accelerated by sharply falling oil prices. The assumed need for more electricity generation in Norway based on natural gas has also disappeared since 2006, when preparations for CCS started at Mongstad power plant in Western Norway. Norway is now on an average a net exporter of electricity, based on renewable hydropower.¹⁴

Kaarsto, one of the two gas-fired power stations that were built on the condition that they would later be equipped with CCS, was closed in 2014. The other power station, Mongstad, is working far below capacity.¹⁵ The hope in 2006 was that CCS plants might become cheaper to build and operate as a result of technical advances made as a result of the larger number of plants built worldwide. Consequently, they would also be cheaper to build and operate in Norway.

From the beginning of the debate in Norway, CCS was chiefly seen as a means of continuing to burn fossil fuels without emitting CO₂ into the atmosphere. But another assumed benefit of CCS is that CO₂ captured from power plants may be used to increase the pressure in oil fields and help extract more oil. This process is called Enhanced Oil Recovery or EOR for short. Falling costs for CCS technology could decrease the price for CO₂ and increase availability. This in turn may increase the use of captured CO₂ in EOR, and consequently help to prolong the oil extraction period in Norway.

12 http://www.regjeringen.no/nb/dep/smk/Statsministerens-kontor/Statsminister_Jens_Stoltenberg/Taler-og-artikler/2006/Rodgronn-manelanding.html?id=273361 Read 15 April 2008

13 In 2005, Norway was the 5th largest net oil exporter, in 2013: no. 12 in the world

14 <http://euanmearns.com/how-much-wind-and-solar-can-norways-reservoirs-balance/> Read 2 February 2016

15 <http://www.aftenposten.no/okonomi/innland/Taper-store-penger-pa-gasskraft-verk-6971753.html> Read 2 February 2016

There are other means of EOR than CO₂, but if CO₂ becomes cheaper than other methods, it will be used instead. This means that EOR can be used in oil fields that otherwise would be closed because of low profitability. The economic benefits from this may be huge. The climate effect may be increased net CO₂ emissions from Norwegian oil extraction, since EOR increases the production from oil wells and makes oil cheaper to buy.

The matching of CO₂ supply from onshore facilities with the demand for EOR, in particular from offshore oil fields in Norway, has turned out to be very difficult. The oil fields generally require more CO₂ than any single gas-fired power plant in Norway will be able to provide. For this and other reasons, the use of CO₂ for EOR has been rejected several times in connection with the development of oil fields in need of EOR.

Norway has almost no coal extraction, except on the Spitsbergen Island in the Arctic. This is a relatively small and heavily subsidized operation.¹⁶ Its continued existence is mainly a result of Norway's political and strategic need to maintain a physical presence in the resource-rich Arctic. The only coal-based electricity generation plant is also here, and supplies the mining settlement of Longyearbyen. The power station is not connected to the main Norwegian grid. The small Norwegian coal extraction (1.8 million tons in 2013)¹⁷ is therefore not an important motive for supporting R&D in CCS, and neither is the tiny power station on the Spitsbergen Island.

What Norway has, is a relative abundance of oil and gas from offshore fields in the North Sea and further north on the continental shelf beyond the coast. At the time of prime minister Stoltenberg's announcement about the Norwegian equivalent to a moon landing in 2006, Norway was the tenth biggest oil producer, but the fifth largest oil exporter in the world. By 2013, the situation had significantly changed. Norway is now the seventh largest oil producer¹⁸, but the twelfth largest exporter.¹⁹ The relatively high level of export is due to Norway's small population (5 million), and low domestic consumption. Norwegian oil production peaked in 2001 at 3.4 million barrels per day (bbl/d), and is now at 1.8 million bbl/d in 2013.

Almost all the natural gas that is not used internally in oil and gas extraction is also exported, most of it by pipeline to the EU countries. In 2006, Norway ranked as the third largest gas exporter, and the fifth largest gas producer in the world.²⁰ As of 2013, Norway is still the third largest natural gas exporter in the world. This means that the gas market, particularly in the EU, is increasingly important for Norway's future oil and gas economy. The recent push by the Norwegian government to ensure a role for natural gas in the

16 The coal mining operations is cutting down in 2014 due to low prices and reduced demand for coal on the world market. The mining company Store Norske is in deep trouble and struggling to survive, despite the subsidies.

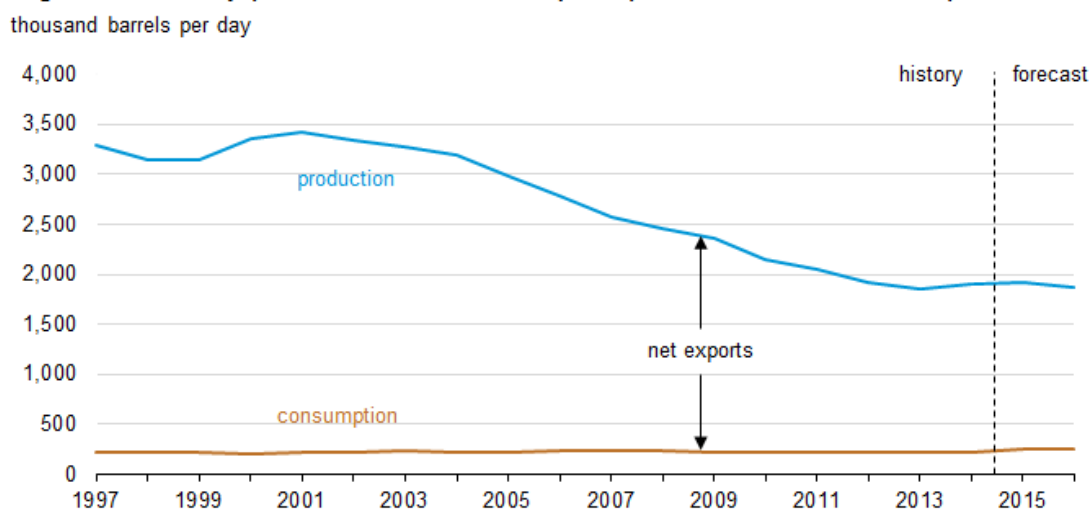
17 <http://www.snsk.no/annual-report-and-accounts.148181.en.html> Read 8 March 2015

18 <https://www.regjeringen.no/en/topics/energy/oil-and-gas/id1003/> Read 30 December 2014

19 <http://www.eia.gov/countries/cab.cfm?fips=NO> Read 10 December 2014

20 <http://en.wikipedia.org/wiki/Statoil> Read 30 December 2014

Figure 1. Norway petroleum and other liquids production and consumption



 Source: U.S. Energy Information Administration, *Short-Term Energy Outlook*, September 2015

future of the EU energy use is an expression of this importance. Combined with the fall in oil production, a drastic reduction in the oil price between 2014 and 2016 has added to the difficulties of the Norwegian oil industry. The oil price has fallen from more than 100 USD per barrel to around 30 USD per barrel.¹⁸ The fall in the oil price has already led to postponement of the development of several large oil fields, and severe cutbacks in manpower and investment in the oil sector. This also has implications for the tax revenue for the government, and there is a widespread belief that the Norwegian oil bonanza is over.

Statoil, which is government majority owned with 67 % of the shares, produce 60 percent of the total Norwegian oil and gas on the Norwegian continental shelf.²¹ The company is a result of a merger in 2007, when the oil- and gas company Statoil acquired the oil- and gas division of Norsk Hydro. Statoil is one of the world's largest vendors of oil, and a significant vendor of gas in the European market. The rest of the oil and gas from the Norwegian fields are produced by a number of foreign owned oil companies with comparatively small shares of the total production.

Statoil is a commercial operation, with the government acting as a regular majority shareholder on the board of the company. The government is exercising its political authority over the oil- and gas sector, including Statoil, through general taxation and environmental taxes, allocation of areas for oil extraction and other economic and administrative regulation of the oil- and gas companies' activities. This means that Statoil's business strategy is being decided within the company. The government seldom, if ever, tries to intervene as long as the money flows. On the other hand, there are obviously many links between the political system and Statoil. Similarly, there are many channels for informal consultations that can also influence the way CCS has become so important in Norwegian politics. This interplay is to some extent

²¹ <http://no.wikipedia.org/wiki/Statoil> Read 30 december 2014

described in the book “Gasskraft” by Andreas Tjernshaugen.²² For our purpose it is enough to say that Statoil and its predecessors, Statoil and Norsk Hydro’s oil- and gas division, has played a largely independent role in the debate about CCS, despite the fact that both Statoil and Hydro, and now the combined company Statoil, has had and still has the Norwegian government as their majority owner.

Cutting down, moving out

Since Norway is a big oil- and gas-exporting nation, it is natural to ask how important CCS is for the Norwegian oil- and gas industry. What role does CCS play in its strategies to meet the need for reduced CO₂ emissions? Statoil and Hydro did play an important part in the introduction of CCS into the Norwegian debate around 1995–1996. A big part of this interest was due to the possibility of building and operating gas-fired power plants for both domestic supply and for supplying their own onshore installations. Both the then separate companies Statoil and Norsk Hydro, clearly announced its interest by financing their own research programs and plans when CCS first entered the Norwegian debate. The interest was and is also caused by the need to secure a long-term market for their products. The industry’s enthusiasm gradually cooled when the high cost of CCS became clear as a result of the first research projects.

After that they lobbied the government to finance R&D for CCS and the oil companies also wanted that the government should cover the extra cost of building and operating CCS-plants and even take the responsibility for the transport and the safe storage of CO₂.²³ After a long and complicated political process the industry also achieved this goal. The Red-Green Stoltenberg government²⁴ pledged in 2005 that it would finance part of the extra cost of including CCS in the two gas fired power stations that were either running (Kaarsto) or in the process of construction (Mongstad). The permissions to build these power plants were given on the condition that they should be equipped with CCS-plants to reduce the emissions of CO₂ at a later stage. The decision was heavily criticized by the NGOs and the opposition, who demanded that the power plants should be equipped with CCS-plants from the start of operations. A government-financed company, Gassnova, was also started. Gassnova was given the operational responsibility for the capture, transport and storage of CO₂ from the power plants at Kaarsto and Mongstad. This entailed the responsibility for running the capture facility, building the pipelines to the reservoirs in the North Sea where the CO₂ is going to be stored, transporting the CO₂, injecting it and then monitor and ensure the safe storage of the CO₂. The Norwegian government also promised to finance the storage of the CO₂ captured from the first gas-fired power plants equipped with CCS.²⁵ These promises became part of a wider agreement in

22 Andreas Tjernshaugen: Gasskraft. Tjue års klimakamp. Pax Forlag, Oslo 2007.

23 Andreas Tjernshaugen: "Gasskraft," Pax Forlag, Oslo 2007 p 162

24 A coalition of the Labor Party, the Socialist Left Party and the Centre (Agrarian) parties.

25 <http://www.gassnova.no/wsp/gassnova/frontend.cgi?func=frontend.show&template=home&language=UK&lang=en&site=gassnova> Read 15 April 2008

the Norwegian parliament on Norwegian climate policy, signed by most of the political parties represented.²⁶ This agreement has also been respected by the government that took over in the autumn of 2013. As we shall see, the promises have been made obsolete by later developments, but the promises and the agreement became a cornerstone of Norwegian climate policy from 2005 to 2013. They therefore had a crucial influence on the government's efforts, or lack of efforts, to mitigate emissions domestically with other tools and measures than CCS.

A number of options exist for the reduction of CO₂ emissions in oil and gas extraction, processing and transportation that do not depend on CCS. The main reason why these other options are not implemented is the increased cost of oil extraction. The technological complexities of retrofitting existing oil production platforms, where space and time for retrofitting is very limited, make these options very costly. Shutting down production to install more energy-efficient electricity generation equipment, for example, would be costly if it is done on an individual platform. On the other hand, it is possible to supply platforms with electricity from land by cables. Separate platforms could also be set up that act as power stations for several production platforms in the vicinity. These options have not been fully exploited. It can be argued that even if the industry has actively explored the potential and cost of CCS in the initial stages of the debate, the debate has also reduced the pressure on the industry to implement policies other than CCS for CO₂ reduction.

Another plausible reason for the oil- and gas industry's gradual loss of enthusiasm is that emissions from the oil- and gas sector in Norway are expected to peak and then gradually diminish after 2020.²⁷ This is the base scenario, without any further instruments and measures being introduced to regulate the emissions. The scenario also assumes that there will be no new giant oil fields like the Ekofisk-field in the future. Nobody knows for sure what can be found in the Barents Sea, but 10-15 years of active exploration have so far not turned up any large finds.

The relative contribution of the oil and gas sector to national emissions grew considerably between 1990 and 2000 as the extraction of oil increased. The total emissions from the sector will decrease in absolute numbers from 2020 and in relative importance from now until 2050. After reaching a peak in 2001, oil production will be steadily reduced in the years to come, but gas production will be stable or increase.²⁸ Nevertheless, CO₂ from the increase in gas production is not expected to compensate for the decrease in CO₂ emissions from oil production. Norwegian oil production peaked in 2001 at 3.4 million barrels per day (bbl/d), and is now at 1.8 million bbl/d in 2013.

26 <https://www.regjeringen.no/nb/dokumenter/meld-st-21-2011-2012/id679374/?q=Karbonfangst&docId=STM201120120021000DDDEPIS&ch=1> Read 30 December 2014

27 <http://www.miljodirektoratet.no/Documents/publikasjoner/M287/M287.pdf> Read 30 December 2014

28 https://snl.no/Norsk_oljehistorie Read 30 December 2014

This is nearly a 50 percent reduction compared to the peak year.²⁹ This trend will continue, as the oil reserves are gradually depleted. More than 50 percent of the proven reserves have already been extracted, and few new, large fields have been discovered for a relatively long period of time. However, production from existing, old oilfields has shown a slight increase the recent three years. This is just a miniscule increase compared to the big decline since 2000³⁰.

Statoil is very intent on securing new resources both inside and outside Norway, as the prospects for oil production in Norway diminishes. Inside Norway, the oil industry, labor movement and politicians from many political parties are pushing hard for the opening up of new areas in the north of Norway. The present Conservative/Populist government has responded to this pressure, and has opened many new so-called blocks for oil exploration. This has been much criticized by the environmental organizations and a few political parties, for several reasons. One is that the Arctic and the areas outside northern Norway are some of the richest fishing grounds in the world, and very vulnerable to oil spills. The other argument is that the world cannot use all the available carbon resources if we should reach the 1,5 degree goal in the recently concluded Paris climate agreement. One cannot be sure that the new areas opened for exploration will lead to the discovery of new, big oil fields. The huge decrease in oil prices means that all exploration for new oil fields is being reduced to save money. Investment in oil production is also reduced. So the opening of new areas for exploration will probably not lead to a total increase in Norwegian oil production in the longer run. All the same, the areas should be left unexploited, the oil and gas should be left in the ground. Oil and gas that is not pumped up cannot be burned and therefore cannot add to the CO₂ in the atmosphere. The Norwegian government's sales pitch for gas as an intermediate fuel in the transition to a sustainable energy system in Europe is not in the best interest of the environment. Leaving oil and gas in the ground would be in the best interest of the environment

According to their website, the company is active in 30 countries all over the world.³¹ Statoil purchased around 2007 ownership in oil extraction from tar sand in Canada, for which it is heavily criticized.³² It is using its knowledge and expertise regarding off-shore oil-fields outside several African countries (Nigeria, Angola) and in Azerbaijan³³ by the Caspian Sea. Statoil has also secured a part in the development of a gas field in the Russian part of the Barents Sea.³⁴

29 <http://www.eia.gov/countries/cab.cfm?fips=NO> Read 10 December 2014

30 <https://www.eia.gov/todayinenergy/detail.cfm?id=23372> Read 2 February 2016

31 www.statoil.com/no/ Read 30 December 2014

32 <http://www.statoil.com/no/About/Worldwide/NorthAmerica/canada/OilSands/Pages/Statoil-InCanada.aspx> Read 30 december 2014

33 <http://www.statoilhydro.com/en/ouoperations/pages/default.aspx> Read 10 April 2008

34 <http://www.statoil.com/no/about/worldwide/russia/pages/default.aspx> Read 30 December 2014

The CO₂-emissions from Statoil's oil production outside Norwegian borders does not affect the national Norwegian emissions. Emissions are always counted in the country where the extraction takes place. The CO₂-emissions from its gradually decreasing Norwegian production is consequently of less importance than if it had continued to be a purely domestic operation. Statoil's motivation to press for the introduction of CCS in connection with the Norwegian oil production, at least in a short and medium term, is therefore probably less important than it was in 1995-1996. The use of CCS in connection with one or more natural gas based electricity generating stations was also probably the most important for Statoil and the other oil companies in the mid-90s. On the other hand, Statoil also has an interest in CCS for its continued extraction of oil and gas in the longer term, primarily as a means of Enhanced Oil Recovery, but also as a means of securing its long-term market for oil and gas. Without CCS, the use of Statoil's resources must be decreased and eventually phased out. Recently, it has also announce its interest in providing CO₂ storage facilities for parties outside Norway, based on their knowledge of the North Sea oil fields and geological structures.

CCS and the national mitigation plan

The Norwegian government's climate gas emissions mitigation plan has until now (2016) chiefly been used to buy emission credits from abroad, and to use CCS domestically to reduce GHG emissions. This plan was also accepted by the majority of the political parties in the parliament and laid down in the Climate Accord in 2008³⁵. The policy was continued by the new conservative-populist government of Erna Solberg that won the elections in autumn 2013. The lack of other strong domestic actions in the government mitigation plan is due to several factors. Emission credits from abroad and CCS reduce the need for unpopular domestic taxes and other limitations on CO₂ emissions. Due to Norway's huge surplus of cash from its oil and gas revenue, it is also very easy for Norway to buy all its emission credits.

The governing coalition of political parties in Norway in 2008 consisted of the Labour Party, the Socialist Left Party and the Centre (Agrarian) Party. The government declared its intention in 2007 to reduce emissions of GHG gases by 30 percent by 2020 compared to Norway's emissions in 1990, and to become carbon neutral by 2050. In 2008, Norway advanced the date for climate neutrality from 2050 to 2030 in a statement issued together with three other countries at the launch of a UNEP initiative.³⁶ The conservative-populist government that took over in autumn 2013 has not changed this pledge, as it became part of the wider agreement among the parties represented in the Norwegian Parliament in 2012. This policy was adopted in a declaration of most political parties in the Norwegian Parliament, the so-called Climate Accord.³⁷ As we shall see, this goal has been superseded by the Solberg

35 https://www.regjeringen.no/globalassets/upload/MD/Vedlegg/Klima/avtale_klimameldingen.pdf

36 <http://peopleandplanet.net/doc.php?id=3209> Read 15 April 2008

37 <https://www.regjeringen.no/nb/dokumenter/meld-st-21-2011-2012/id679374/?docId=STM-201120120021000DDDEPIS&ch=1&q=> Read 30 December 2014

government's adoption of the EU goal of 40 percent reduction by 2030 in January 2015, but it was the policy up till then.

The Stoltenberg pledge of 30 percent reduction by 2020 has in the past been held up by NGOs and others as an example for other countries to follow. So how did the previous and the present Norwegian government plan to fulfill their respective pledges? How big is the challenge, and in which sectors are the challenges most acute?

In 2009, Norway was 32nd on a list of the world's top carbon emitters, with 8.9 tonnes of CO₂ per capita, according to the latest available emission data. In comparison, the US has 17.2 tonnes per capita and the European Union 8.1 tonnes CO₂ per capita. China has 6.2 tonnes per capita.³⁸ The average emissions in many developing countries are so low that an automatic dishwasher in Europe is, for example, responsible for emitting as much carbon into the atmosphere in a year as three Ethiopians!³⁹

Where are the CO₂ reduction challenges in the Norwegian economy greatest?

The CO₂ reduction challenges in Norway can be read from a scenario produced in 2014.⁴⁰ As described above, emissions from Norway's oil and gas extraction are going to decline because of diminishing oil extraction.

In contrast to the stable or diminishing emissions in other sectors, the rapidly rising emissions from the transportation sector are a major challenge in a climate context. It will continue to increase up to 2030, and then level off in this projection. Car-ownership is widespread, the population fairly dispersed and even the bigger urban areas are relying heavily on private cars for transportation. Norwegians also fly 10 times more than other Europeans per capita. The emissions from different forms of transport are therefore expected to grow, both in total and in relative importance in the national total.

Emissions from the electricity generation sector are important in most other countries in a climate mitigation context. In Norway electricity generation in contrast does not offer great possibilities for emission reductions, since it is almost 100% renewable hydropower. When the gas-fired power plant at Kaarsto started commercial production on 14 December 2007,⁴¹ this renewable percentage was reduced to about 97 percent. The gas-fired power plant at Kaarsto could supply about 3 percent of Norwegian electricity or 3.5 TWh if it was generating at full capacity.⁴²

38 http://en.wikipedia.org/wiki/List_of_countries_by_carbon_dioxide_emissions_per_capita
Read 30 December 2014

39 Carbon Dioxide Emissions Accelerating Rapidly, Frances C. Moore, Earth Policy Institute
9 April 2008, read 10 April 2008

40 <http://www.miljodirektoratet.no/Documents/publikasjoner/M287/M287.pdf> Read 30 December 2014

41 http://www.naturkraft.no/default.asp?V_ITEM_ID=735 Read 15 April 2008

42 http://www.naturkraft.no/default.asp?V_ITEM_ID=725 Read 15 April 2008

However, the gas-fired power plant at Kaarsto was closed down in October 2014, because of poor profitability.⁴³ The power plant at Mongstad is generating electricity at far below its capacity.⁴⁴ This means that Norway still obtains almost 100 percent of its electricity needs in an average year from renewable hydropower or wind power, and exports electricity in most years. Most of the available, economically viable hydropower projects have already been developed. Public resistance against hydropower projects has increased because of the great environmental impact, to the point that it is difficult to get permits for large new projects. The domestic consumption of electricity has been stable since 1998, and Norway has had a net export of 3 TWh per year on average since the year 2000. This export share is likely to grow in the years to come because of a growing surplus of electricity. The grid operator, Statnett, plans to invest in new capacity in the grid to handle an additional production of 13.2 TWh, and to increase export capacity with new power lines to other countries. The increase comes on top of an average yearly production of around 127 TWh,⁴⁵ and a maximum yearly production of 147.9 TWh in 2012.⁴⁶ This production comes almost entirely from renewable energy sources, and again almost purely hydropower with a little fossil and wind in addition. The reason for the growth, according to Statnett, is the establishment of a Swedish-Norwegian common electricity certificate market. Climate change is also partly responsible: milder, wetter winters create a bigger surplus of electricity.

The development of renewable energy sources for electricity generation has turned the assumption behind the drive to build gas-fired power plants in the 1990s on its head. Back then, further increase in domestic electricity consumption or the export of electricity to other countries was expected to be mostly covered by sources other than hydropower. In this situation gas-fired power plants were the main option for significant increases in generation capacity. The industrial sector, including the oil companies, was also afraid that widely varying electricity generation from a system dominated by hydropower could cause spikes in the electricity price in dry and/or cold years. Thermal electricity generation plants were seen as a partial insurance against price spikes. Gas-fired power stations have consequently also been central to the Norwegian climate debate for the last 20 years. Today, the Kaarsto power station has been closed down because of big losses, and the power station at Mongstad is running below its capacity. The low profitability of natural gas fired power stations in Norway is due to two factors: a high market price for gas, and low prices for electricity, due to the market surplus. It is worth

43 <http://www.tu.no/kraft/2014/10/03/taper-100-millioner-i-aret---na-stenges-kaarsto-kraftverket> Read 30 December 2014

44 <http://www.aftenposten.no/okonomi/innland/Taper-store-penger-pa-gasskraftverk-6971753.html> Read 2 February 2016

45 https://www.regjeringen.no/globalassets/upload/oed/faktaheftet/fakta_energi_og_vannressurs.pdf Read 31 December 2014

46 <http://lab.redhost.no/statnett/nup-2013/files/assets/common/downloads/publication.pdf> Read 31 December 2014

noting that there are several gas-fired power stations in Norway that are not connected to the grid, but only supply oil and gas terminals for processing on land. These power stations have only occasionally caused debate and protests. The main focus has been on those connected to the national grid and intended as a source of supply for all sectors, except the oil and gas sector.

The Norwegian Climate Mitigation plan – little domestic action

The scenario for the development of Norwegian emissions described above has also been part of the background for the mitigation policies envisioned by the government white paper⁴⁷ from 2012. The Norwegian environmental NGOs have for years been fairly unified in their demand for stronger policies for domestic reductions than the government proposed in its mitigation plan. Norges Naturvernforbund/Friends of the Earth Norway has been particularly vocal in this demand.⁴⁸ One of the main weaknesses of the government mitigation plan from the NGOs point of view is the lack of strong domestic measures to meet the projected increase in the transportation sector. The many plans for new infrastructure (roads, airports) in the transportation sector will most certainly contribute to more emissions. The climate mitigation plan lacks the instruments that can integrate policies on road construction, building of airports and other infrastructure into the plan. Criticism has also been directed at the lack of action in all the other sectors, where there are obvious and well-documented actions that could be taken. A report prepared for the government by the Norwegian Environment Agency in 2014 lists a large number of such policies and measures that could bring Norway's GHG emissions down and fulfill Norway's Kyoto obligations through chiefly domestic action.⁴⁹

Given the lack of strong domestic action to fulfill Norway's Kyoto obligations, the Stoltenberg government's pledge to become carbon neutral in 2030 seemed to be difficult to fulfill. The Solberg government's pledge of 40 percent reduction by 2030 likewise does not specify how it will be achieved. Both before and after the conclusion of the Kyoto Protocol negotiations in 2001, different governments have also refused to set a limit on how much of its obligations Norway should reach by using the so-called flexible mechanisms: Emission Trading, Joint Implementation and the Clean Development Mechanism – CDM. Environmental organizations have been fairly united in their demand that Norway should do as much as possible by domestic implementation and at least 50 percent domestically⁵⁰. The governments, both

47 <https://www.regjeringen.no/contentassets/aa70cfe177d2433192570893d72b117a/nofdfs/stm201120120021000dddpdfs.pdf> Read 30 December 2014

48 http://naturvernforbundet.no/klima/norsk_klimapolitikk/alt-om-klimameldingen-og-klimaforliket-article26633-131.html Read 31 December 2014

49 <http://www.miljodirektoratet.no/no/Publikasjoner/2014/Desember-2014/Knowledge-base-for-low-carbon-transition-in-Norway/> Read 30 December 2014

50 <http://www.forumfor.no/ressurser/politiske-innspill/innspill-til-cop20-rapporten> Read 8 March 2015

past and the present, on their side have insisted that Norway should only do domestically what is cheaper to do in Norway than by buying emission credits from the flexible mechanisms.

Norway can now reap the benefits of efforts during the negotiations for the Kyoto Protocol to get flexible mechanisms included in the Kyoto Protocol. The peculiar Norwegian circumstance in this respect is that buying emission credits from other countries is also easier to do for Norway than almost all other countries. Norway has an income from oil and gas extraction that is far in excess of what can be spent domestically without creating serious inflation. The surplus revenue is invested in stocks and property abroad through what is called the Norwegian Pension Fund Abroad – SPU (Statens Pensjonsfond Utland). When the oil and gas are gone, the interest from the investments will in the future pay for Norwegian pensions and other material welfare benefits. The Pension Fund has already amassed a fortune of 4,570 billion NOK or around 630 billion euro, and is still growing.⁵¹ This means that Norway can pay for a huge amount of emission credits abroad, without having to divert money from other purposes in the present government budgets. A whole year's emissions in Norway are around 54 million tons of CO₂-equivalents today⁵². At a price of around 7 euro per ton of carbon⁵³, it would in theory cost maybe 103 million euro or 890 million NOK to cover this by buying emission credits from abroad.¹ In practice, it would probably not be possible for Norway to buy enough emission credits through the EU ETS to cover all its emissions. There are limits imposed on how much of its reduction commitment a nation that is part of the EU emissions “bubble” can cover by buying emission allowances. But, in theory, Norway could become “carbon neutral” TODAY, using a relatively small part of its economic surplus from oil and gas extraction! Financially, there is no need to wait until 2030 for Norway to do so, since it would require less than some week's growth of the Norwegian Pension Fund Abroad!⁵⁴

The history of CCS in Norway

The decision to build a full-scale CCS plant at Mongstad was made in December 2007 by the Stoltenberg government, and the decision to stop the project was made in September 2013 by the same government. The incoming conservative-populist Solberg government upheld the decision to close the Mongstad CCS project when it came into power. Officially the Solberg government's goal is still a full-scale CCS plant before 2020. So far, it seems to be investigating possibilities for investing in CCS plants in other countries more eagerly. In 2014 the present government took two initiatives to help

51 <https://www.regjeringen.no/nb/tema/okonomi-og-budsjett/statens-pensjonsfond/statens-pensjonsfond-utland-spu1/markedsverdi/id696852/> Read 8 March 2015

52 <http://www.ssb.no/klimagassn> Read 8 March 2015

53 <https://euobserver.com/environment/127481> Read 8 March 2015

54 <http://framtiden.no/200705042032/pressemeldinger/klima/klima-handling-na.html> Read 15 April 2008

spread CCS technology to other countries. It has promised to finance part of the building of a CCS plant in one of the EU countries. Most likely, this will be a plant in Rotterdam in the Netherlands. The other initiative is to give economic support to a branch office of the Norwegian foundation Bellona in Kiev, in Ukraine, with the explicit purpose of assisting with the introduction of CCS in Ukraine.

A small pilot project to capture – and then release – CO₂ from a garbage incinerator in the capital Oslo has been started on 25 January 2016, and will run for 5 months. In the industrial hub around the cement industries in Brevik and the fertilizer production in Porsgrunn at the coast south-east of Oslo, possibility studies are being carried out. These studies are also supposed to be finished by 1 June 2016. A decision about which alternative to pursue in the future will be made in 2018. Incidentally, this will be made after the national elections in the same year. It is tempting to see this as an attempt by the government to postpone a possibly unpopular and/or expensive decision as long as possible.

In January 2015 the Norwegian government announced that it would seek to become a member of the EU Climate Bubble. Around 50 percent of Norwegian emissions already have to be covered by emission allowances from the ETS. Now, the Norwegian government wants to become a full participant in the EU climate reduction goals. Negotiations are under way between Norway and the EU. If successful, this may possibly make it easier for Norway to take part in financing CCS plants in EU countries. It may also enable Norway to count the reduction in CO₂ emissions from CCS plants abroad as part of fulfilling the reductions targets under the EU Climate Bubble. The details in the agreement between Norway and the EU have not been concluded, as this has to wait until the EU has finished its own ETS (Emission Trading System) agreement in late 2016/early 2017.

The previous Stoltenberg government's pledge to introduce a full-scale CCS plant at one gas-fired power station for general supply has been a hot issue for many years in Norway. After many rounds of what the supporters of CCS looked upon as broken promises, the government finally said on 18 December 2007 that the planned gas-fired power plant at Mongstad would be equipped with a CCS plant to remove CO₂ from the exhaust gases, but not from the start of its operation. Several test plants would be built first, in order to test different technologies for the removal of CO₂ from the flue gases. The decision to build a full-scale CCS plant at Mongstad would be made after analyzing the results from the test plants. The investment decision was again postponed several times, until the outgoing red-green government finally abandoned the project to build a full-scale CCS plant in September 2013.⁵⁵

Then, on 3 October 2013, the owners of the gas-fired power plant at Kaarsto decided to close the power station because of poor profitability.⁵⁶ The power

55 <http://www.bloomberg.com/news/2013-09-20/norway-drops-moon-landing-as-mongstad-carbon-capture-scrapped.html> Read 31 December 2014

56 <http://www.aftenposten.no/okonomi/innland/Taper-store-penger-pa-gasskraft-verk-6971753.html> Read 31 December 2014

station at Mongstad is also running below capacity and with no increase in the foreseeable future. This made the power station at Mongstad less attractive as a CO₂ source for a CCS plant, because the fixed investment would be the same, but the cost per unit of CO₂ removed would be much greater. Suddenly, Norway was without two of the most relevant gas-fired power stations for testing the viability of a full-scale CCS plant.

The incoming conservative-populist Solberg government upheld the decision made by the previous government regarding the Mongstad project. Officially its goal is a full-scale CCS plant before 2020.⁵⁷ So far, it seems to be investigating possibilities for investing in CCS plants in other countries more eagerly. In 2014 the present government has taken two initiatives to help spread CCS technology to other countries. It has promised to finance part of the building of a CCS plant in one of the EU countries. Most likely, this will be a plant in Rotterdam in the Netherlands. The other initiative is to give economic support to a branch office of the Norwegian foundation Bellona in Kiev, in Ukraine, with the explicit purpose of assisting with the introduction of CCS in Ukraine.⁵⁸ This last decision caused a critical reaction from an NGO in Ukraine, which stated that the ailing and very polluting coal-based power stations and industrial plants in Ukraine should be closed down, and not given a prolonged existence based on the promise of CCS.⁵⁹

The decision to close the Mongstad CCS project was widely criticized by the opposition in the Norwegian parliament, mainly because of what was seen as a waste of money. It was also criticized by those in favour of CCS, mainly because it meant abandoning the CCS project. A public hearing about the decision was held in parliament in February 2014. At the hearing, former prime minister Jens Stoltenberg and the former minister of oil and energy, Ola Borthen Moe, defended the decision by stating that building a full-scale CCS plant at Mongstad would be very expensive, and that it would not lead to the necessary reduction of construction costs that was necessary in order to promote CCS in other countries. Two environmental foundations, Bellona and Zero, criticized the decision to build test plants first, and said that if the government had decided to use tested technology, e.g. amine-based scrubbing, a full-scale CCS plant could already have been operational. Representatives for some industrial suppliers of other technologies said the same, but regarding their own technologies. The researchers and experts more or less agreed with the strategy of testing many different technologies in order to find one with a promise of reduced costs.

CCS is one part of the Norwegian government plan to fulfill its Kyoto obligations, and in a longer timeframe, become carbon neutral. This goes a long way towards explaining the present strong Norwegian interest in CCS.

57 <https://www.regjeringen.no/nb/tema/energi/CO2-handtering/Regjeringa-sin-strategi-for-CO2-handtering/id765961/> Read 31 December 2014

58 <http://bellona.no/nyheter/internasjonalt/2014-11-bellona-etablerer-seg-ukraina> Read 31 December 2014

59 <http://www.energypost.eu/ukraines-coal-power-plants-need-planned-phase-ccs/> Read 17 December 2014

It has long been an established government policy to find cost-effective ways of climate mitigation, e.g. ways of meeting Norway's obligations in the cheapest possible way. Whether CCS fits this description is debatable, to say the least, when you look at the challenges ahead. The government is on the other hand counting on a strong reduction in cost per ton of CO₂ avoided in the future through CCS. Even if this hope is not fulfilled, the Norwegian government also has the option of buying emission credits to cover its needs. It could be said that the Norwegian government will win either way, at least in the first commitment period. However, as many commentators have pointed out, including the NGOs, this lack of urgency in reducing emissions may now turn out to be negative in the next commitment period, when the necessary cuts will be bigger and the cost of emission credits will be higher.

The Norwegian prime minister, Mr. Jens Stoltenberg caused a media storm when he claimed that building a full-scale CCS plant in Norway should be the Norwegian equivalent to a moon landing.⁶⁰ Afterwards, the conflicting messages about how this should be achieved in reality caused many sarcastic comments from the political opposition and in the media. The level of explicit ambition also made the red-green government more vulnerable to criticism. In the Norwegian and foreign media the decision to close down the CCS project at Mongstad attracted headlines such as "The moon landing has crashed". The obvious result was that any Norwegian government in the future will be careful to avoid a similar announcement.

The fact that Norway is uniquely able to buy whatever climate certificates it needs to become carbon neutral, and without any hardship or sacrifice for the Norwegian population is likely to cause envy and condemnation. A super-rich nation that can buy itself out of the need to reduce its domestic emissions is not very admirable. It is far better for the Norwegian reputation abroad if the country can contribute to a technical solution available for use by anyone. At the same time Norway could create a technology that can be exported with profit, if it was developed in Norway, that is!

Any government in Norway is most likely trying to avoid politically costly implementation measures in Norway such as higher gasoline taxes and taxes on airfares, restrictions on private car use etc. Any government, whatever country, wants to stay in power. Any democratically elected government that introduces tough domestic climate action measures will probably lose power as many voters will vote for other parties in the next elections. This is a sad and a universally acknowledged fact.

In the government budget for 2016, a flight tax of 88 NOK or about 9 Euro⁶¹ was introduced. This might be a significant turning-point and a new direction for the government's efforts to curb the growth of CO₂-emissions.⁶²

60 http://www.regjeringen.no/nb/dep/smk/Statsministerens-kontor/Statsminister_Jens_Stoltenberg/Taler-og-artikler/2006/Rodgronn-manelanding.html?id=273361 Read 15 April 2008

61 Exchange rate per 2 February 2016

62 <http://www.ch-aviation.com/portal/news/42836-airlines-warn-of-repercussions-over-norways-new-flight-tax> Read 2 February 2016

Airlines have been very critical, some have suspended flights, and a private airport near the capital Oslo has warned about having to close down. Norwegians fly 10 times more than the EU-average. Hopefully the tax will reduce this rate, and bring down the CO₂ emissions from the air traffic.

CCS played a prominent role in the former red-green government's pledge for Norway to become carbon neutral by 2050. The change in government in 2013 would in itself not have led to less dependence on CCS in the national climate mitigation policies. Most of the political parties represented in the Norwegian parliament reached a climate accord in 2007 that took a generally positive attitude towards CCS.⁶³ This attitude has been upheld in later revisions. It also colours the official Norwegian opinion of the EU Energy Union. In a statement with a preliminary Norwegian view on the EU Energy Union, the Solberg government upholds its view that CCS must play an important role in the EU.⁶⁴ However, the role of CCS was changed dramatically in Norwegian domestic politics, when the outgoing red-green government closed the Mongstad CCS project in autumn 2013. After September 2013, the focus on CCS in Norway has definitely been reduced. After close to 20 years of debate about gas-fired power plants, and 17 years of debate about using CCS to manage emissions from the same power plants, both themes have suddenly become significantly less relevant in the political debate in Norway.

There are signals about a possible new effort by the Norwegian government to establish CCS in Norway before 2020. A small-scale pilot project to capture – and then release – CO₂ from a garbage incinerator in the capital Oslo has been started on 25 January 2016, and will run for 5 months. In the industrial hub around the cement industries in Brevik and the fertilizer production in Porsgrunn at the coast south-east of Oslo, pre-feasibility studies have been carried out, and further studies are taking place. These studies are also supposed to be finished by 1 June 2016. At the cement plant of Norcem in Breivik, several technologies have been tested, and will be continued until 1 June 2016. At the fertilizer plant of Yara in Porsgrunn, there are also studies going on.⁶⁵ The key-words here are “pilot project”, “testing”, “small-scale” and “feasibility studies”. NO decision has been made by the government to start work on a full-scale CCS plant in Norway, and nothing so far indicates that a decision is near. According to the minister for oil- and energy in Norway, Mr. Tord Lien, the results of these studies and test projects will then be evaluated. A decision about which alternatives to pursue further will be made after the national elections in 2018.⁶⁶

Bellona, a Norwegian organization that has been a steady supporter of CCS since the beginning of the debate in Norway, is very critical towards the

63 <http://www.stortinget.no/diverse/klimaforlik.html> Read 14 April 2008

64 https://www.regjeringen.no/contentassets/6915351e4720471c9a53658105526cac/non-paper-on-energy-union_norway.pdf Read 10 March 2015

65 <https://www.regjeringen.no/en/aktuelt/ccs-pre-feasibility-study-on-potential-full-scale-projects-in-norway-delivered/id2410129/> Read 2 February 2016

66 Dagsavisen, 10 February 2016.

present government's CCS-policy. According to Bellona⁶⁷, an investment decision for a full-scale CCS plant must be made now, in 2016, if it should be up and running by 2020. The government's official goal of a full-scale CCS plant by 2020 will therefore not be reached, according to Bellona. The government has promised to finance a full-scale CCS plant before 2020, not specifically in Norway. But with the development of CCS plants in the European Union also progressing at a snail's pace, Bellona is probably right that the government's promise will not be fulfilled by 2020.

In January 2015 the Norwegian government announced that Norway would negotiate with the European Union to become full member of the EU Climate Bubble. Around 50 percent of Norwegian emissions already have to be covered by emission allowances from the ETS. Now, the Norwegian government wants to become a full participant in the EU climate reduction goals.⁶⁸ If successful, this may possibly make it easier for Norway to take part in financing CCS plants in EU countries. It may also enable Norway to count the reduction in CO₂ emissions from CCS plants abroad as part of fulfilling the reductions targets under the EU Climate Bubble. The details in the agreement between Norway and the EU have not been concluded, as this has to wait until the EU has finished its own ETS (Emission Trading System) agreement in late 2016/early 2017.

If you weigh the different Norwegian stakeholders and their relative interest in CCS against each other, politicians in Norway between 2007 and 2013 probably had at least as great a need for CCS as the oil extraction business, and maybe greater. The "naturally" declining emissions caused by reduced domestic oil production and the gradual shift of Statoil's operations to other countries are the main reasons for the oil sector's relatively lesser dependence on CCS in the short and medium term. The European Union's directive to promote renewable energy sources and energy efficiency, which Norway has adopted, has also contributed strongly to a shift of interest. The focus has turned away from gas-fired power plants as a source for domestic electricity supply and export, and more towards saving electricity through increased efficiency, wind power and to some degree also hydropower.

Gas fired power plants: a national trauma

CCS did not reach its prominence in the Norwegian mitigation plan between 2008 and 2013 without a previous development and debate. CCS was propelled to its present position by previous chains of events. In particular, CCS has been the result of a peculiar Norwegian political trauma: 20 years of NGO-led resistance against gas fired power plants.

A conflict about the construction of gas-fired power plants for supplying the national grid with electricity has at times dominated the political agenda in Norway for the last 20 years or so. It has also played a prominent part on a

67 Dagsavisen, 12 February 2016.

68 <http://www.reuters.com/article/2015/02/04/norway-climatechange-idUSL6N-0VE2QW20150204> Read 10 March 2015

more permanent basis in the entire period. It even caused the resignation of a Norwegian government, the government of Prime Minister Kjell Magne Bondevik on 9 March 2000. His resignation has been claimed as being a “world first”, e.g. the first government crises in a parliamentary democracy caused by an environmental issue. In the words of Mr. Andreas Tjernshaugen in his book “Gasskraft”, the issue has been a national trauma for much of the 20 years between 1987 and 2007.⁶⁹

In countries that relies on a mix of coal, oil, fossil gas and nuclear for its electricity supply, the reasons for the conflict may be difficult to understand. Electricity produced from gas-fired power stations emits less CO₂ per kWh than a comparable coal- or oil-fired power station. In many countries the transition from coal to gas in the electricity sector is an important measure in reducing national GHG-emissions. Norway is different, because the Norwegian electricity supply has historically relied almost 100% on renewable hydropower. The introduction of fossil fuels in electricity generation could therefore increase CO₂-emissions substantially. Each such power plant is a big point source of emissions. One typical plant of 420 MW could increase the national emissions of Norway by 5-6 % alone back in the 90's, without CCS. It would therefore have a significant impact on Norway's possibilities to reduce its GHG-emissions in total. The gas-fired power plants consequently became a natural focus for the NGOs and climate mitigation supporters in all political parties. The conflict cut across most of the political parties being able to form a government, either alone or in a coalition with others. This contributed to the intensity of the debate, since the question about allowing the building of gas fired power plants was crucial for the formation of several of the governments, both minority governments and coalition governments that has ruled Norway since the mid-90's.

CCS as political “glue”

The previous red-green (Social Democrats – Socialist Left – Centre/Agrarian) coalition government's great reliance on CCS in their mitigation plan was also the result of a political compromise at the time of the formation of the coalition. In 2005, the Social Democrats wanted to license two gas-fired power stations for general electricity supply. The Socialist Left party was against this because of the big increase in Norwegian CO₂ emissions that these plants would cause. A compromise was reached: the power stations could be built, provided that they were fitted with CCS as soon as this was technically and economically feasible. The compromise enabled the Socialist Left party to take part in the coalition government with a majority in parliament. CCS acted in this way as a “political glue” for the red-green coalition. When the coalition stepped down in October 2013, the need for CCS in connection with the Mongstad gas-fired power plant did not seem as crucial as before. Among the possible explanations for the shift in policy was that the electricity supply situation had changed, with less dependence on gas-

69 Andreas Tjernshaugen, “Gasskraft”, Pax forlag, Oslo 2007, p. 221

fired power plants and CCS compared to earlier. The official reason for the decision was the high cost of building a full-scale CCS plant at Mongstad, with the likely result that it would not bring the average cost of CCS down.

The outgoing government generously cleared the table for the new government by closing down the Mongstad CCS project, as one of its last decisions in power. It is tempting to conclude that the “glue” was no longer needed as the coalition government was disbanded, for whatever reason. The outgoing government may also have wanted to remove a possible source for criticism from the incoming government about the use of huge sums of money on a project that was not going to be a breakthrough for CCS technology. The criticism came anyway.

Gas fired power plants – a divisive issue in Norwegian politics

The Norwegian environmental NGO`s achieved success in bringing the issue into the forefront of the public debate in the early 90`ties, as described in Mr. Tjernshaugen`s book “Gasskraft”.⁷⁰ As a consequence, it also became a highly divisive issue in Norwegian politics, both between the political parties and inside the parties. Norway has had a succession of mostly minority governments, and often coalition governments, since the 80` s. The red-green coalition government had a majority backing it in the parliament, and was in fact an exception from this pattern. In every combination of political parties forming the different coalition governments during the last 20 years there has been at least one party opposed to gas-fired power plants, due to its climate impact. In the case of single-party minority governments, such as the Social Democratic governments of Mr. Jagland and the first government of Mr. Stoltenberg, there was significant internal opposition within the party to gas fired power plants, even if the official position was in favor. The two minority Social Democratic governments also relied on other political parties in the Parliament for staying in power, again with opposition against gas fired power plants as a critical factor determining the support. Several other political parties have also experienced considerable internal conflict over this issue. Among them are the Socialist Left party that were taking part in the former Red-Green governing coalition led by Prime Minister Jens Stoltenberg, together with the Social Democratic Party and the Centre (Agrarian) Party.

Given that the power plants became so decisive in determining who would govern Norway, CCS became a tempting possibility for the politicians to “have their cake, and eat it too”. CCS made it seemingly possible to have gas fired power plants, but without an increase of CO₂-emissions to the atmosphere. The promise of CCS therefore made it possible to reach a compromise between those in favor and those against the power plants, and pave the way for successive governments from Prime Minister Jagland`s Social Democratic government in 1997 and onwards. It is therefore fair to say that CCS became a “glue” in Norwegian politics since it was introduced in 1995-1996.

70 Andreas Tjernshaugen, “Gasskraft”, Pax forlag, Oslo 2007 p 115

In this situation most of the political parties did not have a strong interest in looking critically at the realities about CCS. The old adage “Don’t look a gift horse in the mouth” seems quite appropriate here. Nobody wants to take a hard look at the realities of storing CO₂ underground for thousands of years, or the other negative consequences of the technology. The Norwegian debate (as in other countries) has mostly been about the cost of carbon capture, and different methods and strategies for achieving the lowest cost, in the short time perspective as well as in a longer perspective. The critical question about the safety of CO₂ storage from leaks has therefore hardly been debated publicly.

A leak of methane (natural gas) from the Aliso Canyon natural gas storage facility in California started on 23 October 2015, and was not stopped until 11 February 2016.⁷¹ The leak was reported to be bigger than the methane leak to the atmosphere from the oil well Deepwater Horizon in the Mexican Gulf. The methane emitted could have a greenhouse gas effect comparable to up a quarter of the total US emissions in a year. The natural gas storage was used for distribution of gas to customers in the area. Natural gas was pumped down in a depleted oil field with numerous unused, old oil wells. The leak occurred in a disused oil well that was more than 60 years old. Aliso Canyon gas storage facility is located on dry land. Transporting the necessary equipment to the site is relatively easy. Even so, it took more than 3 months to plug the leak.

The incident highlights the risks involved when using underground storage of gases lighter than air, be it methane or CO₂. It also highlights the difficulties involved in finding and plugging a leak in a storage facility. These difficulties may be much bigger when operating under water in a challenging environment such as the North Sea, for example in the winter. In a British report from 2012 it is estimated that it will take about two months to drill a so-called relief well in order to stop a leak of CO₂ from a storage facility from the time. This is counted from the time that the drilling equipment is in place. The time to locate the leak and to mobilize a drilling rig also has to be taken into account. This may well increase the time necessary to plug the leak considerably. In the meantime, the leaking CO₂ may reach such proportions as to reduce the economic reason for the whole operation. If the whole CCS-operation cannot reduce the CO₂ emissions to atmosphere cheaper than other available measures, there is no point spending extra energy and money on the method.

Lack of independent academic research

One contributing factor in the lack of criticism is the dependence of all academic geological and geophysical research institutes on funding from the oil industry. Students and teachers at the University of Bergen have protested against this dependence. Their argument is that it compromises the independence of the research that is conducted, and prevents researchers

71 https://en.wikipedia.org/wiki/Aliso_Canyon_gas_leak

from looking at alternative solutions to our energy needs, other than oil and gas. Peter M Haugan, professor and researcher of physical oceanography, is a leading critic of the dependence of petroleum research in Norwegian academia.⁷² He is also a critic of the unquestioning belief that many have in the possibilities for underground storage of CO₂ in the North Sea.

CCS at the Sleipner Field

The Sleipner gas field in the Norwegian sector of the North Sea is seen by many as an example of a successful CCS project. It has therefore been used by the proponents of CCS as evidence of both the practicality of carbon capture and the safety of underground storage of CO₂ from carbon capture facilities in general.

However, the Sleipner CCS operation is a very special case, as stated in a report from AirClim Secretariat published in 2008⁷³. The CO₂ is extracted from the natural gas coming up from the Sleipner gas field. This natural gas is very cold and under very high pressure. Extracting CO₂ from hot exhaust gases at atmospheric pressure from a fossil-fuelled power plant is very different, and much more difficult. This makes it difficult to use the Sleipner CCS, as well as the similar Snøhvit CCS in Northern Norway, as arguments in favour of the viability of CCS in general.

The Sleipner CCS started operating in 1996. Since then, about 1 Mt of CO₂ per year has been separated from the natural gas extracted from the gas field. Nearly 48 million cubic metres of CO₂ have been injected into the Utsira sandstone formation between 1996 and the present date.

An EU-funded project called ECO₂ has investigated the influence of CO₂ seeping from the seabed above the area where the CO₂ was injected, and has also gathered high-resolution seismic data from the geological layers, or cap rock, above the storage area. What they found was one big crack 25 kilometres north of the storage area, and numerous vertical, smaller so-called pipes and chimneys in the rocks covering the CO₂ storage. Some of them went all the way down to the sandstone formation that contains the CO₂. The researchers state that there is no evidence of any seepage from the CO₂ injected through these cracks.⁷⁴

The Sleipner Field – safe against leakage by accident

Professor Peter M Haugan from the Geophysical Institute at the University of Bergen, Norway, says that this may be just a coincidence. No examination of the cap rock on top of the CO₂ storage area was conducted prior to the start of injection. The biggest crack that was found (up to 10 metres wide and 3 kilometres long), could well have been situated right above the injection site. His conclusion is that this proves the need for very expensive explora-

72 <http://pahoyden.no/2014/01/vil-trappe-ned-norsk-oljeutvinning> Read 8 March 2015

73 <http://www.airclim.org/sites/default/files/documents/APC21.pdf>

74 [ECO2_Brochure_Update_July2014.pdf](http://www.airclim.org/sites/default/files/documents/APC21.pdf) (755.8 KiB) Read 11 September 2014

tion of sites intended for storage of CO₂.⁷⁵ Such exploration of potential CO₂ deposits might take anything between three years at best and up to 10 years in very difficult cases, and there are no guarantees that these explorations will automatically lead to a positive conclusion.

The Norwegian government announced in the beginning of January 2016 that it has given Statoil a contract of 35 mill NOK to look for suitable geological formations to store CO₂ underground on three different locations. The Utsira formation is one of these. The search shall be concluded by 1 June 2016. It is doubtful if it is possible to find a geological formation that is safe against CO₂-leakage in 5 months time, if one should follow professor Haugan`s argument above.

The need for site specific investigations is also pointed out in a report about the possibilities for CO₂ storage in the British sector of the North Sea.⁷⁶ The report underlines that it has estimated the probabilities and the rates of leakage based on the best available data and estimates. Even so, there are no absolute guarantees of permanent storage. The authors state that CO₂ from a storage facility in general is unlikely to leak because of the geological structures of the North Sea. However, the authors warns that there are site specific conditions that may cause a higher risk for leaks. One type of risk is boreholes with old oil- and natural gas wells. There are many different aspects of such old and unused wells that may cause a leak. One cause is the cement that has been used to seal old, unused wells. Under the influence of CO₂ mixed with saline water the cement may erode and start leaking. Another risk is geological faults and cracks. One must make sure that such faults do not extend all the way from the layer used to store CO₂ and up the seabed above. Even if this is not the case, fault-lines and cracks may be re-activated as a result of the injection of CO₂. A thorough examination of the cap layer for faults and old boreholes was not conducted before the Utsira formation was taken into use before the injection of CO₂ was started in 1996. It is highly possible that the use of the Utsira sandstone formation as a CO₂ storage facility would not have been allowed if the EU regulations for ensuring safe storage had been in place in 1996. This directive was finalized in 2009⁷⁷, which is a good 13 years after the CO₂ storage facility in the Utsira formation started its operation.

Statoil is, on the other hand, very optimistic about the potential for CO₂ storage in the North Sea, at least in the longer term. The company`s long experience in underwater operations, seismic data gathering and interpretation and understanding of the reservoirs is their competitive advantage. According to Statoil the technology is, however, untested. There are no large-scale, commercial CO₂ storage facilities in the world today. Most of the CO₂ capture plants in the world today use the CO₂ either in EOR – Enhanced Oil

75 Professor Peter M Haugan, Personal communication, 11 September 2014

76 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/272201/CO2_Storage_Liabilities_in_the_North_Sea_-_An_Assessment_of_Risks_and_Fi...pdf.
Read 24 February 2016

77 <http://eur-lex.europa.eu/legal-content/EN/LSU/?uri=CELEX:32009L0031>

Recovery – or in industrial production. There are also no large-scale Carbon Capture operations going on in Europe that makes CO₂ storage necessary in the immediate future. The cost of storing CO₂ underground in the North Sea is so high that the price on CO₂ emissions has to increase significantly before a commercial storage facility will be viable. The price must be at least 50 USD per ton CO₂ before it can be profitable. Today, the cost in the EU is around 6 USD per ton.⁷⁸ Before you reach 50 USD per ton CO₂ a whole host of other technologies will probably be cheaper to use. This will greatly reduce the potential need for CO₂ storage facilities in the North Sea.

CCS - a divisive issue among NGOs

There is a clear lack of critical debate about the shortcomings and unproven aspects of CCS technology in Norway. Environmental organizations and the wider environmental movement in Norway have been divided on this issue. The environmental foundation Bellona has been the leading, permanent and very vocal advocate of CCS since 1996 in Norway and has also been influential in the EU. Another foundation, the Zero Emission Resource Organisation, was established by former Bellona employees, and has been actively supporting CCS up to the present. Environmental NGOs such as Friends of the Earth/Norges Naturvernforbund, Nature and Youth/Natur og Ungdom have supported and campaigned for CCS to a varying degree in the past. Both are now passive supporters. Naturvernforbundet/Friends of the Earth Norway has been a passive supporter since 2007. Natur og Ungdom/Nature and Youth was very active around 2005–2006, but does not have an active campaign for CCS any more. WWF Norway has been largely silent, both in the past and now. Two organizations, Greenpeace and FIVH/Future in Our Hands have been openly critical in the past, and still are. In recent years both have also been less vocal.

An important reason for the lack of public debate about CCS in Norway has also to do with the attitude towards CCS among the environmental NGO's and foundations.

At the same time as CCS become a prominent part of the political debate and later of the national mitigation plan, CCS also became a highly divisive issue for the environmental organizations and the wider environmental movement. A broad alliance of environmental NGOs, labour unions, church organizations and political parties managed to postpone the construction of gas-fired power plants in Norway for 17 years, from the first debate in 1990 until the power plant at Kaarsto started production on 14 December 2007. In doing so, they managed to defeat the industry and its political supporters. However, the broad alliance that managed to postpone the construction of gas-fired power plants split over the issue of CCS. The split has meant that the environmental organizations has actively supported, passively accepted or been silent or not very vocal in their opposition, with the exception of Greenpeace and FIVH/Future in our hands.

78 Aftenposten 12 February 2016

The leading advocate for CCS since 1995-96 among the NGO's in Norway has been the environmental foundation Bellona.⁷⁹ Bellona, led by Frederic Hauge since the start in 1986, has been actively campaigning for CCS both in Norway and inside the EU Commission since 1996. Bellona is a Norwegian based and controlled entity (although with branch offices abroad) and gets almost all the funding for its CCS-work from different commercial corporations and interests, as well as the Norwegian government. Bellona is also represented on different expert committees in the European Union handling CCS.

Former employees from Bellona have formed the foundation Zero – short for Zero Emissions Organization – which is also promoting CCS.⁸⁰ Zero is mostly funded by the industry, and some government project support.

Nature and Youth/Natur og Ungdom, an environmental organization for people up to 25 years of age, is formally part of Naturvernforbundet/ Friends of the Earth Norway but decides on its own policies independently. The organization has previously played an important role in the resistance against gas-fired power plants. It has a positive view on CCS, as seen in its platform.⁸¹ Nature and Youth has in the past actively campaigned for CCS, most recently in connection with the negotiations between the political parties in the Norwegian parliament about a broad climate agreement. Nature and Youth had a leading role in convincing the party convention of the Socialist Left party in 2005 to accept CCS. By doing so, Nature and Youth/Natur og Ungdom helped pave the way for the participation of the Socialist Left party in the red-green governing coalition (2005–2013), together with the Social Democrats (traditionally a proponent of gas-fired power plants) and the Centre/Agrarian party.⁸² In 2014, Nature and Youth/Natur og Ungdom did not give CCS a high priority. It does not have an active campaign for CCS, according to its website.⁸³ Energy efficiency seems to be the most important measure for combating climate change, followed by renewable energy sources.

Norges Naturvernforbund, representing Friends of the Earth in Norway, does not campaign actively for CCS in 2014. Its position has shifted over the years. Originally it merely said that gas-fired power plants, with or without CCS, were unnecessary for the supply of the Norwegian electricity system. Between 2005 and 2007 it was a more active supporter of CCS, saying that energy efficiency and renewable energy were not enough to cut emissions as much as needed. Since 2007 and up to the present in 2014, its position has been that if gas-fired power plants are built, they should be equipped with

79 <http://bellona.org/publication/bellona-foundations-response-european-commissions-consultative-communication-ccs> Read 3 March 2015

80 <http://www.zero.no/ccs> Read 3 March 2015

81 <http://nu.no/getfile.php/Bilder/Artikkelbilder/Organisasjon/Arrangement/Landsm%C3%B8te/Milj%C3%B8politisk%20plattform%20vedtatt%202014.pdf> Read 3 March 2015

82 Andreas Tjernshaugen, "Gasskraft", Pax forlag, Oslo 2007, p 176

83 www.nu.no

CCS.⁸⁴ Otherwise, CCS does not have a high priority, according to its website.⁸⁵ Energy efficiency is the most important means of countering negative climate effects and other environmental effects of energy use, according to the organization's website.

WWF Norway has been chiefly silent regarding CCS, both in the past and in 2014. WWF Norway does mention CCS in a list of possible mitigation measures, citing that its modelling of climate mitigation up to 2050 shows that 100 percent reduction will not be possible without CCS. But CCS is not high on its agenda in 2014.⁸⁶ Energy efficiency is also highest on the WWF list of climate measures.

On the opposite side you have Greenpeace Norway and another Norwegian organization, the Future in Our Hands (FIVH). Both question the possibility of safe storage in the longer term, as well as the feasibility of using CCS as a major technology to reduce emissions, taking into account the long lead-time and cost of developing the technology. Both also point to more efficient energy use and increased use of renewables as the major strategy for combating the climate problem. Greenpeace and FIVH have also questioned the net impact of CCS if the CO₂ is used for EOR – Enhanced Oil Recovery – and asked if this will not actually lead to more CO₂ being released into the atmosphere because of the extra oil being produced. When the additional oil is burned, it will release CO₂ into the atmosphere that will, at best, equal the amount of CO₂ being stored in the reservoir. Most likely, the extra oil produced by pumping CO₂ into the reservoir will lead to a net increase in the total amount of CO₂ reaching the atmosphere.

CCS – what technology to use?

A part of the debate about CCS in Norway has been what technology should be used for the first full-scale CCS-plant. The only technology at the moment, which has been used in large-scale operations, is a method using a chemical substance called amins to bind the CO₂ in the flue gas. This technology does not promise great possibilities for bringing down the cost of carbon capture, according to a panel of experts appointed by the Norwegian government. Consequently, the panel recommended that a normal procedure for technology development should be followed, with different technologies for CO₂-capture tested. On the basis of these tests, a decision of which technology to use in a full-scale CCS-plant could then be reached. Greenpeace in Norway has supported this approach. In connection with the debate over a full-scale CCS-plant at the Kaarsto and Mongstad power plants, several organizations with Bellona in the front argued that it would be important to get a first full-scale CCS-plant in place here as quickly as possible. The

84 <http://naturvernforbundet.no/getfile.php/Dokumenter/Naturvernforbundets%20prinsipprogram%20vedteke%20p%C3%A5%20LM%202013.pdf?redirect=urialias> Read 3 March 2015

85 www.naturvern.no

86 http://www.wwf.no/dette_jobber_med/klima/klimalosninger/ Read 3 March 2015

importance of getting a full-scale plant up and running as quickly as possible was so high for these supporting organizations that it would be better to build it with old technology such as amin-based capture technology, rather than testing out several new technologies before committing to one in particular. Greenpeace argued that if one were going to spend billions of Norwegian Kroner (NOK) on CCS, it would at least be more sensible to spend the money on a technology that promised to bring down the cost per ton captured significantly. However, Greenpeace also pointed out the shortcomings of the whole CCS-chain, including the insufficient knowledge about storage.⁸⁷ The position of Greenpeace Norway regarding CCS mirrors that of GP International, and is still critical towards CCS. However, CCS is not high on the agenda for GP Norway in 2014.

The Executive Director of FIVH, Mr. Arild Hermstad, clearly expressed the views of his organization in connection with the news on 18 December 2007 that the government gave up on the plan to introduce a full-scale CCS-plant at the Mongstad gas fired power plant from the start of its operation. Mr. Hermstad said that this demonstrated the danger of one-sided focus on such technologies, because while the debate about CCS has been going on in Norway, the government has done very little to use other instruments to reduce domestic GHG-emissions.⁸⁸ In a debate article written together with professor of Geophysics at the University of Bergen, Norway, Mr. Peter M Haugan and Mr. Jon Hille, the authors give a more detailed analysis of the problems connected with CCS.⁸⁹ In the article, the net effect of using CO₂ to push up more oil from the underground – Enhanced Oil Recovery or EOR – is estimated to give 1, 8 times as much CO₂ to the atmosphere as building a conventional gas fired power plant and letting the emissions directly into the atmosphere. The possibilities of finding reservoirs that can hold CO₂ stored underground for thousands of years is also clearly a field where the knowledge is not sufficient, according to the article. The basic position of FIVH seems unchanged, but it does not give CCS a high priority in its work in 2014.

Lack of initial opposition from the NGOs

From the review above it is possible to conclude that the widely varying views held by the different organizations have contributed to the lack of a serious and critical debate about CCS and its shortcomings in Norway. This is not the whole explanation, but it is at least an important part. A broad coalition led by the environmental NGOs was able to delay the conventional gas fired power plants for 17 years. But when Bellona embraced CCS and became the most vocal supporter and actively campaigned for CCS as THE

87 <http://www.greenpeace.org/norway/press/releases/fornybar-energi-og-smartere-en> Read 15 April 2008

88 <http://framtiden.no/200712202150/pressemeldinger/klima/skrinlegg-mongstad-kraftverket.html> Read 15 April 2008

89 <http://framtiden.no/200802202151/meninger/klima/manelanding-eller-buklanding.html> Read 15 April 2008

solution, the other organizations either joined in on Bellona`s side, or for a long time became invisible in the debate. The reasons for the other NGO`s to support Bellona`s positive advocacy in favor of CCS or keeping a low profile were in the beginning partly tactical. Also those critical to CCS saw the tactical value of using CCS as way of delaying the construction of conventional power plants without CCS. If this was not motivation enough by itself, the perceived risk of an open debate between the environmental organizations about CCS was and is a supporting motive. The organizations were afraid of hurting the credibility of the collective environmental movement by openly disagreeing about the methods to reach commonly held goals. As we see, this has changed during the last few years. One reason for this is that it has become all too obvious how CCS has become a substitute for other actions to reduce CO₂ emissions domestically in Norway, as stated by Arild Hermstad, head of FIVH.

Norway as an CCS-advocate internationally

Another question which is natural to ask is: Does the (relatively) heavy spending on CCS R&D make Norway an important player in the debate about CCS internationally? If so, how does Norway try to influence the debate?

CCS in the Kyoto Protocol

Norway is a strong supporter of the UN, and contributes financially to many of its operations and programs. Norway has also been active in development aid and in other ways supporting the developing nations. As a consequence, Norway enjoys in general a fairly positive reputation in international negotiations under the UN. This has been a valuable asset also in the climate negotiations. Norway was an early supporter of the Kyoto Protocol under the then prime minister Gro Harlem Brundtland. Later, it sided with USA, Australia, Japan and other nations, the so-called “Umbrella group”. This (in-official) group of nations was heavily criticized by the international NGO network Climate Action Network – CAN - for blocking the progress in finalizing the Kyoto Protocol. In the climate negotiations in Marrakech in 2001 Norway finally left the Umbrella group and sided with the EU. After 2001 Norway has aligned itself more closely with the EU, basically in order to get access to the early emissions trading system that the EU has organized. After 2001 the EU has incidentally also shown an increased interest in CCS as a mitigation technology.

In the ongoing climate negotiations, Norway has in the past argued consistently for CCS to be included in the Clean Development Mechanism (CDM) under the existing protocol.⁹⁰ The parties to the climate negotiations finally agreed to this in Durban in December 2011.⁹¹ According to this decision, the parties to the Protocol accept CCS projects in principle as part of the Clean Development Mechanism. The board that evaluates and accepts projects can, according to this decision, also include CDM projects if they fulfill the requirements regarding methodology for accounting etc. How much influence Norway actually wielded on this issue, is difficult to say. In general, small nations like Norway can only influence international negotiations by the strength of their argument, since it does not have the economic and other means of power as the big nations have. If Norway has had an influence on the climate negotiations in the past, it has been because of the arguments and expertise it could bring to the negotiating table. CCS is undoubtedly an area where Norway has expertise to bring, but the question remains: how good are the arguments?

The future of CDM as part of a future climate agreement for the period after 2012 is under debate, and no one can say at present if it will survive in the present form, or if it will be replaced by a radically different system. The

90 <http://www.regjeringen.no/nb/dep/md/aktuelt/nyheter/2007/CO2-handtering-til-u-land-gjennom-gronne.html?id=493390> Read 15 April 2008

91 <http://unfccc.int/resource/docs/2011/cmp7/eng/10a02.pdf#page=13> Read 6 March 2015

Climate Action Network (CAN) is highly critical of CDM because of past experience with many projects that have had negative environmental and/or social impacts in the host countries, as well as highly questionable real climate benefits. In 2008, CAN demanded a totally different system with real environmental and social integrity. In 2013, CAN argued that it is necessary to review and strengthen the existing rules governing CDM projects, even though it still remains critical of them.⁹²

The NGOs following the negotiations as part of Climate Action Network adopted a common position that it did not want CCS as part of CDM within the first Kyoto period, up to 2012. The reason given for this was that the technology is largely untested. It needs to be much more developed and tested in the rich part of the world that has the necessary technological and scientific expertise before it is applied in developing countries with a much lower scientific and technological capacity to monitor for leakage etc. The monitoring of CO₂-deposits against leaks and other technical problems are at present also outside the scope of most developing countries to handle.⁹³

So why is Norway promoting CCS in the climate negotiations? The official answer is that Norway wants to help developing countries to take this technology into use, and because inclusion of CCS-projects in the CDM will be the best way of securing a standardized set of rules for an environmentally safe way of using CCS. This is not necessarily untrue, but there are also other plausible reasons behind Norway's efforts to include CCS in the CDM, as we shall see.

One interpretation is that Norway sees the need to spread the technology and increase the number of projects. A greater number of projects will speed up the learning process and reduce the cost per ton CO₂ captured. In the development of new technologies, one often talks about "learning curves". Simply put this means that there is a relationship between the number of units of a product and the cost of production for one unit. A commonly used example is the production of processors that is the heart of PC's and a lot of other applications. A doubling of the number of units produced usually leads to a 50% reduction in production cost. This is then the typical "learning curve" for this particular technology. By getting CCS included in CDM, the hope is that it will lead to many more units being built with the help of the extra money that selling CDM-certificates can provide.

The idea is to create a win-win-win situation. First; the Norwegian government hopes to buy CDM-certificates from CCS-plants in other countries in order to cover Norwegian Kyoto-obligations. Then, because of the lower cost of CCS as a result of more units being built, CCS will also become cheaper to build in Norway. This will make future oil- and gas extraction from the (rapidly diminishing) Norwegian oil- and gas fields more economical. The

92 <http://www.climatenetwork.org/publication/views-possible-changes-modalities-and-procedures-clean-development-mechanism> Read 6 March 2015

93 <http://www.climnet.org/EUenergy/CCS/positions/NGO%20position%20on%20CCS%20in%20CDM.pdf> Read 15 April 2008

Norwegian government also hopes to get other countries to provide money for CCS-projects through technological transfer funding. Several mechanisms are being set up to help the developing countries to combat climate change by enabling them to use more advanced technology. If CCS could be one of the technologies financed through these mechanisms, it would be even better for Norway.

The Paris agreement of December 2015 did introduce “two different frameworks for market approaches that will be developed in detail over the next years”, according to one observer⁹⁴. What role CCS will have in these frameworks remains to be seen.

CCS – a costly detour on the way to a sustainable Norway?

Economic and political motivations, combined with a partly positive and partly silent NGO-community has contributed to the present political commitment towards the use of CCS in Norway. The total effect of this commitment has been negative for the efforts to reduce the GHG-emissions in other sectors than the oil- and gas sector, especially the transport sector, where the emissions are growing fastest. The emissions from the oil- and gas sector are predicted to peak in a relative short time, and then be gradually reduced in the years to come, both in absolute and relative terms. This will happen even without the use of CCS, due to the rapid extraction and depletion of the Norwegian offshore oil reserves. A focus on CCS and emissions from the oil sector instead of other sectors with growing or stable emissions may therefore be a wrong priority.

Norway has many other options for reducing its CO₂ emissions, other than by CCS. Stopping further development of new oil fields is one, and particularly in the very vulnerable Arctic. Another option is reducing emissions from the transportation sector, which is otherwise going to expand.

To the extent that CCS has overshadowed the other national mitigation potentials and reduced the efforts in the other sectors of the Norwegian economy, CCS may prove to have been a costly detour on the road to a climate-friendly Norway.

The cost of buying emission credits for the Norwegian total yearly Greenhouse gas emissions:

54 million tons CO₂ ekv/3,65 = 14.794.521 tons carbon x 7 Euro = 103.561.647 Euro x 8,6 = 890.630.165 NOK

In rounded numbers this is 103 million Euro or 890 million NOK.

94 <http://carbonmarketwatch.org/news-paris-treaty-establishes-new-carbon-trading-mechanisms/>

