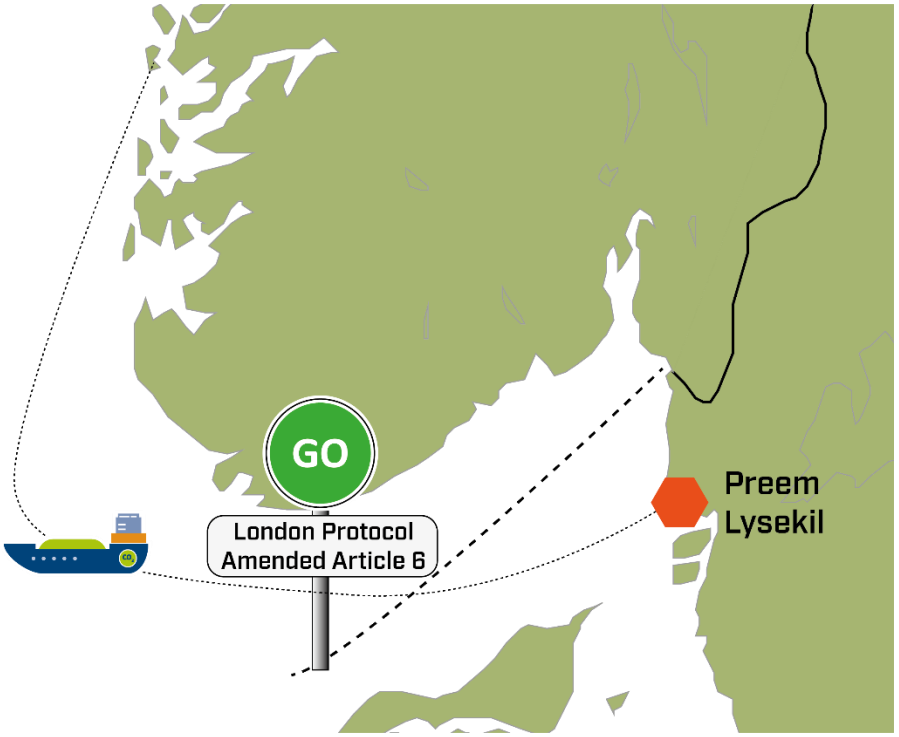

Project Report

Legal and regulatory framework for Swedish/Norwegian CCS cooperation

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Report No:

2022:2022:00023 - Unrestricted

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KEYWORDS:
CCS, Sweden, Norway, London Protocol, EU-ETS, Bio-CCS

VERSION
1.0

DATE
2022-01-20

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PROJECT NO.
502002275

NO. OF PAGES/APPENDICES:
21/0

SUMMARY
A description is provided of the legal/regulatory situation, as of early December 2021, for CO_2 transport from Sweden/Preem AB to Norway/Northern Lights.
CO_2 transport from Sweden to Norway for the purpose of geological storage under the seabed is since 2019 legal, thanks to the provisional application of the amended Article 6 of the London Protocol, provided that the necessary unilateral declarations are deposited from Norway and Sweden to IMO and that Sweden and Norway enter a bilateral agreement on the matter.
Economic incentives for CCS include the EU-ETS for fossil CO_2 and the Swedish support for Bio-CCS through reverse auctioning.

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REPORT NO
2022:00023

ISBN
978-82-14-07748-3

CLASSIFICATION
Unrestricted

CLASSIFICATION THIS PAGE
Unrestricted

Document history

VERSION	DATE	VERSION DESCRIPTION
0.9	2022-01-05	For partners' approval
1.0	2022-01-20	Final version

Table of contents

List of abbreviations

Bio-CCS	Capture and Storage of CO_2 from biogenic sources, a.k.a BECCS
CBD	Convention on Biological Diversity
CCS	CO_2 Capture and Storage
CDR	Carbon Dioxide Removal (net removal of CO_2 from the atmosphere)
EC	European Commission
EU ETS	European Union Emission Trading System
GHG	Greenhouse gases
IEA	International Energy Agency
ILUC	Indirect Land Use Change
IPCC	Intergovernmental Panel of Climate Change
LCA	Life Cycle Assessment
LULUCF	Land use, land-use change and forestry
MRR	Monitoring and Reporting Regulations
NZE	Net Zero Emission
SDS	Sustainable Development Scenario

1 Introduction

Preem AB is the largest fuel company in Sweden and has two refineries located in Lysekil and Gothenburg on the west coast of Sweden. They are among the largest point source emitters of CO_2 in Sweden with 1.5 Mt/y CO_2 emitted at the Lysekil refinery, of which 480 kt/y is emitted by the hydrogen production alone. Preem wishes to tackle its part of the Swedish emission challenge by becoming climate neutral by 2045. Preemraff Lysekil is also one of the most energy efficient, complex, and integrated refineries in Europe and aims to be competitive also in a low carbon future. Preem, therefore, wants to investigate the potential for CO_2 capture at their Lysekil refinery with subsequent shipping to the planned CO_2 storage facility of Northern Lights on the west coast of Norway, planned to be operational in 2024.

The Norwegian Government has in December 2020 approved funding for a CO_2 capture and storage project, Longship[1], that involves shipping of CO_2 from the cement manufacturer Norcem in Brevik on the southern coast of Norway to the Northern Lights storage site on the west coast of Norway. This means that the infrastructure for receiving and storing CO_2 will be built over the next few years and made operational in 2024.

In the Preem CCS project, Preem AB has along with the partners investigated the potential for CO_2 capture at the Lysekil refinery, with subsequent liquefaction and transport for storage on the Norwegian Continental Shelf (NCS). The project was funded by Gassnova/CLIMIT, the Swedish Energy Agency (Svenska Energimyndigheten) and Preem AB, and the partners were Preem AB, Aker Carbon Capture, Equinor, SINTEF Energy and Chalmers University of Technology.

If realized, CCS at Lysekil could be one of the first CCS projects in Sweden. Consequently, at the beginning of the project, there was some uncharted territory regarding international regulations and legislation for CCS and shipping of CO_2 from Sweden to Norway. This report, therefore, puts focus on the legal and regulatory barriers and solutions for CCS including Bio-CCS (or BECCS) and transborder shipping of CO_2 for storage.

The legal and regulatory framework for CCS and other climate change mitigation measures is evolving rapidly on national and European levels. The present report reflects the status in this area early in December 2021.

2 Climate goals

2.1 Swedish Climate Goals

In 2017, the Swedish Parliament approved its climate policy framework comprising three key elements: A Climate Act, a Climate Policy Council and the climate goals. The Climate Act ensures that the Government climate policy is based on the climate goals, while the Climate Policy Council reviews how well the policy meets the climate goals. According to the Climate Act, the Government must every four years produce a climate policy action plan for the next four years.

The Swedish long-term Climate goal states that Sweden by 2045 shall have net zero greenhouse gas (GHG) emissions. Emissions within Swedish territory are set to be reduced by at least 85% compared to 1990 levels, meaning that the remaining emission reductions required to reach net zero must be achieved

[1] https://gassnova.no/en/full-scale-ccs

through supplementary measures[2]. These include the uptake of carbon dioxide into forests and soils as a result of additional measures, emission reductions implemented outside Sweden's borders, and CCS/Bio-CCS. Furthermore, the climate goal states that after 2045, Sweden should achieve net negative emissions.

While the 2045 and post 2045 goals refer to total GHG emissions, there are also interim targets set for 2020, 2030 and 2040 that apply to emissions outside the EU Emission Trading System (EU ETS) only. These interim targets are:

- By 2020 GHG emissions should be 40% lower than in 1990.
- By 2030 GHG emissions should be 63% lower than in 1990.
- By 2040 GHG emissions should be 75% lower than in 1990.

Even the interim targets may be partially achieved through complementary measures; Up to 8 and 2 percentage points of the emission reduction targets in 2030 and 2040, respectively. There are also specific interim targets for domestic transport (NVV, 2020).

In 2019, Sweden emitted 50.9 Mt CO_2e (CO_2 equivalents) which corresponds to 29% lower emissions than in 1990. This includes EU ETS facilities but does not include LULUCF. In March 2020, the Climate Council concluded that Sweden may reach the 2020 interim target through use of complementary measures. However, none of the goals in the climate policy framework beyond 2020 will be achieved under current conditions and exisiting policies (Bonde et al., 2020).

2.2 Preem Climate Goals

Preem's climate goal is to become the world's first climate neutral petroleum and biofuel company. This entails a net zero goal for emissions along the entire value chain: From upstream extraction, through pre-treatment and refining, towards down-stream end-use and product combustion. The climate goal is set to be reached by 2035 at the latest.

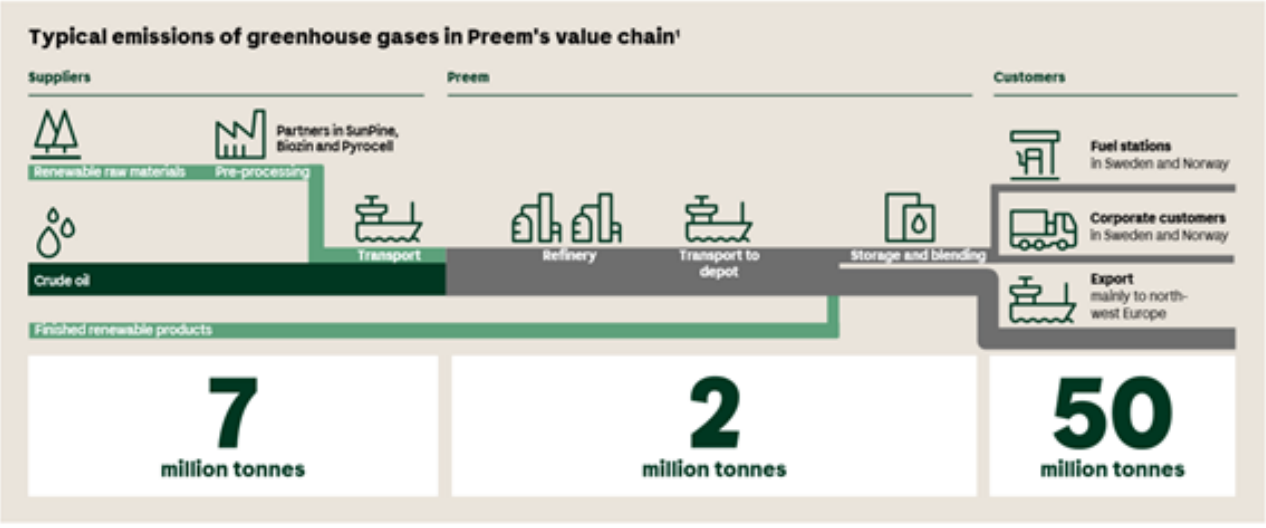

Figure 1: Preem's value chain with typical emission levels

[2] Additional measures mean that accounted net removals and emission reductions in the Land Use, Land-Use Change and Forestry (LULUCF) sector which would have occurred even in the absence of the supplementary measures should not be able to be counted towards the climate goals as supplementary measures (SOU, 2020).

Preem's overarching climate goal is more ambitious than the Swedish national climate target, aiming to reach net zero 10 years before the Swedish target. Since 2020, Preem has implemented a number of important priorities linked to the transition. The focus is now entirely on projects and initiatives that actively contribute to the climate target, and climate neutrality will be achieved by focusing on the following four priority areas:

- *Adapt the refineries so that fossil crude oil can be replaced by renewable raw materials.* The combustion of fossil products is the main cause of carbon dioxide emissions along the value chain. To achieve the climate goal, Preem needs to drastically reduce the use of crude oil and replace it with renewable alternatives, such as bio-oils, which come from sustainable waste products from forestry and agriculture and the food industry. In the first phase, Preem wants to increase the renewable production capacity to at least 2.5 million cubic meters by 2026 and to reach approximately five million cubic meters by 2030. At the same time the fossil production will be reduced.

- *Establish CO_2 capture facilities and evaluate compensatory measures.* Preem's refineries are some of Sweden's largest, individual sources of emissions. Fossil emissions will decrease as fossil raw materials are replaced with fossil-free alternatives. By installing carbon capture technology, carbon dioxide can be captured, instead of being released. In combination with renewable raw materials, negative emissions occur. In addition to carbon capture, Preem is evaluating the possibilities for other compensatory measures.

- *Replace natural gas with renewable gas and production of fossil-free hydrogen.* Hydrogen is an important ingredient in fuel production. Today, natural gas is mainly used to produce hydrogen. Hydrogen production is one of the main causes of the carbon dioxide emissions generated at refineries. By replacing fossil natural gas with renewable alternatives such as biogas and renewable residual streams from production, emissions can be significantly reduced. Another way is to produce fossil-free hydrogen through the electrolysis of water and fossil-free electricity.

- *Adapt production capacity and broaden operations to include more product offerings that are in demand in a sustainable society.* To achieve the climate target, Preem will gradually reduce today's large-scale production and sale of fossil fuel products. Preem also sees great opportunities in broadening its business and including new types of products that are required in a sustainable society. One example is the increased production and sale of renewable components for processing in chemical industries.

3 Bio-energy with carbon capture and storage

Combined with CCS, use of biomass has the potential to provide net removal of CO_2 from the atmosphere. However, in order for the Bio-CCS to provide net negative emissions, it is essential that the biomass *production and use* is sustainable and causes lower emissions of greenhouse gases than fossil fuel-based systems. This is important both in a medium- and a long-term perspective and must apply to the entire supply chain: production, transport and conversion. In addition, the production of biomass should not cause deforestation or in other ways reduce carbon stocks at landscape level, reduce biodiversity or long-term soil production capacity, deteriorate soil or water quality, or cause harmful emissions of pollutants (NVV, 2021).

In 2018, the International Panel on Climate Change (IPCC) highlighted the importance of Bio-CCS to provide reasonable probability for the global temperature increase to be limited to 1.5 °C, particularly in the

second half of this century. The use of CCS and Bio-CCS must come in addition to very rapid reduction of greenhouse gas emissions. Three out of four IPCC scenario families (P2-P4) included cumulative use of CCS up to year 2100 ranging between 348 and 1218 Gt, of which 151 to 1191 Gt was from Bio-CCS. The first family of scenarios (P1) did not include CCS/Bio-CCS at all, instead relying on a rapidly declining fossil fuel consumption (IPCC, 2018).

Furthermore, in 2021, the IPCC published the Working Group I contribution to the Sixth Assessment Report of the IPCC (IPCC, 2021). Here, it is observed that Bio-CCS (referred to as BECCS in the IPCC report) can result in a removal of CO_2 from the atmosphere, but also that replacing carbon-rich eco-systems with herbaceous bioenergy plants could deplete the soil-carbon stocks and reduce the storing capacity of standing forests. It is also mentioned that deployment of Bio-CCS at scales envisioned by many 1.5–2.0°C mitigation scenarios could threaten biodiversity and require large land areas, competing with afforestation, reforestation and food security. The use of biomass for biofuels, with or without CCS, should therefore be accompanied by a cradle-to-grave LCA to estimate the net Carbon Dioxide Removal (CDR) potential.

The International Energy Agency (IEA) gives mixed signals with regard to their view on the use of Bio-CCS. The use of Bio-CCS has been reduced substantially in their most recent climate scenarios in the World Energy Outlook, foremost due to potentially negative consequences related to land use, biodiversity, and food security. For instance, IEA's Sustainable Development Scenario (SDS) developed to keep the global temperature increase to well below 2°C assumes 0.25 Gt bio-based CO_2 being captured and stored in 2050 versus a median of 4.7 Gt in the IPCC scenarios for 1.5°C temperature increase (IEA, 2019, 2020b; IPCC, 2018). On the other hand, in IEA's special report on CCUS in the 2020 edition of Energy Technology Perspectives, annual global use of Bio-CCS in the SDS increases from 81 Mt CO_2 captured and stored in 2030 to 955 Mt in 2050, and further to 3 Gt in 2070. By 2070, it is assumed that 52.3 Gt biogenic CO_2 has been captured and stored (IEA, 2020a). In the IEA NetZero by 2050 report published in 2021, it is observed that the NZE (Net Zero Emissions) scenario by IEA uses less bioenergy than the IPCC scenarios, while a larger role is attributed to hydrogen, wind, and solar energy. Still, BECCS/Bio-CCS is part of the necessary CDR that is required to reach net-zero. The IEA NZE scenario comprises 1.9 Gt CO_2 captured and stored from Bio-CCS/BECCS and Direct Air Capture, which is a significant amount.

The EU Commission (EC) expresses the same concerns as the IEA regarding Bio-CCS. However, in its "A clean planet for all" communication from 2018, it states that it may be necessary to utilise Bio-CCS to neutralise hard-to-abate fossil-based emissions, particularly if the 1.5°C target is to be reached. The Commission's in-depth analysis supporting the Commission's communication included nine scenarios targeting 80% or 100% GHG emission reductions by 2050. In eight of the nine scenarios, of which two targeted zero emissions in 2050, there is only a modest use of Bio-CCS ranging from 4 to 14 Mt CO_2 in 2050. The two scenarios targeting zero emissions in 2050 build upon high incentives for LULUCF with one version also including a limited demand for biomass. The ninth, the so-called 1.5 TECH scenario also yielding zero emissions in 2050, assumed 178 Mt biogenic CO_2 being captured and stored in 2050 (European Commission, 2018b, 2018c).

In Sweden, there is an increasing interest for both CCS and Bio-CCS, partly as an option to reduce and/or neutralise fossil-based emissions in certain industry sectors. Relevant sectors are the cement industry, waste-based combined heat and power plants as well as for hard-to-abate emissions in the agricultural sector. Another reason for the increasing interest is the possibility for reaching the Swedish goals of net negative emissions after 2045. The prospects for Bio-CCS are particularly promising in Sweden with several large-scale emitters of biogenic CO_2 located along the coastline and easy access to storage sites in the North Sea. Studies have also indicated that installing CCS in pulp and paper plants emitting large amounts

of biogenic CO_2 will be a cost-efficient way to meet Sweden's climate goals (Garðarsdóttir, Normann, Skagestad, & Johnsson, 2018; Johnsson, Normann, & Svensson, 2020).

3.1 Bio-CCS from an EU ETS and MRR perspective

Each year, industrial installations that are included in the EU Emission Trading system (EU ETS) must surrender a number of allowances equal to the total CO_2 emissions from that installation during the preceding calendar year. This was established by Directive 2003/87/EC of the European Parliament and the Council of 13 October 2003, amending Council Directive 96/61/EC (ETS-directive) Article 12 item 3 (European Commission, 2003).

According to Article 12 item 3a, an obligation to surrender allowances shall not arise in respect to emissions verified as captured and transported to a facility for permanent storage. This principle is operationalized through more detailed rules in the 2018 amendment of Commission Regulation (EU) No 601/2012 of 21 June 2012 (European Commission, 2018a) on Monitoring and Reporting Regulations (MRR). However, as MRR Article 49 (1) explicitly refers to fossil-based carbon in relation to CCS, Article 12 item 3a is not applicable in the case of Bio-CCS.

In July 2020, the EU Commission replied to a request from the Norwegian Ambassador to the EU confirming that there is no legal ground within the EU ETS directive that can support Bio-CCS. However, the Commission clearly indicates in its reply that there is a positive interest for Bio-CCS within the Commission. The Commission stated that other instruments can address the issue of, and create incentives for, bioenergy with CCS in a more efficient way than the ETS. Furthermore, the Commission claimed that they would study these instruments in its further work on the European Green Deal (see section 3.4).

3.2 Moratorium on climate-related geoengineering

During the 10th Conference of the Parties for the Convention on Biological Diversity (CBD) held in Nagoya, Japan in October 2010, the Parties set a moratorium on climate related geoengineering as part of decision X/33, stating that no such activity may take place until it is adequately justified. Climate related geoengineering was here partly defined as *"any technologies that deliberately increase carbon sequestration from the atmosphere on a large scale that may affect biodiversity (excluding carbon capture and storage from fossil fuels when it captures carbon dioxide before it is released into the atmosphere)".* Carbon sequestration, in turn, is defined as the process of increasing the carbon content of a reservoir other than the atmosphere.

The Swedish Government Inquiry on a "Strategy for negative greenhouse gas emissions" (SOU 2020:4) states in its final report that *"Sweden should work to ensure that the decision on the so-called moratorium on geoengineering adopted at the tenth meeting of the Convention on Biological Diversity (CBD) in Nagoya (COP10) is amended so that Bio-CCS and other non-fossil CCS are not covered by the moratorium".* The Inquiry considers the actual legal status of the moratorium to be uncertain. However, the Inquiry also assesses that there is a risk that the moratorium will be interpreted and applied in a way that constitutes an obstacle to the development of Bio-CCS in Sweden and other countries, and thus in the long run could fail to meet the goals of the Paris Agreement. Sweden should therefore work to change the moratorium so that this risk is eliminated. In November 2021, the Swedish Energy Agency stated that they agree with the position of the Inquiry and that they are currently – in its role as national centre for CCS – investigating the implications of the moratorium for Bio-CCS (Energimyndigheten, 2021).

3.3 Swedish incentives for Bio-CCS

The Swedish Inquiry on a "Strategy for negative greenhouse gas emissions" (SOU, 2020) concludes that supplementary measures including Bio-CCS will be required to reach the Swedish climate goal of net zero emissions in 2045 and even more so to reach the target of net negative emissions thereafter. The Inquiry furthermore states that the cost of achieving net zero emissions by 2045 will rise without the use of such supplementary measures. The Inquiry claims that early action will create room for manoeuvre at a later stage since the supplementary measures are generally characterised by high complexity and long lead times, pointing out that if Bio-CCS shall play a significant role in climate policy in 2045, the first plants will likely need to be taken into operation in the 2020s. Thus, the Inquiry also states that a politically backed quantitative target for supplementary measures by 2045 will facilitate long-term planning and action for potential project owners. The Inquiry proposes that at least 1.8 Mt biogenic CO_2 should be captured and stored annually by 2030 and recommends a minimum level of 10.7 Mt annually through supplementary measures by 2045, of which 3-10 Mt should be through Bio-CCS.

The Inquiry also concludes that there is a lack of national and EU-wide incentives for large-scale Bio-CCS and that an incentive structure needs to be introduced. This should promote technological development and demonstration activities as well as create predictable long-term economic conditions for large-scale Bio-CCS projects. More precisely, directed to the Swedish Government, the Inquiry recommends:

- Continued support for technological development and demonstrations in the field of Bio-CCS such as the existing investment aid instrument for negative emissions.
- Application of reverse auctioning, where the lowest bidder for stored biogenic CO_2 should be granted a compensation equal to the difference between the agreed price for the stored CO_2 and the value of any additional funding, nationally or from the EU. The Inquiry recommends that payment of the funds should be conditioned upon the applicant having applied for relevant support also from the EU.
- Work for instruments promoting Bio-CCS at EU level, such as changing the EU ETS to where Bio-CCS yields emission credits that may be used within the ETS.

In 2018, the Swedish Government announced that the "Industriklivet" program would allocate SEK 300 million annually from 2018 to 2040 to support the Swedish industry in their transformation towards zero GHG emissions. After several extensions, the program has a total budget of SEK 750 million in 2021 of which SEK 100 million should be dedicated to investing in technologies leading to negative emissions. In September 2021, the Government proposed in its draft state budget a further SEK 217 million extension to the program for 2022. Between 2023 and 2027, the program has so far been allocated SEK 300 million per year, of which SEK 50 million will be for projects related to negative emissions (Miljödepartementet, 2020; Miljödepartementet & Finansdepartementet, 2021).

The Government has also set up a program for green investment credit guarantees through which the state will promote large industrial investments that contribute to achieving the environmental goals and the climate policy framework. For 2022, the Government proposes to raise the program framework from SEK 15 billion to SEK 50 billion and further to SEK 65 billion in 2023 and SEK 80 billion in 2024 (Miljödepartementet & Finansdepartementet, 2021).

In December 2020, the Swedish Energy Agency was commissioned by the Government to produce a proposal for an agreement that enables the export of carbon dioxide from Sweden for long-term geological storage and which ensures that transport and storage takes place in a safe and responsible manner. The assignment states that the Swedish Energy Agency should set up a proposal for an agreement with Norway that meets the requirements set by the London Protocol (see 4.1) and examines conditions

for similar agreements with other countries, such as the United Kingdom and the Netherlands. The Energy Agency was at the same time also appointed National Centre for CCS (Regeringen, 2020b).

The Energy Agency was also tasked by the Government to propose a system for the financing of Bio-CCS either through reverse auctioning or so-called fixed storage money (Regeringen, 2020a). The Energy Agency published its final proposal in November 2021, suggesting reverse auctioning with the first auction taking place in 2022-2023 with actual first storage in 2026, pending on the proposed aid scheme being approved by the EU Commission (Energimyndigheten, 2021).

In November 2021, the Swedish Parliament approved the state budget for 2022 put forward by the opposing parties in the Parliament. The state budget for 2022 includes introducing a system for operating support for Bio-CCS in the form of reverse auctioning. Here, the players who can deliver the service of capturing and storing CO_2 at the lowest cost win the tender. The budget proposes that the Swedish Energy Agency should be provided with funds so that up to 2 million tons of CO_2 can be captured and stored annually concluding that the Energy Agency hence should receive a total funding of SEK 36 billion between the years 2026 and 2046 to support Bio-CCS. Also, the budget allocates SEK 5 million per year to the Energy Agency to prepare for an increased use of Bio-CCS and to review how CCS in general can be implemented in Sweden (Sveriges Riksdag, 2021).

3.4 European incentives for Bio-CCS

As of December 2021, there are no incentives in place for bio-energy with CCS on an EU level. However, as mentioned in section 3.1, the Commission is investigating ways to introduce instruments that can address the issue of and create incentives for Bio-CCS. These instruments will be studied in the Commission's further work on the European Green Deal.

In December 2019, the EU presented the European Green Deal proposing to raise the Union's greenhouse gas emission reduction targets from 40% to 55% by 2030 compared to 1990, and to achieve zero net emissions by 2050. In March 2020, the Commission presented the Climate Law proposing to turn the new, more ambitious climate targets put forward in the Green Deal into a legal obligation (European Commission, 2020). On 9 July 2021, the EU published Regulation (EU) 2021/1119 (the European Climate Law) which enshrines in law the EU´s objective of reducing net greenhouse gas emissions by at least 55% by 2030 and to become climate neutral by 2050 (European Commission, 2021c).

In July 2020, the delegated taxonomy regulation entered into force setting the basis for economic activities to qualify as environmentally sustainable, and by that, also establishing six environmental objectives:

- Climate change mitigation.
- Climate change adaptation.
- The sustainable use and protection of water and marine resources.
- The transition to a circular economy.
- Pollution prevention and control.
- The protection and restoration of biodiversity and ecosystems.

The proposed regulations stated that the manufacture of biomass, biogas or biofuel should reduce the risk of Indirect Land Use Change (ILUC) and deliver robust climate benefits compared to fossil fuels. In order to be taxonomy eligible, it must be produced from the advanced feedstock listed in Part A of Annex IX of EU Directive 2018/2001 (the revised Renewables Directive – RED II).

In June 2021, the Commission published technical screening criteria for a number of activities meeting the two first objectives (climate change mitigation and adaptation). Contrary to an earlier proposal, which was met by massive criticism, bioenergy will no longer be considered as a transitional activity as long as its use is consistent with the sustainability framework for those sectors laid down under Directive (EU) 2018/2001 (the RED II Directive). For an activity to be classified as sustainable according to the taxonomy regulation, it will have to be both taxonomy *eligible*, i.e. yield substantial contribution to climate change mitigation and adaptation, and taxonomy *aligned*, i.e. meet the technical screening criteria set out in the annexes to the regulation. Annex 1 sets the screening criteria for climate change mitigation while Annex 2 sets the screening criteria for climate change adaptation (European Commission, 2021a).

Activity 4.8,"Electricity generation from biomass", is the only activity in the regulations where Bio-CCS is mentioned explicitly by the technical screening criteria for climate change mitigation. This concerns electricity generation installations with a total rated thermal input above 100 MW, which must meet one or more of three criteria of which carbon capture and storage technology is one. The two other criteria being to attain an electrical efficiency of at least 36% or application of highly efficient Combined Heat and Power (CHP) technology set out in the Directive 2012/27.

The criteria for Activity 4.13, "Manufacture of biogas and biofuels for use in transport and of bioliquids", states that if CCS is applied, it will have to follow the technical screening criteria laid out for Activity 5.11 (Transport of CO_2) and 5.12 (Underground permanent geological storage of CO_2). The screening criteria also sets limits on the feedstock that can be used, stating that food- and feed-crops should no longer be used to produce biofuels. Apart from that, the feedstock must follow the sustainability criteria set out in the RED II Directive, which is under revision.

In July 2021, the European Commission presented the "Fit for 55" package which contains legislative proposals to revise the entire EU 2030 climate and energy framework. This included a significant revision of the RED II Directive (which otherwise should have been implemented by 30 June, 2021) to meet the new targets set for greenhouse gas emissions, to implement the measures proposed in the energy system integration and hydrogen strategies as well as other initiatives adopted under the European Green Deal. The Commission is currently preparing the new RED III Directive, which as of November 2021 is being discussed within the EU Parliament and the EU Council. The Commission's proposals for RED III, that will have the most significant effect on the use of bioenergy in Sweden, is a prohibition on the use of all biomass from primary and highly biodiverse forests (rather than just agricultural biomass, as in the RED II directive) and from stumps and roots, as well as an obligation for Member States to design support schemes for renewable energy in accordance with the biomass cascading principle.

The European Commission has announced that it will publish a Communication entitled "Restoring sustainable carbon cycles" during the fourth quarter of 2021. A roadmap for this initiative outlining the thinking of the Commission was published in September 2021 (European Commission, 2021d). Here it is mentioned that *"The initiative aims to develop a long-term vision for sustainable carbon cycles (including capture, storage, and use of CO_2) in a climate-neutral EU economy and to kick-start the development of technological and nature-based solutions. The Communication will present the long-term role of nature- and technology-based solutions for the capture, storage or use of CO_2 towards an EU economy that first becomes climate neutral and subsequently removes more greenhouse gases than it emits."*

Furthermore, the roadmap provides a link to another initiative, "the Certification of carbon removals – EU rules" (European Commission, 2022). It is on this website announced that a public consultation is planned for the first quarter of 2022 and the adoption by the Commission by the fourth quarter of 2022. This initiative will propose EU rules for certifying carbon removals, and develop the necessary rules to monitor,

report and verify the authenticity of these removals. The aim is to expand sustainable carbon removals and encourage the use of innovative solutions to capture, recycle and storage of CO_2 by farmers, foresters, and industries.

4 CO_2 transport from Sweden to Norway for storage on the Norwegian Continental Shelf (NCS)

4.1 The London Protocol

The London Protocol aims to protect the marine environment from dumping of wastes. Originally the protocol did not include CO_2 as one of the compounds permitted for dumping, and thus it presented a barrier against proceeding with offshore CCS activities. Furthermore, the original Article 6 of the Protocol bans transport of wastes, including CO_2, to other countries for storage (Figure 2, left).

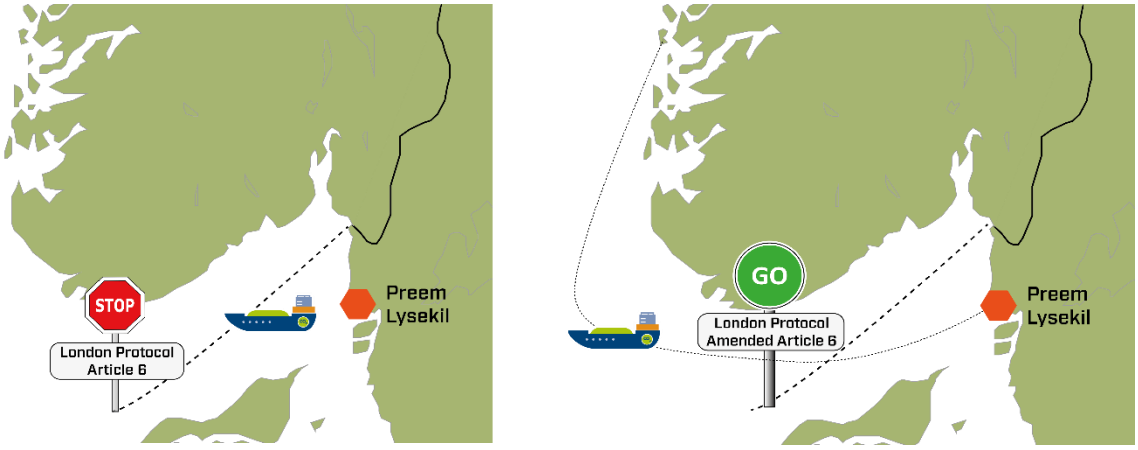

Figure 2. Left: The original Article 6 of the London Protocol bans transport of wastes, including CO_2, to other countries for storage. Right: The amended Article 6 allows for transborder shipment of CO_2. A provisional application of the amended Article 6 was adopted by the IMO in October 2019.

In 2006, the London Protocol partners adopted amendments that created a legal basis for storage of CO_2 under the seabed (IMO, 2019a), while excluding the use of CO_2 waste streams for enhanced oil recovery. In 2009, an amendment was made to Article 6 allowing transborder shipment of CO_2. However, for the latter amendment to get into force it must be adopted by 2/3 of the 53 parties, which by July 2019 had only been signed by six. Since then, Sweden has ratified the amendment (in June 2020). In October 2019, the International Maritime Organization (IMO) allowed for a provisional application of the 2009 amendment to the Article 6 of the London Protocol (Figure 2, right). This means that those parties who wish to use the amendment to Article 6 has the right to do so, while it has no legal bearing for the parties who do not wish to export or import CO_2 for permanent geological storage.

In practice, countries that wish to allow for export of CO_2 for injection and permanent storage under the seabed must deposit a Unilateral Declaration on provisional application of the 2009 Amendment to the London Protocol Article 6 to the Depositary (Secretary-General of the IMO). This means that in the case of transporting CO_2 from Sweden to Norway, both Sweden and Norway must deposit such unilateral declarations. Thereafter, a bilateral agreement must be established between Sweden and Norway. This agreement shall include confirmation and allocation of permitting responsibilities between the two countries, consistent with the provisions of the London Protocol and other applicable international law, to define a stable framework for the transborder CO_2 transport. This agreement should be expected to cover items such as cost sharing, monitoring of the transport, reporting and liability, in addition to the mentioned permitting regimes. The bilateral agreement shall also be notified to the Depositary. It should

be noted that countries can deposit unilateral declarations on the provisional application of the 2009 Amendment to the London Protocol Article 6, even if they have not ratified the amendment of Article 6.

It is the authors' understanding that the unilateral declaration of the provisional application of the amended Article 6 is only necessary for the two countries exporting and receiving CO_2, and for the purpose of offshore CO_2 storage. This means that a ship carrying CO_2 can pass through the territorial waters of a third country, without the third country having to deposit a unilateral declaration to the IMO or enter into an agreement with the exporting and receiving countries.

The London Protocol does not regulate ship transport of CO_2 for other purposes, e.g., for CO_2 capture and use (CCU). The main regulatory problems for transborder shipment of CO_2 and Bio-CCS are listed in Table 6.1 along with the solutions.

4.2 EU ETS and CO_2 ship transport, taxonomy regulations

4.2.1 Current situation for the EU ETS

The EU Emissions Trading System (EU ETS) allows subtracting the CO_2 emissions that are captured and transported for storage. Up till now in the EU ETS, CO_2 transport network has been defined as transport by *pipelines* and a clarification regarding CO_2 transport by *ship* was therefore required. In 2019, Norway sent a request for a clarification to the Commission which presented the following argumentation:

> *"When transfer of CO_2 from the ship or truck to the pipeline transport network or storage site is completed, Norway's understanding is that the capture installation can subtract the CO_2 from its emissions."*

The Commission was asked to comment on this and on the scope of the permits and monitoring plans for the capture operator and the storage operator.

4.2.2 The EU ETS clarification from the Commission on ship transport

In a letter of July 2020, the Commission agrees with the Norwegian view:

> *"The capture installation should be allowed to deduct from its emissions any CO_2 intended for the offshore storage facility. Each of the two capture installations in Oslo and Brevik under the project should be allowed to deduct from its emissions any CO_2 intended for the offshore storage facility. The Commission should be informed of the measures put in place, including tailor-made thorough monitoring plans to be developed for each capture installation in close cooperation with the responsible Norwegian public authorities, accounting for any CO_2 lost in transport. The installations remain of course responsible for any CO_2 released into the atmosphere and for surrendering the corresponding amount of allowances - the measurement of the losses would indeed take place at the point of delivery."*

It is observed by the authors that in the first sentence of the reply from DG CLIMA it is stated that the Commission agrees with the Norwegian view.

A noteworthy consequence of the above interpretation is the delay in subtraction of CO_2 emissions for the capture installation – this subtraction must wait until the captured CO_2 is delivered from a truck or ship to the pipeline transport network. This should mean that the capture operator (Preem in this case) will be liable for any losses of CO_2 until the CO_2 transfer to the storage operator (Northern Lights in this case) at the receiving terminal is completed, as illustrated in Figure 3.

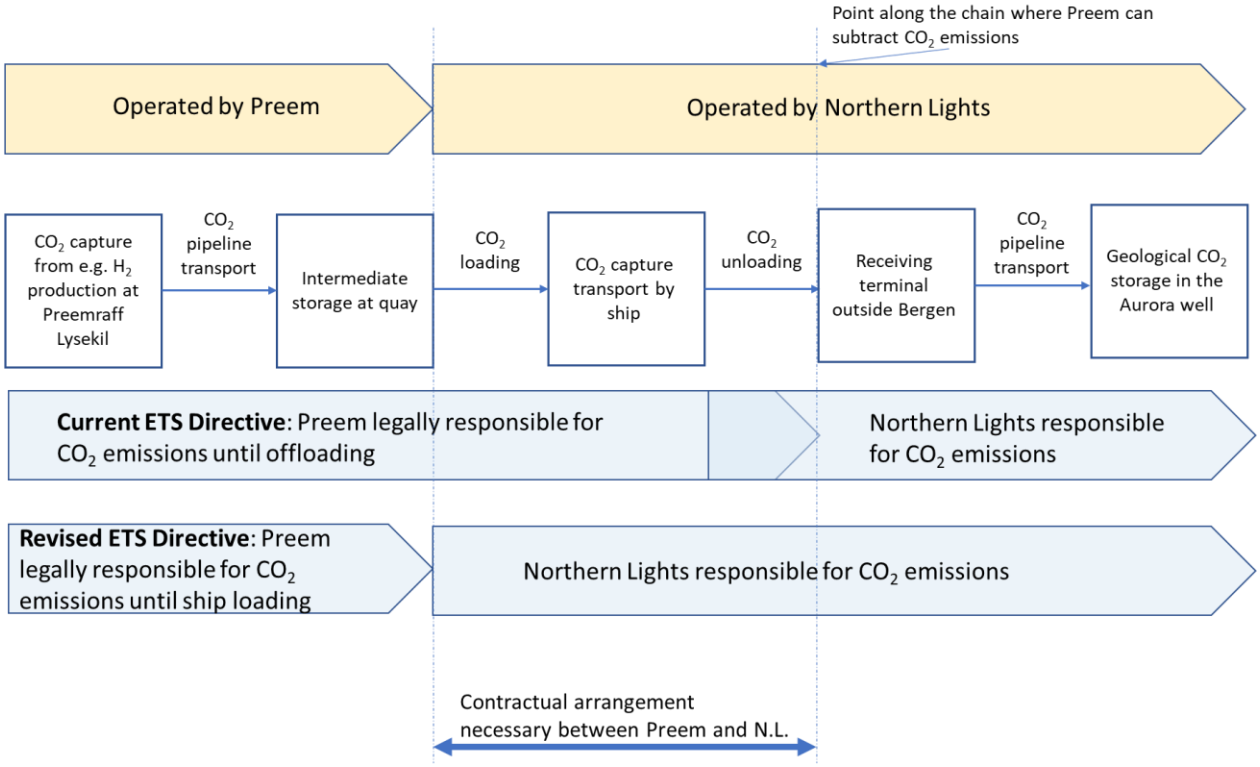

Figure 3: Liability for CO_2 emissions during capture, transport and storage under the current EU ETS regulations. With the suggested revision of the EU ETS (section 4.2.3), Northern Lights will be responsible for emissions during CO_2 ship transport. Preem will still have to wait with subtracting emissions until the CO_2 is delivered at the receiving terminal.

If the transport to the receiving terminal is operated by a different legal entity than Preem as capture operator, Preem will under the current EU-ETS still be liable for any CO_2 released to the atmosphere during the transport (emissions and losses). Thus, such CO_2 cannot be subtracted from Preem's emissions and Preem will consequently be liable for CO_2 emissions that it does not have direct control over. This could be solved by contractual arrangements, including for instance an obligation for Northern Lights to compensate Preem for economic damage due to losses of CO_2 during transport.

Our understanding of the current regulative situation is that Preem's permit and monitoring plan must cover the capture installation, transport by pipeline and/or trucks to the intermediate storage at their harbour, and the transport by ship to the receiving terminal. The storage operator must have a permit and monitoring plan covering the receiving terminal, transport by pipeline and the storage activity. It should be noted that it is currently not fully resolved whether the CO_2 offloading, and CO_2 emissions during offloading to the receiving terminal would have to be included in Preem's permit and monitoring plan, or by the Northern Lights permit and monitoring plan.

4.2.3 Proposed revision of the EU ETS system regarding emissions during ship and truck transport

An amendment of the EU ETS system was proposed on 14 July 2021 (European Commission, 2021b). Among many other things, it is proposed in this amendment that emissions from CO_2 transport "by means other than pipelines, such as by ship and truck" shall be included in the EU ETS, provided that the emissions are not accounted for under another activity under the EC CCS Directive (Directive 2009/31/EC). The suggested change clarifies the responsibility for CO_2 emissions during transport – it will be the ship

operator, truck operator etc. that is responsible for the emissions during the transport, and not the capture installation as illustrated in Figure 3 above and described in section 4.2.2.

However, the proposed change in the EU ETS will *not* resolve the challenges related to the understanding of *when* CO_2 emission allowances can be subtracted. The reason for this is that the MRR regulation Article 49 still states that CO_2 quotas that are not emitted can be subtracted only when the CO_2 is transferred out of the installation to a *transport network* with the purpose of long-term geological storage in a storage site permitted under Directive 2009/31/EC. The CCS Directive still defines a transport network in a manner that only comprises pipelines (including associated booster stations) for the transport of CO_2 to the storage site. From the capture installation perspective, the contractual situation would be simplified e.g., if a transport network was redefined under the MRR regulation to comprise not only pipeline transport but also ship, trucks and other tank-based transport modalities (e.g. trains). On the other hand, bearing in mind that the purpose of CCS is to reduce CO_2 emissions to the atmosphere and that there is always a probability of minor CO_2 losses from tank-based transport, if a capture installation can subtract CO_2 emissions at the point where the ship is loaded, it will be allowed to subtract more allowances than the amount of CO_2 that will finally be stored.

In sum, as long as the definition of CO_2 transport network is not revised, Preem will not be allowed to subtract the CO_2 captured until it is delivered at the receiving terminal at Øygarden. However, when the change in the EU ETS is implemented, Preem will not be legally responsible for CO_2 emissions during transport from Lysekil or Gothenburg to Øygarden (Figure 3). The number of allowances that Preem can avoid surrendering will typically be slightly reduced compared to the amount of CO_2 that is captured. A contractual arrangement between Preem and Northern Lights should take this into account.

4.2.4 CO_2 transport and storage under the delegated taxonomy regulations

The delegated taxonomy regulation sets technical screening criteria for "Transport of CO_2" (Activity 5.11) and “Underground permanent geological storage of CO_2” (Activity 5.12). With regard to transport of CO_2, the following criteria must be met:

- The CO_2 transported from the installation where it is captured to the injection point does not lead to CO_2 leakages above 0.5% of the mass of CO_2 transported.
- The CO_2 is delivered to a permanent CO_2 storage site that meets the criteria for underground geological storage of CO_2 set out in Section 5.12 of this Annex; or to other transport modalities, which lead to permanent CO_2 storage that meet those criteria.
- Appropriate leakage detection systems are applied and a monitoring plan is in place, with the report verified by an independent third party.

With regard to Activity 5.12, Storage of CO_2, the screening criteria refers to the CCS Directive for characterisation and assessment of the potential storage complex and surrounding area, and that the site has appropriate leakage detection systems and a monitoring plan of the injection facilities, the storage complex, and the surrounding environment.

4.3 Hazardous Noxious Substances Convention

The International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea 1996 (HNS) has not yet entered into force. However, it has the support of a number of states. The HNS convention aims to ensure prompt and effective compensation to those who have suffered from damage to person and/or property. This includes cost of clean-up and economic losses resulting from the maritime transport of hazardous and noxious substances.

The HNS convention covers chemicals such as oils, liquefied gases, liquid substances defined as noxious or dangerous, hazardous materials and substances carried in packaged form as well as solid bulk materials possessing chemical hazards. The convention establishes the principle that the 'polluter pays' by ensuring that the shipping and HNS industries provide compensation to those who have suffered loss or damage resulting from an HNS incident. The HNS convention provides a framework for an international system where the shipping, oil, gas, chemical, petrochemical, and other HNS industries are committed to paying compensation. The HNS Convention benefits all State Parties (producing, receiving and coastal states) by establishing a system of strict liability and clear claims criteria (IMO, 2019b).

A recommendation from the PhD study "The Liability regime for CO_2 shipping" performed in the NCCS Centre (O'Brien, 2020) was that the HNS convention should enter into force before large-scale CO_2-shipping becomes a reality. This is in order to provide consistent liabilities to shipowners and ensure predictable compensation for victims. It is vital that widespread ratification of the Convention continues to be encouraged by the IMO and the EU to secure its entry into force. The Protocol to the Convention has so far been ratified by five states, including Norway, and in July 2019 the IMO reported that several other states had made significant progress so that further ratifications are anticipated. The target time frame for entry into force is 2022 (Skuld, 2020).

5 CO_2 storage

5.1 Northern Lights

Northern Lights Joint Venture (NLJV) is responsible for the CO_2 transport, receipt, and permanent storage of CO_2 in a reservoir in the northern North Sea in the Norwegian full-scale carbon capture and storage (CCS) project "Langskip" (Longship). The project will initially include capture, transport, and storage of CO_2 from the Norcem cement plant at Brevik, Norway (400 tpa CO_2). Furthermore, CO_2 capture from Fortum Oslo Varme (400 tpa CO_2) is envisaged in the Longship project, but funding for the CO_2 capture installation is only partly guaranteed by the Norwegian state and, as of early December 2021, not fully secured.

The funding for the Longship project was approved by the Norwegian Parliament on the 14 December 2020. Infrastructure construction is (in 2021) ongoing, including the terminal for receiving CO_2 ships, and an order has been placed for two CO_2 carriers with 7,500 m^3 cargo capacity and a length of 130 m (Northern Lights, 2021). Initially, Northern Lights includes capacity to transport, inject and store up to 1.5 million tonnes of CO_2 per year. Once the CO_2 is captured onshore, it will be transported by newly designed ships, injected, and permanently stored 2,600 meters below the seabed of the North Sea. The facilities are scheduled to be operational in 2024.

The CO_2 receiving terminal will be located at the premises of Energiparken industrial area in the municipality of Øygarden in Western Norway. Exploitation License EL001 was awarded in January 2019. In March 2020, the Eos confirmation well was successfully drilled and completed, confirming the reservoir characteristics and storage capacity. Plans exist to increase the capacity to 5 Mt per year through additional phases of development and an increasing customer base.

5.2 Legal framework for CO_2 storage on the NCS

In Norway, storage activities not associated with or related to petroleum activities are primarily regulated by the Norwegian Act relating to "scientific research and exploration for and exploitation of subsea natural resources other than petroleum resources and mineral deposits" (LOV-1963-06-21-12), as well as the associated regulations relating to exploitation of subsea reservoirs on the Continental Shelf to store CO_2

and relating to transport of CO_2 on the Continental Shelf (FOR-2014-12-05-1517) – "The CO_2 Storage Regulations" or “Regulations”.

This framework regulates the exploitation of subsea reservoirs for storing CO_2, as well as exploitation, transport, and storage of CO_2 in such reservoirs in areas subject to Norwegian jurisdiction. The regulations also apply to transporting CO_2 and exploitation of subsea reservoirs to store CO_2 in and outside the Norwegian Continental Shelf when this follows from international law or from a treaty with a foreign state. Similar to the regulations associated with the production of petroleum resources, the regulations for storing CO_2 in subsea formations are licence-based. The Norwegian State has exclusive ownership of subsea reservoirs on the Continental Shelf with regards to the utilisation to store CO_2, and no CCS activities may be carried out or conducted without a permit. The Norwegian framework is based on, and reflects, the EU CCS Directive, which entered into force in June 2009 and was then incorporated into the EEA Agreement with effect from June 2013.

In addition to setting out the necessary permits, the CO_2 Storage Regulations also establish specific requirements and obligations for the different project phases. These obligations include monitoring requirements, obligations related to CO_2 leakage prevention, obligations to implement corrective measures in the event of subsurface irregularities, financial security requirements, as well as decommissioning obligations. The Regulations also stipulate the terms for transferring remaining obligations to the State at the end of a project following shutdown of a storage location, as well as providing general provisions associated with third party access to the storage facilities.

The EU CCS Directive also contains provisions relating to environmentally safe storage of CO_2. These provisions were implemented in Norwegian law through an amendment to the Pollution Control Regulation on 22 October 2014, which incorporates a new Chapter 35 about "Storing CO_2 in geological formations". Pursuant to Chapter 35 of the Regulation, a permit for injection and storage of CO_2 must be obtained through an application to the Norwegian Environment Agency.

CCS activities will also be subject to the Norwegian legal framework which is generally applicable for a broader scope of business activities, including the Pollution Control Act, as well as the Planning and Building Act, the Climate Act, the Greenhouse Gas Emission Trading Act, and respective associated regulations.

6 Conclusions and Identified Actions

This report presents the legal and regulatory matters that are relevant for realizing cross-border CO_2 ship transport from Sweden to Norway of CO_2 captured from the Preem refineries in Lysekil and Gothenburg. Furthermore, it puts focus on the current situation where there are economic incentives only for fossil CO_2 (the EU-ETS), whereas the future perspectives and incentives for Bio-CCS currently are unclear. The main legal hurdle for cross-border ship transport was resolved in 2019 with the provisional application of the amended Article 6 of the London Protocol. The challenges described in the report are summarized in Table 6.1 below, together with identified solutions and actions.

Table 6.1: Challenges, solutions, and actions for achieving cross-border transport for storage of CO_2 from Sweden to Norway.

Challenge	Solution/Action
The London Protocol did not include CO_2 as one of the compounds permitted for dumping and therefore provided a barrier to CCS activities	**SOLUTION:** An amendment was made to the London Protocol in 2006 allowing storage under the seabed.
Article 6 of the London Protocol banned transport of wastes to other countries for storage.	**SOLUTION:** In 2009 an amendment was made to Article 6 allowing transborder movement of CO_2. In October 2019 the IMO allowed for a provisional application of the 2009 Amendment to the Article 6 of the London Protocol. This means that those parties who wish to use the amendment to Article 6 has the right to do so. **ACTION:** Countries transporting CO_2 must deposit a unilateral declaration on provisional application of the 2009 Amendment to the London Protocol Article 6 to the Depositary (Secretary General of the IMO). **ACTION:** Sweden and Norway must enter into an agreement which shall include confirmation and allocation of permitting responsibilities between the two countries to define a stable framework for the transboundary CO_2 transport[3].
The EU-ETS allows subtracting the emissions that are captured and transported by pipeline for storage. Ship transport is not mentioned.	**SOLUTION:** When transfer of CO_2 from a ship or truck to the transport network or storage site is completed, the capture installation can subtract the CO_2 from its emissions. **ACTION:** Develop tailor-made, thorough monitoring plans for each capture installation in close cooperation with the responsible Norwegian and Swedish public authorities, accounting for any CO_2 lost in transport, and to keep the Commission informed of the measures put in place. **ACTION:** Since the industrial installation with CO_2 capture will be responsible for any CO_2 emissions during transport, an action under the current EU-ETS is to establish a contractual agreement between the industry and Northern Lights, to regulate e.g. compensations for CO_2 losses during transport. Once the amended EU-ETS system enters in force, the CO_2 emissions during ship transport will be the responsibility of the ship operator. As long as the definition of CO_2 transport network is not changed to comprise ships, trucks etc., the situation will still be that the capture installation can subtract the CO_2 emissions only when the CO_2 is delivered to a pipeline or to storage.
Economic incentives for capturing and storing biogenic CO_2 is lacking in the EU-ETS, but the EU Commission is working on developing other supportive instruments.	**ACTION:** Industries considering implementing Bio-CCS should follow this development and be prepared to respond to public consultations on the matter.

[3] The Swedish Energy Agency has been commissioned by the Government to produce a proposal for an agreement that enables the export of carbon dioxide from Swedish operations for long-term geological storage and which ensures that transport and storage takes place in a safe and responsible manner. The assignment includes the Swedish Energy Agency drawing up a proposal for an agreement with Norway that meets the requirements set by the London Protocol and examine whether there are conditions for preparing for similar agreements with other countries, such as the United Kingdom and the Netherlands. The proposal should be handed over to the Government Office by 31 December 2021 at the latest.

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