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Author(s)	
Prepared by	Per Sandberg
Recommended by	Ola Sannes
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Plan for long-term use of the Northern Lights infrastructure

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Per Sandberg, Emil Yde Aasen, Irma Paceviciute, Frode Nebell, Kjersti Vebenstad	
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Recommended (Organisation unit/ Name):	Date/Signature:
Quality and Risk Manager / Ola Sannes	**2019-11-25**
Approved by (Organisation unit/ Name):	Date/Signature:
Project Director / Sverre J. Overå	**2019-11-25**

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1 Background, content and guide to the report

The revised mandate which Gassnova received from the Norwegian Ministry of Petroleum and Energy (MPE) in the autumn 2018 included the instruction that Gassnova should ensure that Equinor (as operator) presents a plan for the long-term use of the Northern Lights infrastructure (hereafter called “the plan”). This report is the formal response from Equinor and the Northern Lights project to this instruction.

The Project has had several dialogues with Gassnova and MPE about their expectations to the plan, and how the instruction is to be interpreted. Key conclusions from these dialogues are:

- The plan is to be a formal delivery from the Northern Lights project.
- The plan is to be delivered 25 November 2019. This date is set to give Gassnova sufficient time to use it in their assessment of socio-economic benefits from Northern Lights, which thereafter is to be quality assured by the KS2 consultants.
- The separate DG3 report “Northern Lights Contribution to Benefit Realisation” (hereafter called “the benefit realization report”), which the project delivered 30.9.19, is comprehensive and covers much of what was originally intended when requesting the plan in autumn 2018. The plan can hence build substantially on, and complement, the benefit realization plan. The plan can hence be quite brief.
- Focus is to be on broad business perspectives. A section on how technical infrastructure needs to be developed would also be valuable. Important to illustrate how public and private investments in Northern Lights may enable larger CCS volumes. Main focus can be on the 5 mtpa scenario, but also show larger perspectives. Illustrate where CCS and companies could be in 10-20 years.
- Illustrate how different state support mechanisms (e.g. TCM, Climit, full scale) work together, how the Northern Lights project work together with research & development, and how Northern Lights enable industrial development.

MPE has also signalled interest in receiving the partner companies’ perspectives on two additional themes:

- In which way is Northern Lights strategically valuable for the partners?
- What are the partners’ perspectives on hydrogen, and how does Northern Lights enable that development?

Since these questions are more for the partners than the project to answer, the Northern Lights project has agreed with Gassnova that these two questions will not be addressed in this plan. Instead, the project has communicated to each of the three partner companies that they are invited to optionally submit individual memos addressing these two questions. The memos can be sent directly to Gassnova before 1.12.19, and they can be made confidential in relation to the other partners if so wished.The plan has three main chapters:

- Scenarios for CCS development in Europe.
- Actions needed to realize the scenarios.
- Development of technical infrastructure to realize the scenarios.

While this document is called a “plan”, it is crucial to recognize that this plan is very different from plans developed e.g. for oil and gas field developments. The main reason for the difference is that while oil and gas developments are delivering resources to an established market demand, Northern Lights is maturing the market along with the project. The plan for long-term use of Northern Lights infrastructure is therefore dependent on EU and European nations being committed to meet their agreed obligations in the Paris agreement and actually implementing the policies and funding instruments that enable necessary solutions. This context of this plan is the main reason for why it is based on scenarios (chapter 2), and with the identification of “who needs to do what” (chapter 3) as its key deliverable. Chapter 3 and 4 focus on actions and infrastructure needed to realize the scenarios. This can also be understood as actions and developments needed to realize the full potential of the Northern Lights infrastructure.

2 Scenarios for CCS development in Europe

The future use of the Northern Lights infrastructure will depend on how the market for carbon capture and storage develops. This development is expected to happen partly as a consequence of the new business models enabled by decoupling the source and the sink of CO2 offered in Northern Lights, by the accumulated offered CO2 storage capacity resulting from CCS projects which are currently developed in Europe, and the resulting decrease in cost of developing CCS which is enabled by the learning effects of these same projects and parallel R&D. To illustrate how this development may span out, the Northern Lights project has developed step-wise scenarios with four steps; 1.5 million tons per annum (MTPA) of CO2 stored, 5 MTPA, 20 MTPA and 100 MTPA. Each scenario is enabled by business and market development activities with specific emission sites interested in capturing their CO2 and transporting it to Northern Lights for permanent storage (hereafter referred to as 3rd parties), combined with strategic R&D projects aimed at de-risking technical barriers to enable a European CCS network to develop. Please refer to the benefit realisation report for more information on how business development and strategic R&D projects mutually enable such scenarios.

These scenarios are specific to Northern Lights, meaning that additional CCS capacity offered by other projects developed in parallel will not be illustrated in the step-wise manner. However, in order to visualize how a future large-scale European CCS network could look, and how Northern Lights would contribute to this, this plan presents one final scenario where the accumulated development of the major CCS projects in Europe is illustrated.

2.1 1.5 MTPA Scenario

Phase 1 of Northern Lights has an annual capacity of storing 1.5 MTPA of CO_2, which will likely be utilized by a combination of emission sources from the Norwegian Full-Scale CCS project and the most mature 3rd party candidates included in the Northern Lights application for an EU Project of Common Interest (PCI). Assuming positive FIDs for both state-supported capture candidates, Fortum Oslo Varme and Norcem, they will each capture approx. 400,000 tonnes of CO_2, resulting in 800,000 tonnes of CO_2 annually to be transported and stored by the Northern Lights. This leaves 700,000 tonnes of spare capacity in Phase 1 for other 3rd party volumes, which will likely enable one or two non-Norwegian 3rd parties to connect to the Northern Lights. As described in the benefit realisation report, the information in the PCI application describe how Air Liquide, Preem, and H2M Eemshaven plan to start their CCS operations in 2025, with a resulting necessity to store their CO_2 emission in the same timeframe. This is also confirmed by the level of maturity of the dialogue between Northern Lights and these 3rd parties. There are also additional 3rd parties who could be ready to store their CO_2 with Northern Lights in the same timeframe without having indicated this in the PCI application. These 3rd parties have trough requests for information (RFIs) for the development of a full-chain CCS solution, and/or through piloting capture technology, indicated to Northern Lights that their start of operation would fit with Northern Lights Phase 1.

The accumulated volumes of captured $_{CO2}$ by possible state-sponsored volumes and the 3rd parties communicated with an indicated start-up in 2025 hence amount to far more than 1.5 MTPA. Given sustained interest from the 3rd parties, this could result in a ‘first to store’ situation where several 3rd parties wish to utilize the spare capacity of Phase 1. This could also generate momentum for the expansion to Northern Lights Phase 2.
A final investment decision (FID) for Northern Lights in 2020 enables the relevant 3rd parties to apply for the first call of the Innovation Fund, as this is expected to match this timing. Given a final approval of the PCI application, which

is expected in January 2020, each of the PCI partners will also be eligible to apply for funding from the Connecting Europe Facility Fund.

Phase 1 of Northern Lights will aim to demonstrate the technical feasibility and commercial attractiveness of European industry to connect to the provided infrastructure. Given that investments in capture technology, intermediate storage and offloading for relevant 3rd parties would require operation for several years in order to be economically feasible with the current ETS price, it is envisaged that the European 3rd parties who connect to Northern Lights in Phase 1 will be utilizing this infrastructure for several years. This is of course dependent on Northern Lights being cost competitive with other alternative CCS projects and CO2 abatements measures.

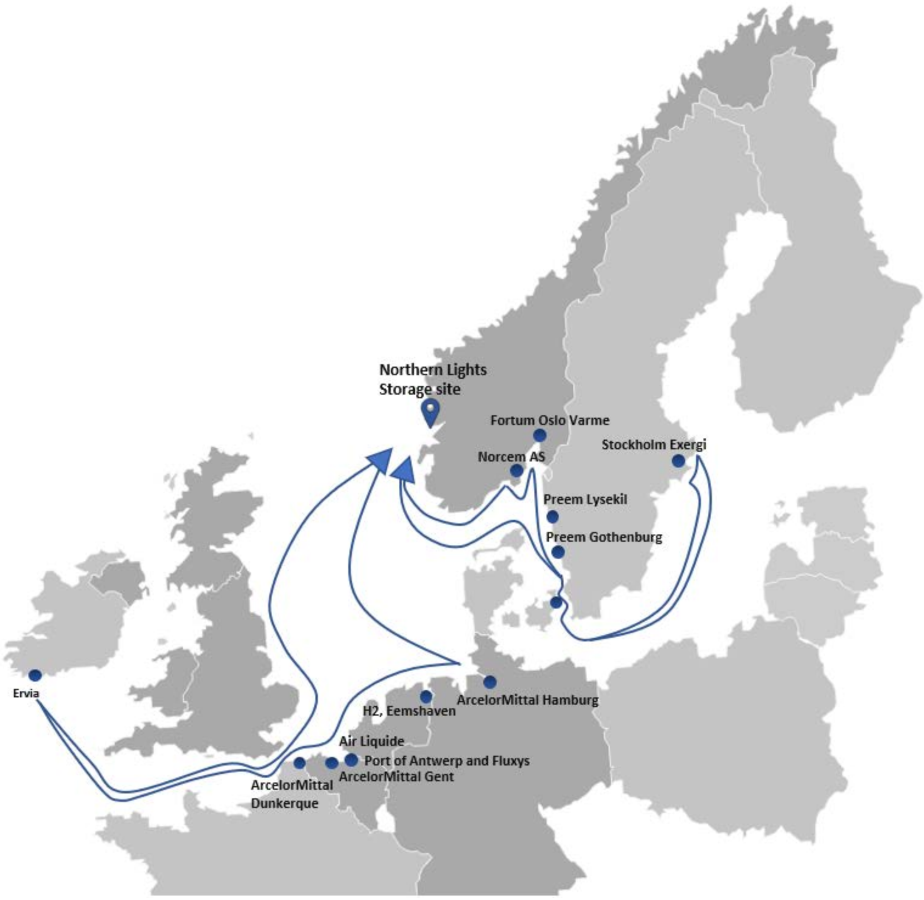

Figure 2-1: The 1.5 MTPA scenario of Northern Lights includes capture candidates from the Norwegian Full-Scale CCS project and the European Project of Common Interest.

2.2 5 MTPA Scenario

Phase 2 of Northern Lights has a planned annual capacity of 5 MTPA, adding an additional 3.5 MTPA of capacity to Phase 1. A Phase 2 expansion will have to be triggered by market pull from commercial 3rd parties, which will be a crucial step in terms of the long-term use of the infrastructure. This is because the initial volumes of CO2 indicated in the PCI and in dialogues with 3rd parties typically range between 300 KTPA and 800 KTPA, with some few outliers in the lower KTPA and higher MTPA ranges. Phase 2 would hence allow for 4 to 8 new 3rd parties to connect to the infrastructure. Combined with the capture sites in Phase 1, this would result in a CCS network consisting of 7 to 12 industrial sources of CO2 which are connected to the Northern Lights infrastructure.

The expansion to 5 MTPA storage capacity would necessitate additional investments from the Northern Lights partnership. This would require specific project development and investment decisions. To trigger such an expansion the demand for transport and storage infrastructure will have to be proven in Phase 1, with more 3rd parties incorporating CCS as part of their decarbonisation strategy. The expansion to Phase 2 could, in terms of market pull, be triggered by the following kind of developments:

1) Market demand from a 3rd party anchor supplier that will increase the total volume of CO_2 significantly above 1.5 MTPA. Such an anchor customer will likely have to be in the MTPA range.
2) Market demand from several volumetrically smaller 3rd parties in parallel. The relevant first moving 3rd parties highlighted in the 1.5 MTPA scenario constitute a total volume of CO_2 that exceeds the capacity of Phase 1 and could therefore create the necessary momentum and market pull to enable an expansion to Phase 2. The expansion will therefore likely be started by adding 3rd party CO_2 volumes from some of the industrial sites in Sweden, Germany, Belgium, France, Netherlands, Ireland or Denmark. Additional CO_2 volumes could be sourced from Norway as well – from emission sites which are not part of the Norwegian full-scale CCS project. Potential Norwegian candidates that joined the PCI application are CO_2 Hub Nordland, Eyde Cluster, and Borg CO_2.
3) A combination of 1) and 2). As an example, the individual 3rd party volumes indicated in the PCI represent a great volumetric range, ranging from 150 KTPA to 3 MTPA, and a number of combinations could enable the market demand needed to trigger a Phase 2 expansion.

For these three developments, the specific timing and combination of these are dependent on technical and commercial maturation between Northern Lights and each of the 3rd parties. External factors could further accelerate these developments. Examples of such factors are dedicated funding for CCS on a national and/or EU level, CCS being implemented in national/regional/city climate strategies, and a sharp increase in the ETS price.

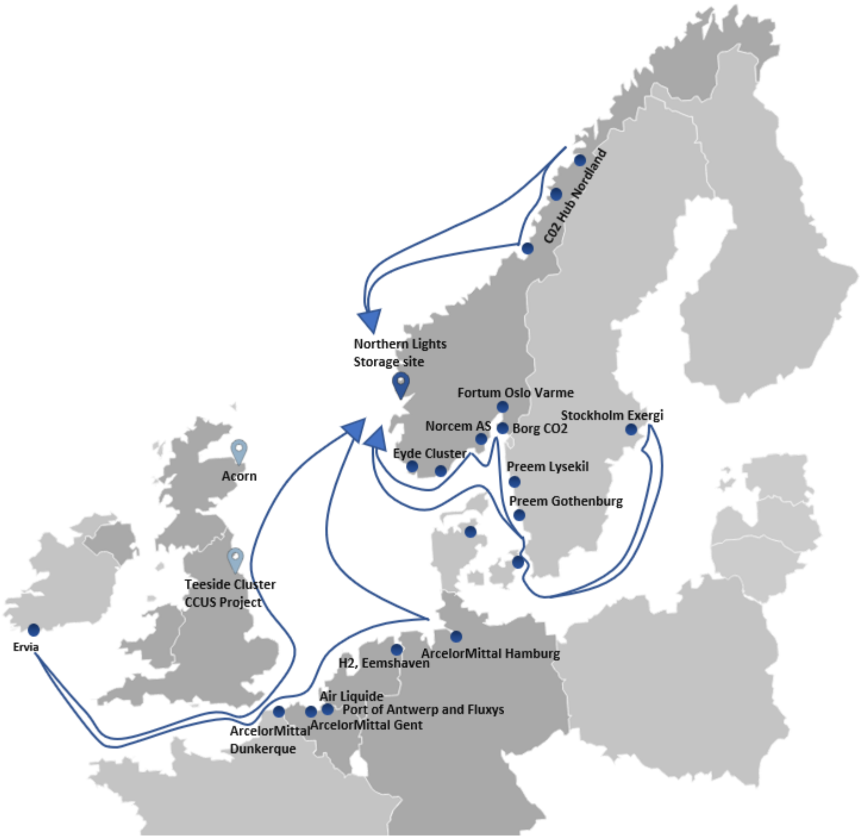

Figure 2-2: The 5 MTPA scenario could be enabled by a large anchor supplier of CO_2, a number of smaller 3rd parties in parallel, or a combination of both.

2.3 20 MTPA Scenario

The 20 MTPA scenario is not included in the current scope developed through the concept and FEED phases in Northern Lights, as these are limited to Phase 1 and Phase 2, representing the 1.5 and 5 MTPA scenarios, but is based on opportunities in the business development funnel of the project. The project is in dialogue with many 3rd parties, spanning from initial interest to negotiating "Heads of terms" and potential tariffs. The technological and commercial maturity of 3rd parties, combined with their strategy for potential CCS development, form the basis of this scenario.

The importance of strategic R&D efforts for enabling the 20 MTPA scenario should be underlined, as these are instrumental to realize cost reductions along the value chain beyond the first two phases of the project. Larger CO_2 transport ships could enable larger volumes and development of barge transport could allow the Northern Lights transport service to reach emission sites located in proximity to rivers. In turn, CO_2 transport by ship could become available to a wide range of emission sites in Europe that have the relevant characteristics for capturing significant volumes of CO_2 for permanent storage. Project development could also facilitate the upscale of CO_2 injection capacities and allow Northern Lights to mature large CO_2 storage locations for volumes beyond 5 MTPA. Improved logistic chains and transport modes could trigger new demand for CO_2 storage across European industries.
The 20 MTPA scenario could be triggered by a combination of developments:

- Eastern Europe connected to Northern Lights: 3rd parties in the Baltic region, Finland and Poland could come on stream, as the combination of decreasing CCS costs and targeted EU funds helps to increase the relevance of CCS as a tool for decarbonisation in larger cities and industries exposed to ETS price.
- River transport enabled: Industrial first-movers in central Europe, most likely in Germany and Switzerland, utilize barge transport on the Rhine to connect to Northern Lights infrastructure. Intermediate storage hubs along the Rhine could allow for a combination of sea/river vessels and barges to offer transport infrastructure to industrial clusters in the area.
- Scale-up effect: During this phase, additional volumes could come from CO_2 capture sites in Sweden, France, Denmark, Germany, and Belgium. This could be a scale-up of existing value chains that already are operational and connected to Northern Lights with volumes in the range of 200 to 500 KPTA. As indicated by for example ArcelorMittal in the PCI description, their captured volume of CO_2 could increase significantly with a factor of 3-10 times (depending on the facility), as the operational experience of successfully capturing smaller volumes enables this increase. This logic has been confirmed in dialogue with other relevant 3rd parties as well, as companies will want to test the technology at smaller, yet industrial, volumes before scaling up. The first movers for such scale-up could initiate this in the 20 MTPA scenario.
- Shift from medium-pressure to low-pressure CO2 carriers enable transport of greater volumes: To minimize cost and technological risks, the ships in Phase 1 are medium pressure, which limits the tank volume of each vessel, resulting in a 7500 m^3 capacity per ship. Strategic R&D projects are currently addressing the transition to low pressure ships, which enable a capacity of 20-30.000 m^3 per ship. As the CCS network develops, ships that can sail longer distances with greater CO2 volumes will allow for an increasing number of 3rd parties to connect.
- Second and third wave of Norwegian capture projects: Through the PCI the Northern Lights has partnered with three key industrial clusters in Norway; Borg CO2, CO2 Hub Nordland and Eyde Cluster. Given that these clusters consist of some of the largest industrial companies in Norway, with specific feasibility studies aiming at implementing CCS, these clusters are expected to connect to the Northern Lights scenario in the 5 MTPA or 20 MTPA scenario. Industrial initiatives aiming to develop CCS in Bergen, Stavanger and Trondheim are also started, which in combination with the industrial clusters will represent the second and third wave of Norwegian capture candidates connecting to Northern Lights. Existing local industry and new establishments in close proximity to Naturgassparken can also be expected to connect to the storage infrastructure.

The 20 MTPA scenario would develop the infrastructure that enable even further growth from 20 MTPA to 100 MTPA. This growth would be enabled by increased capacity and connectiveness in transport and driven by clustering around emerging hubs.

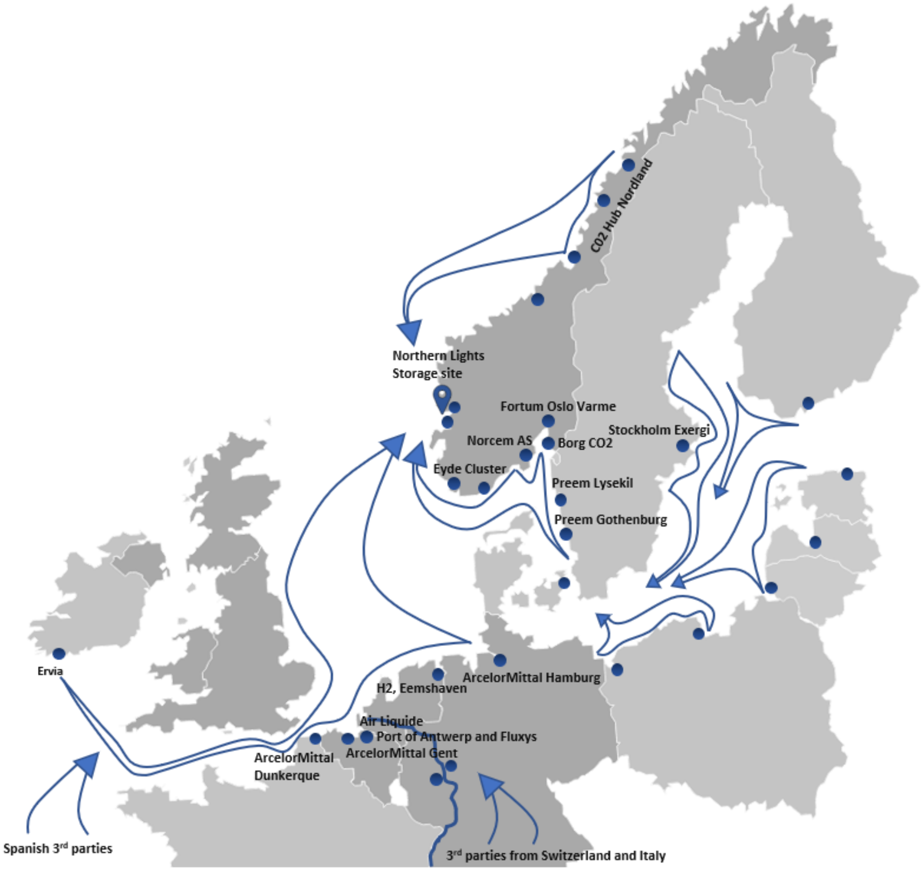

Figure 2-3: The 20 MTPA scenario demonstrates the scale-up effect of the existing network, and additional volumes that could be connected.

2.4 100 MTPA Scenario

In addition to 3rd parties included in previous scenarios, the 100 MTPA scenario includes the accumulated effects of industrial clustering, scale-up of connected 3rd parties and the successful outcome of strategic R&D projects, which in combination could enable the emergence of a European network of CO_2 capture, transport and storage coming in place, with ship-based and pipeline transport complementing each other. The 100 MTPA scenario could be triggered by the following developments:

- Continued scale-up effect: Existing capture candidates scale up from KTPA range to MTPA range, where there is room for such expansion.
- Cluster scale-up: In the 100 MTPA scenario the emerging industrial CCS hubs which were formed in the 20 MTPA scenario are scaled up. Industrial CCS clustering along the Rhine, with the main hubs being based in the Ruhr Area, which together with clusters along the North Sea and Baltic Sea coasts capture significant volumes of CO2 and transport this for permanent storage.
- Inland volumes connected to the network: Inland volumes in central Europe are enabled to connect to the CCS network through rivers and shorter pipelines to existing hubs. This enables large volumes from Germany and Poland to be captured, transported and permanently stored.
- Offshore storage and CO2 pipelines: With the accumulation of larger volumes of captured CO2, it could now be economically viable for offshore pipelines from the European mainland to transport CO2 directly to storage locations on the Norwegian Continental Shelf.

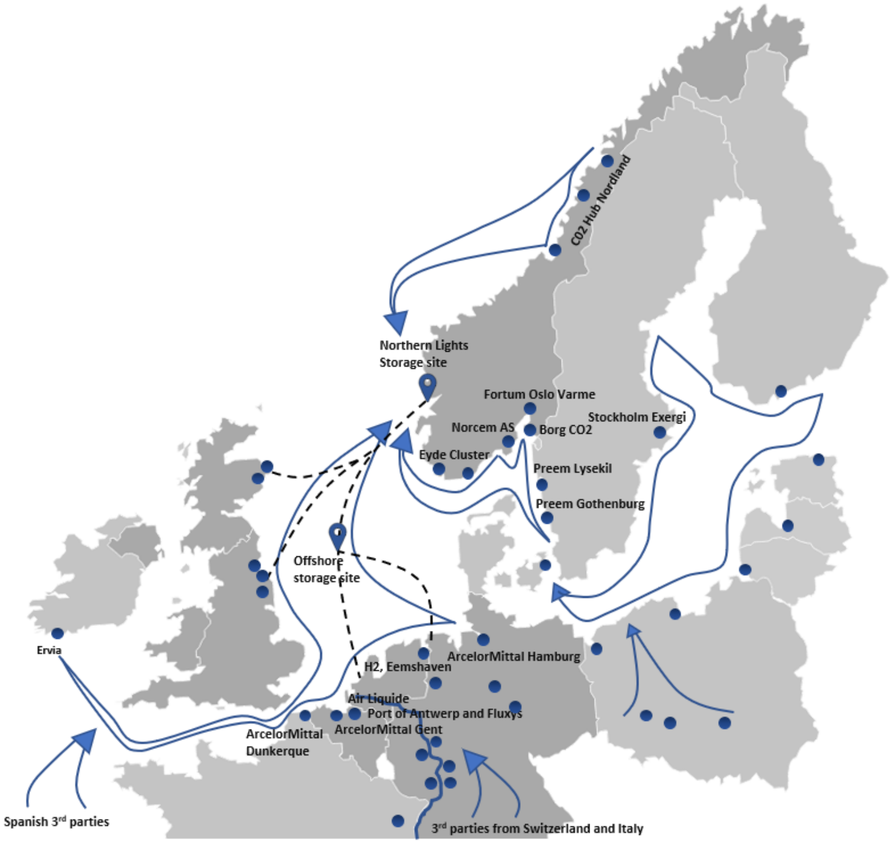

Figure 2-4: The 100 MTPA scenario demonstrates continued scale-up effect, and volumes from inland Europe that could be connected.

2.5 The European CO2 Network Scenario

In parallel to Northern Lights, several other European full value chain CCS project are being developed. As stated in public information, these projects are expected to realise storage in the Netherlands, UK and Ireland in the period between 2020 and 2030. In combination with Northern Lights, these projects would offer substantial storage capacity for CO2, and represent the beginning of a European CCS network. Known project developments that could constitute the initial parts of this network consist of:

- Acorn CCS, St- Fergus Scotland
- OGCI Clean Gas & Teesside Collective, UK
- CO2 TransPorts, Port of Rotterdam Netherlands
- Ervia Cork CCUS, Ireland
- Northern Lights, Naturgassparken Norway
- Athos in Amsterdam
- Zero Humber, UK

This illustrates how a potential CO2 removal ecosystem could look in Europe. Each of the full value chain projects would have additional point sources to the ones indicated in the Northern Lights scenarios, resulting in an accumulated volume of CO2 far exceeding the 100 MTPA.

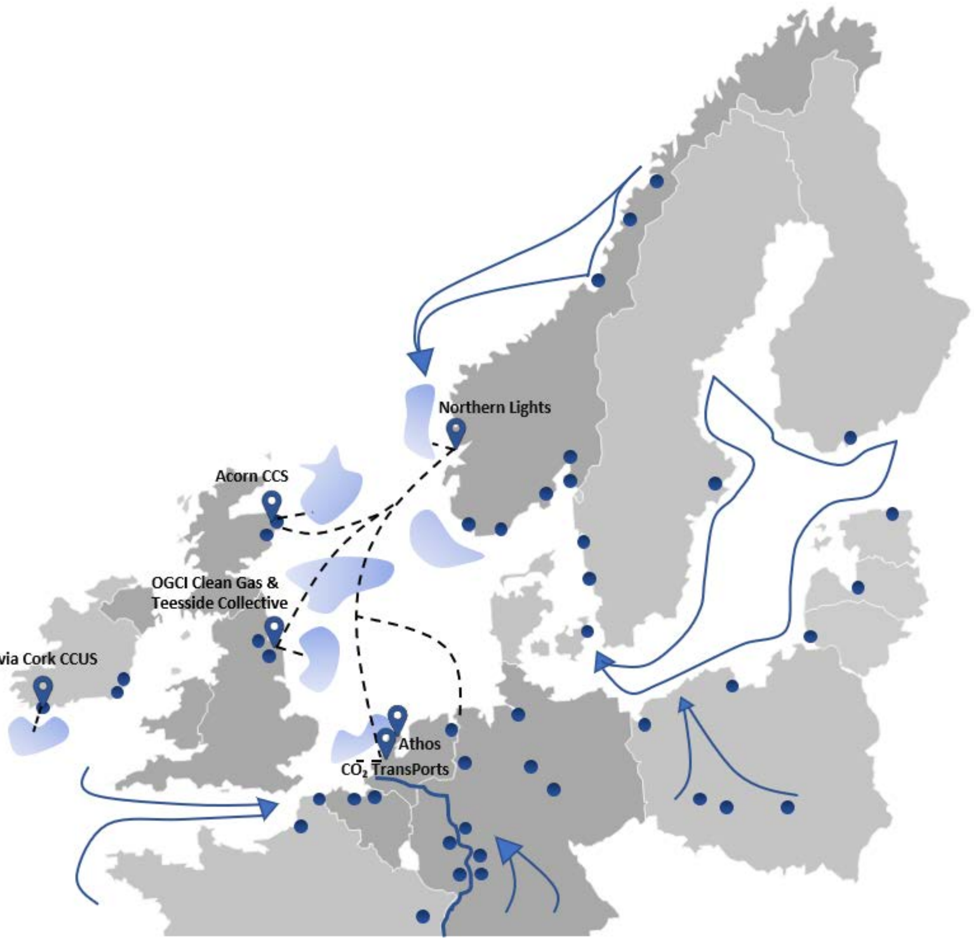

Figure 2-5: The European Network Scenario illustrates the accumulated effect of CO_2 storage projects being connected, building a network across Europe that enable CCS to be an effective tool for decarbonisation.

3 Key actions needed to realize the scenarios

The benefit realisation report has in detail described how the Northern Lights project is working, and plans to work, to build CCS markets by project and business development. Chapter 1.5. is particularly relevant as it describes how the project plans to continue to work on benefit realization. The actions described there have large overlaps with the actions that are needed to ensure efficient use of the Northern Lights infrastructure.

Given the detail of the benefit realization report, the objective of this chapter is to provide a condensed summary of key actions that are needed to realise the scenarios, thereby ensuring that the full potential of the Northern Lights infrastructure is utilized. The summary of key actions is hence a list of “who needs to do what”. Four groups of actors are focused: Northern Lights, 3rd party companies, Norwegian State and EU & Nation States. The perspective is broad, with several types of actions, e.g. industrial, commercial, policy, technological, political, financial and strategical ones. The figure below lists the key needed actions, which then are described in more detail in this chapter.

This list may look like a very demanding list of actions-be-done. It is hence important to recognize that not all of them need to be done immediately and with full force from the beginning. The list of actions points to important things that need to come in place over time, as the potential of Northern Lights infrastructure is increasingly realized through the combined effects of increased climate ambitions, stronger policies, trust in the technical solutions, reduced costs and other factors.

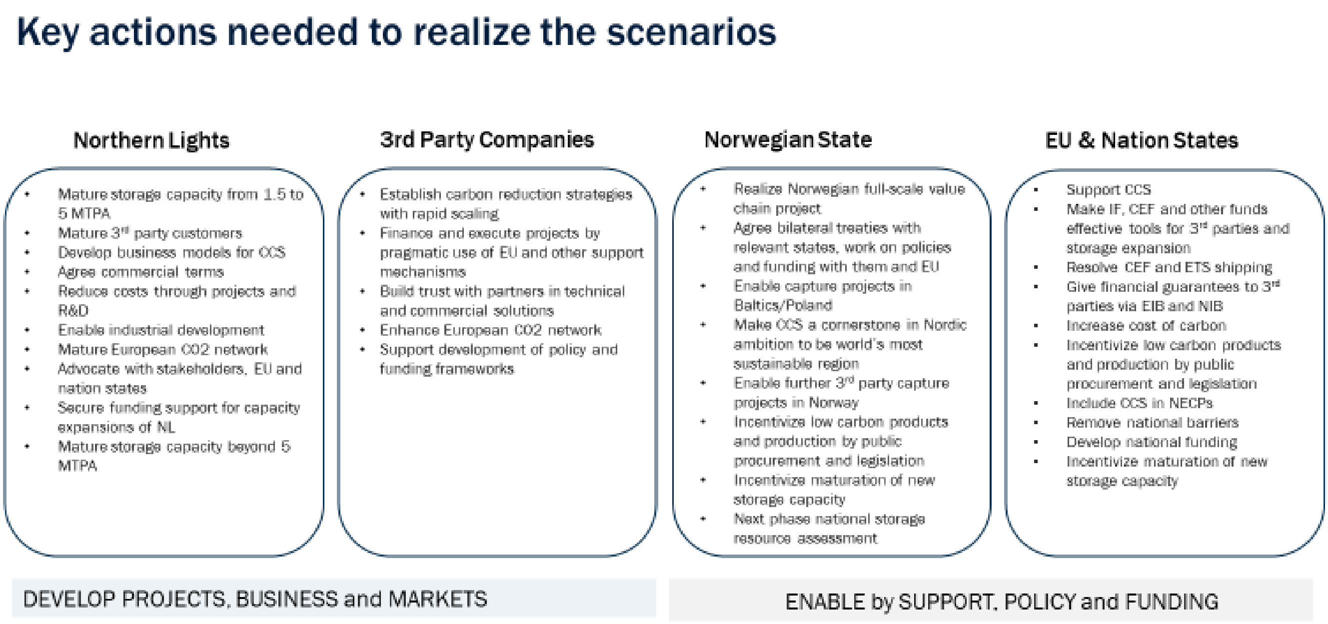

Figure 3-1. Key actions that are needed by key stakeholders for realizing the scenarios.

3.1 Northern Lights

3.1.1 Mature storage capacity from 1.5 to 5 MTPA

This section focuses on maturing storage capacity for Phase 2; expansion from 1.5 MTPA up to 5MTPA. The Northern Lights partnership will be developing the Aurora storage complex based on subsurface data including the Eos well and well test. For Phase 1, a committable initial storage capacity will be defined based on subsurface evaluations with information from the said well.

As the venture injects CO2 it will continuously develop a better understanding of the reservoir performance and update its view of the storage potential of the Aurora reservoir. This will be based on well performance and monitoring of the CO2 plume. Monitoring campaigns will be done regularly and revised according to the information gathered during injection.

Based on the results of the first phase, the project will lay out a strategy for phase 2, i.e. how to increase injection volume to 5 MTPA. This will include detailed planning of the location and design of future injection wells. Storage capacity will need to be verified before final commitments can be made to commercial customers.

3.1.2 Mature 3rd party customers

We refer to the benefit realisation report which in detail describes Northern Lights' approach to maturing 3rd party customers.

3.1.3 Develop business models for CCS

CCS is a proven technology but, with exception for some US regions, it is not existing as a business and service. A fundamental challenge is hence the need for developing business models for CCS together with different industries. Doing so requires pragmatism and creativity.

The main contribution from the initial CCS business projects, such as the first phase of Northern Lights, is to help to build the markets for CCS. This market building is done through providing private and public actors with continuously growing confidence in that CCS solutions and projects are becoming realized, and that they are worth taking part (industry) and to enable through policy and funding (public actors). The confidence is built by public and private actors that in partnership move forward on parallel project, business and market development. This co-ordinated approach was described in detail in the benefit realization report. We will here hence only make some few remarks about the pragmatism and creativity that are crucial for developing the first business models.

It is likely that business models will be different between different industries. It is also likely that they will evolve, and need to evolve, over time. The first generation of CCS projects in Europe does only seem possible to realize through dedicated project-specific funding support from governments and EU. The reason is simply that the alternative, which would be non-project-specific funding schemes such as ETS and higher value for low carbon products and production), presently simply not is sufficient for covering the costs of CCS. There is hence a need for those developing the first projects to build "funding packages" by pragmatically combining the funding sources that are available here and now. Said in another way, they need to develop business models that enable governments to specifically support these early projects. The support can be given in several ways, e.g. through specific funding programs as the ones being matured in Norway or through grants from larger programs such as EU's Innovation Fund.

This model with project-specific support is one in which the financial framework for each project is actually only known on the day when all funding decisions have been made. The financial framework is developed and decided as the project moves forward. While this is an effective model for the early projects, it is also a model that needs to be replaced at some stage. It needs to be replaced with another model in which the policy and financial framework is known before projects are developed and decided. Such a "known framework" provides the framework certainty which is needed for developing projects at scale. Three elements seem particularly promising as cornerstones in such a framework: Higher price of carbon (e.g. ETS), higher value of low carbon products, and tax credits (e.g. such as 45Q in USA).

3.1.4 Agree commercial terms

Northern Lights has taken a precautionary approach to competition law issues by early establishing a small designated 'Clean Team' which is governed by a specific set of rules. Within the boundaries of this framing, the members of the Clean Team can receive, provide and discuss commercially sensitive information.
After having passed the first milestone of formalizing interest together with the 3rd party companies, the Northern Lights team will work closely with them to deepen the joint understanding and technical and commercial concepts. For several of the potential 3rd parties such further maturation has already commenced. Discussion points include technical and commercial topics, including but not limited to:

- rates/volumes (e.g. whether supply rates of CO_2 change over time) and flexibility
- timelines (e.g. commencement date and duration of supplies)
- CO_2 specification (e.g. whether the CO_2 supplied meet existing specifications, or will there be a need to perform technical updates to existing facilities in order to accommodate so-called off-spec CO_2)
- logistics (e.g. who performs transportation; in some rare cases the emitter might want to do this)
- scope for synergies and economies and scale (e.g. between several 3rd parties with adjacent emissions and hence scope for joint liquefaction and offloading facilities)
- the potential risk of failure to supply agreed volumes and pay agreed tariffs, in particular in the long term, e.g. due to discontinuation of the industrial activities that results in CO_2 emissions (so-called Credit Risk; e.g. due to relocation of the activities to countries outside the ETS, bankruptcy, or other fundamental changes).
- liability regime

Following a natural commercial maturation process, Northern Lights and the 3rd party will enter a so-called Heads of Terms (HoT), which is a contract that confirms the main technical assumptions and the key commercial elements the parties agree to. It is expected that some HoTs will be entered into during the first half of 2020, in time for the 3rd parties to strengthen their applications for support from the Innovation Fund.

Entering into HoTs during 1st half of 2020 will also help the Northern Lights JV partners to take their FID, as well as help the Norwegian state take its State FID during Parliament's autumn session in 2020. Subsequent to, and building on the HoT, the parties will then work towards so-called fully termed agreements, where all aspects of the relationship between the parties will be regulated. Such a fully termed agreement is hence a detailed version of the HoT. A fully termed agreement is needed to take a final investment decision on the contractual scope between the 3rd party and Northern Lights.

3.1.5 Reduce costs through projects and R&D

We refer to the benefit realisation report which in detail describes how Northern Lights works closely with the partner companies' R&D organizations to enable more cost-efficient solutions for scaling up CCS in Europe.

That report carefully describes how the Northern Lights project development helps to shape and sharpen the research and technology development of the partner companies, but also of the broader R&D ecosystem. It is such a dual approach of executing projects <u>and</u> R&D in parallel which is the most efficient way for reducing costs and scaling up CCS. This dual approach has been proven over and over again in other technology areas, such as wind and solar. One needs projects to focus R&D, and one needs R&D to be able to improve technologies and solutions from one project to the next. Importantly, one also needs R&D to be able to shift from one concept to another better and cheaper one, for example to larger ships or other transport concepts. It is simply not effective to just do research in order to drive down costs. We need to do projects with the technologies that are at hand, and then all these technologies need to be continuously improved. Just like they are in other areas.

3.1.6 Enable industrial development

To indicate the overall potential market for CO2 transport and storage, we refer to the SINTEF report "Industrielle muligheter og arbeidsplasser ved storskala CO2-håndtering i Norge", (Industrial opportunities and employment prospects in large-scale CO2 management in Norway), from April 2018. The objective with the report was to demonstrate the potential opportunities for industry linked to a realization of full-scale CO2 management in Norway. The fundamental – and sound – premises for the market assessments made in the SINTEF report are that the world, including Norway, will fulfil its Paris commitments and that CCS will cover the share of overall emission reductions that have been identified by IEA and IPCC in key studies.

The market for CO2 management in Europe will according to SINTEF potentially involve from 30,000 to 40,000 jobs directly linked to CO2 management in 2030 and from 80,000 to 90,000 in 2050. Norwegian industrial actors are well equipped to increase their value generation in such a market.

Northern Lights will continue to take a positive and pro-active approach to enabling industrial development, by continuing to openly and frequently present project plans and opportunities. We will also continue to spend time with industry actors that want to understand and discuss industrial opportunities. Recent such dialogues have been industrial park owners, technology providers, storage service providers and shipping service providers, in addition to 3rd party CO2 customers.

3.1.7 Mature European CO2 network

A scenario of a future European network for CO2 removal was presented in section 2.5. The network is centred around the North Sea, and one can already today see the beginnings of such a network through the individual projects that are being developed.

Northern Lights will continue to nurture and mature the European Network. We do this by presenting and promoting the positive vision of such a network to stakeholders, also with other projects as potential hubs and cornerstones in the network. Northern Lights' recent selection as one of five OGCI Kickstarter regions, provides an effective platform for further developing the European network with the other European OGCI Kickstarter regions: OGCI Clean Gas & Teesside Collective, UK, and Porthos, Port of Rotterdam, the Netherlands.

3.1.8 Advocate with stakeholders, EU and nation states

We refer to the benefit realisation report which in detail describes Northern Lights approach to advocacy, and how it relates to business and market development.

3.1.9 Secure funding support for capacity expansions of Northern Lights

Plans for technical expansion of Northern Lights are given in chapter 4 and in 3.1.10 below. As it is expected that Northern Lights can be able to expand beyond phase one before "known" European and Norwegian framework enable CCS projects, such expansion will continue to require specific project funding just like for phase 1.
At the right time, Northern Lights envisages to seek such funding support for expansion from relevant funding agencies, such as EU's Innovation Fund and Connecting Europe Facility as well as the Norwegian State.

3.1.10 Mature storage capacity beyond 5 MTPA

The expansion beyond a 5 MTPA scenario also includes other options than utilizing the initially planned Northern Lights infrastructure.

A concept building on the initially planned Northern Lights infrastructure could typically include a new pipeline, in addition to further expansion of land facilities such as possibilities to offload ships and the use of intermediate storage if required. Provided the committable storage capacity in EL001 is sufficient for such an expansion at the time of project development, the pipeline could go in parallel with the pipeline planned in Phase 1. Alternatively, a new pipeline could bring the CO2 to other storage complexes.

Depending on time scale, new technical concepts such as direct injection from ships offshore, subsea shuttles, and pipelines from other locations and to other storage candidates may be options. The larger optionality, compared with the expansion from 1.5 to 5 MTPA, makes a larger number of storage candidates relevant. For maturation of future storage, the Northern Lights JV will consider multiple aspects including:

- Strategy and process for securing additional acreage.
- Organisation of subsurface work amongst the partners.
- Gathering and use of subsurface data.
- Synergies with other exploration activities within the partner companies.
- Classification of storage capacity.

3.2 3rd party companies

While Northern Lights plans to provide the transport and storage service, the 3rd party customers need to take care of the capture and raise sufficient funding to finance the capture as well as tariffs to Northern Lights. The benefit realization report provides much detail on how Northern Lights work with 3rd party customers on jointly realizing the full CCS value chains. Therefore, we here simply list the key actions that need to be taken by 3rd party companies to realise the scenarios, and thereby the potential of Northern Lights and CCS:

- Establish carbon reduction strategies with rapid scaling
- Finance and execute projects by pragmatic use of EU and other support mechanisms
- Build trust with partners in technical and commercial solutions
- Enhance European CO2 network
- Support development of policy and funding frameworks

3.3 Norwegian State

3.3.1 Realize Norwegian full-scale value chain project

The fundamental action which the Norwegian State needs to do to ensure long-term use of the Northern Lights infrastructure is simply to do its required part of realizing the infrastructure in the first place. This is currently being done through all the activities within the Norwegian full scale CCS value chain, which is hopefully culminating with positive final investment decisions (FIDs) in 2020.

3.3.2 Agree bilateral treaties with relevant states, work on policy and funding with them and EU

The Norwegian State has important roles in helping to enable and realize the business relationships between Northern Lights and its 3d party customers, as it needs to agree the nation-to-nation issues that enable and complement the company-to-company commercial relationships.
The Norwegian state has equally important roles in working with other nations and EU on updating the EU's regulatory framework to enable CCS. The existing EU framework for CCS needs to reflect the new business model and create a level playing field for all modes of transport. The CCS Directive, EU ETS Directive and the TEN-E Regulation should reflect technology and market developments. This is described in more detail chapter 3.4.

The Norwegian state is already doing substantial and successful work with others on bilateral treaties and updating regulatory frameworks. One success stands out as particularly important. The one supranational obstacle related to Northern Lights and CO2 shipping more broadly – the London Protocol – has recently been resolved through an initiative led by the Norwegian government in cooperation with the Netherlands. Norway submitted a resolution for the IMO/LP meeting in October 2019. The resolution was based on Article 25 of the Vienna Convention on the Law of Treaties which states that if Parties to a treaty agree on something, they can act upon this agreement immediately pending administrative implementation in the treaty. The resolution has been adopted and according to it, Parties to the London Protocol have agreed to allow transboundary export of CO2 for the purpose of CCS for countries that wish to make use of it beyond their national boundaries.

The Norwegian state ought to continue the valuable and effective work with other nations. A cornerstone of this can be sharing of experiences and learnings gained from establishing the Norwegian value chain project. This is particularly valuable as the hardest innovation challenges for establishing CCS are not technological, but rather about finding public-private collaboration models. The benefit realization report provides a case description of how the Norwegian state, e.g. through Gassnova, has supported the Swedish development of a CCS framework.

The work with other nations and EU should also address funding. This could involve sharing visions, experiences and perspectives on how effective “pan-national funding packages” can be effectively established. This is clearly topical given the scenario that the Norwegian state and Northern Lights partner companies establish the initial transport and storage infrastructure which industries in other countries can use and help to expand. For this to happen effectively and rapidly, funding from EU and other nations need to complement that of Norway.

3.3.3 Enable capture projects in Baltics / Poland

Northern Lights is doing a dedicated effort to mature CO2 capture projects in the Baltics and Poland. The Norwegian State, through several entities such as Embassies and Innovation Norway, is strongly supporting this, e.g. by valuable opening of doors. This support will need to continue and even be scaled up as promising projects mature further. A particularly promising tool would be to enable and steer EEA/ Norway Grants to support 3rd party customers in their development of projects.

3.3.4 Make CCS a cornerstone in Nordic ambition to be world’s most sustainable region

The Nordic Prime Ministers have recently decided a new vision for the Nordic Council of Ministers towards 2030. The vision is that the Nordic region is to become the world’s most integrated and sustainable region. Work is to be focused on three areas: A green Nordic, a competitive Nordic and a socially sustainable Nordic.

CCS can become a cornerstone in realizing this vision, as it can provide a cross-national solution where CO2 storage in Norway can enable competitive decarbonisation and industrial development in all Nordic countries. One early example of how this can play out is CCS on waste-to energy (WtE) facilities. It seems feasible that WtE facilities in the Nordic capitals may be among early CCS movers. This is driven by these cities having set very high climate ambitions.

3.3.5 Enable further 3rd party capture projects in Norway

Northern Lights is in dialogue with several Norwegian entities that are developing CCS projects in addition to those of Norcem and Fortum Oslo Varme. They will require similar kinds of support as CO2 capture projects in other countries. This will include funding support for project development, as well as CAPEX and OPEX when projects are ready for investment decisions. The dedicated CCS support which Norway has channeled through the Climit program over several years should continue. Its support to R&D and early phase project maturation is truly valuable.

The benefit realization report provides further detail on three of the Norwegian CO2 capture projects.

3.3.6 Incentivize low carbon products and production by public procurement and legislation

While all European CCS projects in the near term, say 5-10 years, will need dedicated and project-specific funding support to be realized, in the longer terms there is a need for a predictable policy and funding framework which is not project-specific. Such a framework will likely have to two main components: A cost of carbon which is considerably higher than today, and higher value for low carbon products and production.

The Norwegian state has an important role in creating market demand for low carbon products. For instance, the State could create procurement initiatives for low carbon products such as steel or cement used in publicly-funded projects. This would create initial demand for low carbon products, thereby incentivising industries and manufacturers across Europe to invest in clean energy infrastructure. This would in turn incentivise the uptake of decarbonisation technologies, including CCS which has ample potential for industrial sector applications. Similar effects can also be achieved by legislation, such as done with blend-in requirements for biofuels.

3.3.7 Incentivize maturation of new storage capacity

The Norwegian State, with its dedicated authorities such as Ministry of Petroleum and Energy (MPE), Gassnova and Norwegian Petroleum Directorate (NPD) will have a key role in ensuring predictable, efficient and reliable framework for enabling the maturation of storage sites. As the companies involved in the injection and storage will require in-depth knowledge of any storage site with their characteristics and risk pictures, the major contribution from the Norwegian State should be by incentivizing the companies' maturation of storage sites.

A key component of such incentives are clear procedures for nomination and application of acreage. The procedure for application and award of survey permits, exploration permits and exploitation permits are set out in the Storage Regulations. As CO2 storage, and its' related maturation of storage sites, is still done in small scale, one efficient way to decide on which area to make available for applications could be to invite companies to communicate storage areas of interest to MPE, who then chooses whether to initiate an application process for that area. Another, and possibly complementary, licensing approach could be that the authorities open up large areas for CO2 storage, and where companies can apply for storage in all areas where a petroleum production license granted under the Petroleum Act have been expired or surrendered.

There is also a need for predictable, attractive and easy-to-understand mechanisms for funding of data acquisition of relevance for CO2 storage. The Norwegian «Leterefusjonsordningen" is a good role model, contributing to reduce the entry barriers for new entrants and facilitating socio-economically profitable exploration activities.

There is a particular need for strong incentives in order to gain maximum value from exploration activities that are done exploring for hydrocarbons, and where some "extra" efforts can provide additional data which is of value for futre CO2 storage while not necessarily from a hydrocarbon perspective. This need becomes topical when a hydrocarbon exploration well comes out as dry. The natural inclination of companies is then to plug, abandon and leave the well as soon as possible. However, by continuing logging activities for some days one could alternatively gain additional data which could be highly valuable for future CO2 storage. Gathering critical data to de-risk reservoir and seal qualities in such a way is very cost-effective, and could also ensure that future CCS projects can be developed faster to meet rapidly emerging storage needs. Those extra days of activity would require strong incentives. Such incentives would not need to apply for all hydrocarbon exploration but could be limited to pre-defined areas that are particularly promising for future CO2 storage. It is crucial that all plug and abandon operations are done thoroughly, also those of dry wells. Abandonment standards must support this.

3.3.8 Next phase national storage resource assessment

NPD has delivered CO2 storage atlases off Norway that identify main aquifer formations for CO2 storage. In analogy to the CO2Stored database in UK, a next phase of storage assessment would include aquifer local structures within the identified aquifer formations and associated storage range. Storage Resources would be classified according to their maturity with a management system analogous to the SRMS developed by the Society of Petroleum Engineers.

3.4 EU and Nation States

3.4.1 Support CCS

The European Union is a major stakeholder in the development of a European CCS network. Effective and efficient collaboration with member states in the EU whose industries could be clients of the Northern Lights is also key to unlocking the true potential of developing a European CO2 transport and storage network.

Setting the right legislative as well an appropriate CCS funding framework are crucial steps. Early investments in full-scale CCS facilities on the capture, transportation as well as storage infrastructure are necessary to reduce the costs of CCS and help commercialise it for wide industrial use.

The European Commission has a vested interest in succeeding to scale up the CCS solution in the upcoming decade to make it commercially available to the EU's large industrial polluters in the mid- to long-term as decarbonisation targets become stricter. Northern Lights can be a strategic project for the EU's leadership as ever-more stringent decarbonisation targets will elevate the relevance.

We are engaging in an inclusive and open dialogue with the European Commission. We aim to continue it to make sure that Northern Lights is compatible with EU's regulations on CCS and can also benefit from the support mechanisms. Continuous cooperation with, and support from, the European institutions is necessary to realise the strategic value of the Northern Lights project.

3.4.2 Make Innovation Fund (IF), Connecting Europe Facility (CEF) and other relevant funds effective tools for 3rd parties and storage expansion

The EU has previously attempted to support CCS technologies in Europe and foster their scale-up and commercialisation. In 2009, the EU launched both the European Energy Programme for Recovery (EEPR) as well as the New Entrants' Reserve 300 (NER300), both of which were tailored to support CCS projects in the EU. With a budget of €1.6 billion, the EEPR was designed to support offshore wind and CCS projects. In parallel, the NER300 collected €2.1 billion funds from the sale of 300 million emission allowances under the EU ETS to support CCS as well as renewable energy projects. In 2018, the European Court of Auditors carried out an evaluation of the two programmes and concluded that neither of them had been successful in scaling up the CCS technologies[1]. The report suggests that adverse investment conditions; cumbersome and inflexible application and project selection procedures under NER300 and the EEPR; uncertainty in regulatory frameworks; as well as the collapse in carbon price under the EU ETS in 2011 all contributed to the failure in launching any successful CCS projects. The inability to realize CCS technologies has made many EU policy makers question the viability of the technology itself. It is hence crucial that the present generation of CCS projects succeed.

[1] Special Report *'Demonstrating carbon capture and storage and innovative renewables at commercial scale in the EU: intended progress not achieved in the past decade'*, European Court of Auditors, October 2018

The new funding cycle of the EU will include support mechanisms for the CCS technologies. In particular, the Innovation Fund (IF) – a successor of the NER 300 – is considered to be the main tool for scaling up CCS activities across Europe. One of the main priorities of the IF will be to enable cost-efficient decarbonisation pathways for Europe's energy-intensive industries. Depending on the EU ETS price, the Fund is expected to amount to at least €10 billion and will be available from 2021 to 2030. Learning from the mistakes of the previous funding cycle, the EU policy makers aim to make the IF flexible enough for various and versatile decarbonisation projects, including CCS. Calls are planned to be launched on an annual or at least biannual basis, thereby enabling a flexible project selection procedure. There has also been a change in terms of focus on the energy-intensive industries for CO_2 capture: projects under previous support schemes were mostly tailored to reducing emissions from coal and gas power plants with post-combustion capture of CO_2. These changes indicate that the EU has been able to draw learnings from the previous programmes and is working to make CCS a European success story in the period 2021-2030.

It is crucial that IF actually ends up funding CCS projects; CAPEX and OPEX of investment projects as well as project development. With FIDs for the Norwegian value chain projects being taken in 2020, the transport and storage service will be in place for European capture sites to apply to IF for CAPEX and OPEX already in the first call.
We refer to the benefit realization report for further details.

3.4.3 Resolve Connecting Europe Facility and ETS shipping issues to make them inclusive to CO_2 shipping

In addition to the Innovation Fund, there are several other planned EU funding programmes that could be used to support CCS. First, the Connecting Europe Facility (CEF) for energy, which is the EU's main programme for reinforcing physical cross-border energy (electricity, gas and CO_2) interconnections in the EU. While the CEF has not yet funded construction works for CCS infrastructure, it has in the previous EU budget period awarded several CCS projects with study money. The CEF is aimed at building European links to transport CO_2 from capture to storage locations. However, according to the European Commission's interpretation, funding cross-border CO_2 ship infrastructure does not fall within the scope of the CEF funding due to the fact that ships are mobile infrastructure. On the other hand, cross-border CO_2 transport pipelines can benefit from CEF funding, which creates an unfair bias vis-à-vis shipping for CCS projects across the EU. The shipping solution has several advantages for the start-up phase of a European CCS network, namely by increasing the flexibility of the CCS chain in Europe as it allows to connect emitting sites to several sequestration sites and can add new CO2 volumes from elsewhere. It should therefore be included within the framework of CEF infrastructure funding. Shipping is a crucial part of the CCS network development in Europe. The issue remains a high priority for Northern Lights and we are engaging with the European Commission advocating potential solutions.

The EU ETS is a major economic incentive for CO_2 capture and storage by industrial emitters as they can recover the EU ETS allowances by proving that the CO_2 from their emissions has been captured and permanently stored. However, transport of CO_2 by ship is not included in the definition of CO_2 network under the current rules of the EU ETS. In detail, the CCS Directive [2009/31/EC](2009/31/EC) defines the CO_2 transport network as '*the network of pipelines, including associated booster stations, for the transport of CO_2 to the storage site.'* In addition, Annex I of the EU ETS Directive [2003/87/EC](2003/87/EC), which provides a list of activities that are covered by the Directive limits CO_2 transport to pipeline only. These provisions effectively exclude shipping as transport solution for captured CO_2. An unfavourable interpretation of this provision is that capture installations that opt to ship CO_2 to permanent storage would not be able to retain allowances and therefore lose the financial benefit under the EU ETS. The Norwegian government has sent a communication to the European Commission with regards to this issue and the possible interpretations and are to our knowledge still waiting for a response. The EU ETS allowance issue nevertheless remains among the priorities to solve for the CCS projects in Europe. In parallel with the EU ETS issue, the earlier mentioned 2009 CCS Directive should also be reviewed in order to update it in line with technological and market development for CCS.

It should be mentioned, though, that while the now resolved London Protocol issue was a real roadblock for Northern Lights 3rd party development, these ETS and CCS Directive issues are not roadblocks to any similar extent. But they make the realisation of shipping solutions more cumbersome, and would be valuable to have resolved.

3.4.4 Give financial guarantees to 3rd parties via EIB and NIB

While the European Investment Bank (EIB) and the Nordic Investment Bank (NIB) presently do not provide funding in the form of grants, they can still be important in enabling CCS value chains through its project finance lending. These banks, which are increasingly turned towards supporting environmental and climate action, can hence provide access to cheap capital as well as provide guarantees that enable the realization of novel value chains.

3.4.5 Increase cost of carbon

Carbon price on emissions is the most relevant factor determining the industry's readiness to explore emission mitigation options, including CCS. Therefore, in the mid- to long-term the EU ETS price must be made compatible with the EU's climate ambitions. This implies a growing price pressure on Europe's industrial emitters, while guaranteeing that the system is not prone to price crashes such as the one of 2011. In 2017, the EU ETS Directive was reviewed in a bid to improve its stability. The revision foresees that the number of total emission allowances available will contract by 2.2% annually starting from 2021, compared to 1.74% currently. The revision also foresees the establishment of the Market Stability Reserve (MSR), where surplus emission allowances would be placed to improve the resilience of the EU ETS to future shocks. In addition, the revision established a gradual reduction of free allocation for less exposed sectors: it foresees a phase out of free allocation after 2026, gradually reducing from a maximum 30% to 0 by 2030. The reduction of free allocations will put considerable pressure on Europe's industrial emitters and encourage them to search for alternatives.

Carbon price pressure can have a negative impact on the competitiveness of the European industries. As means of protecting Europe's industries vis-à-vis global competition, the European Commission's President-elect Ursula von der Leyen has proposed the creation of a carbon border adjustment mechanism. Such a mechanism would foresee protective measures for low carbon industrial products to make them competitive with carbon-intensive products from abroad. While such a policy proposal would be contested on the grounds of trade rules, the details of it remain to be seen as Ms von der Leyen's Commission is yet to start its mandate. Nevertheless, a carbon border adjustment mechanism could have important consequences for the EU's industry, both in terms of preventing carbon leakage and encouraging low-carbon industrial activities as well as antagonising different industrial players with varying degrees of exposure to trade. Such a policy measure would also impact the Northern Lights project as more emissions-intensive industries based in the European market would be looking for ways to mitigate their emissions at a cost-competitive price.

3.4.6 Incentivise low carbon products and technologies by public procurement and legislation

The EU's 2030 climate and energy framework relies to a large extent on the targets set in each sector and subsector. However, setting targets alone will prove insufficient to foster the clean energy transition. They must be coupled with a supportive regulatory and policy framework that can promote R&D investment as well as the adoption of advanced decarbonisation technologies. In addition, charging the industry for CO_2 emissions without providing any incentives can have an adverse effect on the EU's industrial base and competitiveness by encouraging emitters to move their production elsewhere.

As a first step, the EU must work towards creating an internal market demand for low carbon products. For instance, the EU or national governments across the EU could create procurement initiatives for low carbon products such as steel or cement used in publicly-funded projects. This would create initial demand for low carbon products, thereby incentivising industries and manufacturers across Europe to invest in clean energy infrastructure. This would in turn incentivise the uptake of decarbonisation technologies, including CCS which has ample potential for industrial sector applications.

3.4.7 Include CCS in national energy and climate plans (NECPs)

CCS remains a relatively unknown climate change mitigation measure among policy makers in EU member states. For most part it is due to the absence of successful large-scale CCS projects in Europe. Therefore, the Northern Lights project plays an important role in increasing the understanding of CCS technology among the European politicians. In addition, the increasing pressure for mid- and long-term GHG emission reduction targets in the EU has elevated the policy makers' interest in technologies that can achieve higher emissions reduction, including CCS. It is therefore crucial that the European governments start considering CCS as a viable emission reduction tool in planning their national climate policies. Several governments in the EU, including the Netherlands, Sweden and the UK, have already created financial support schemes for testing the CCS technologies in the industry. This is an important first step in creating the trust and gradually the momentum for CCS development in Europe.

The EU's 2030 climate and energy framework obliges member states to outline national climate policy measures in the upcoming decade to demonstrate how national efforts can help the Union achieve collective GHG emission reduction, renewable energy and energy efficiency targets by 2030. The so-called National Energy and Climate Plans (NECPs) are a good platform for including CCS as climate change mitigation measures. Outlining ambitious CCS technology deployment plans in the NECPs can be an effective measure of increasing public awareness about the technology. We have already engaged with the Northern Lights' partners asking them to inform their respective governments about the project and potentially include it in their national plan as means to reduce emissions in the 2030 perspective. Member states must submit their final NECPs in December 2019. These plans will be reviewed and updated every two years in cooperation with the European Commission. We consider it is a good framework for communication with the national authorities, in particular as the Northern Lights project matures.

3.4.8 Remove national barriers to CCS

In addition to increasing the relevance of CCS in the national climate change mitigation planning, it is also important that governments across the EU can guarantee adequate regulatory conditions for CO2 capture, transport and storage projects. The latter goes hand in hand with increasing the understanding about the technology and effectively reducing the bias towards it. Green-leaning parties across Europe often choose to dismiss the CCS technologies for climate mitigation purposes through selective facts and arguments, thereby politicising the topic. It is important for national politicians across the EU to understand that CCS should not be excluded from the climate change debate, in particular given its potential to reduce emissions in the energy-intensive sectors. Some countries have restrictive regulations when it comes to deploying CCS infrastructure, which is further proof of political bias towards the technology. It is therefore crucial to communicate that projects such as the Northern Lights can 'outsource' the CO_2 storage part from countries where the emission sources are, which in turn eliminates any risk concerns related to storage safety. The Northern Lights project is working closely with the capture-side partners to make sure there are no regulatory obstacles for CCS. We expect the process to accelerate with the maturation of the Northern Lights project.

3.4.9 Develop national funding schemes to support CCS scale-up

State funding is crucial for early phase CCS support, in particular for the capture side projects. The Northern Lights' CO_2 capture partners are some of Europe's most ambitious and forward-leaning companies that are willing to lead the clean energy transition. However, given that CCS has not yet been deployed at scale, the costs are still too high to be sourced privately, even when taking into account the pressure of the EU ETS prices. Therefore, financial support from the government is necessary to encourage CO_2 capture projects in Europe and trigger cost reduction along with commercialising the technology. Section 3.4.2 provides an outline of the EU funds that are tailored to support CCS projects in Europe. These funds can work in cooperation with national level support as long as it is compatible with the State Aid rules. The EU alone may not be able to guarantee a sufficient funding level for capture projects, which is why it is crucial that member states co-finance them. As mentioned in section 3.4.7, several countries have already earmarked funds for early-phase development of CCS. We expect other member states that are involved in CCS projects to follow suit and design support schemes that would allow to scale up CCS deployment in Europe, thereby enabling the technology's commercialisation.

3.4.10 Incentivize maturation of new storage capacity

While it is crucial that Norway continues to take a leadership role in development of CCS, including maturation of storage sites, there will also be future needs and opportunities for developing CO2 storage in other nation's offshore acreage. Learnings and knowledge dissemination from the early activities in Norway could then be of great value

EU and governments in European states will need to do many of the same things described for the Norwegian state in 3.3.7 in order to incentivize companies to mature CO2 storage sites, both in terms of data gathering and strategic use of O&G infrastructure.

4 Development of technical infrastructure to realize the scenarios

Development of the technical infrastructure must be an integrated part of the business development strategy. With the interest seen from 3rd parties for potential storage in Northern Lights, studies of a Phase 2 development with a capacity of up to 5MTPA is currently being launched.

The Northern Lights infrastructure has been designed with flexibility for expansion as a fundamental design philosophy. Figure 4-1 shows an illustration of the concept and initial capacities in the Phase 1 development.

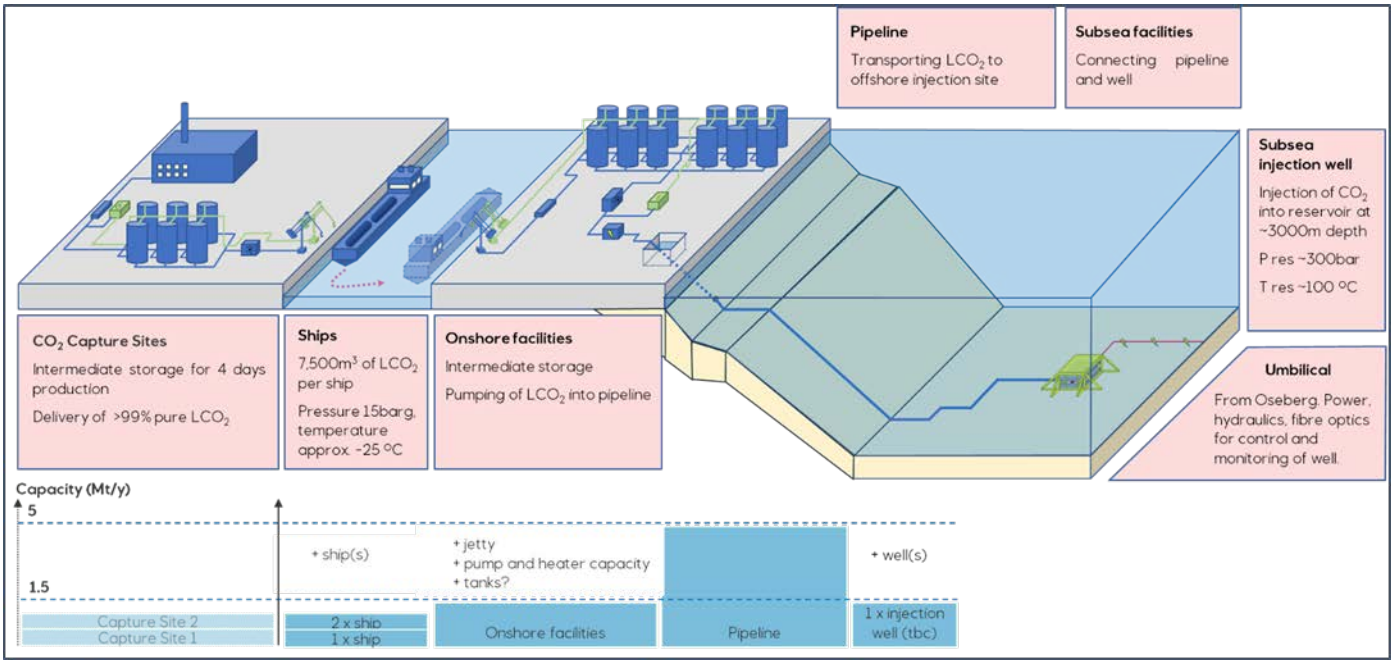

Figure 4-1. Northern Lights concept building blocks with capacities in the first phase shown with blue shading.

The design basis capacities for the first phase and strategy for future increase in capacity is outlined below for each part of the infrastructure:

- **Ship:** The strategy is to optimize the number of ships for the volumes to be shipped. Currently initial volumes include volumes from the two capture projects in the Norwegian demonstration project, with one ship with a cargo capacity of 7,500m3 planned for each capture plant. New volumes may require additional ships.
- **Onshore facility:** The onshore processing equipment (pumps, heaters) is sized according to design basis for phase 1 of 1.5MTPA. Additional throughput will require additional capacity in processing equipment. Tie-in points for new equipment are identified in the initial design.
- **Storage volume:** The onshore storage volume is based on a ship cargo size of 7,500m^3. Additional storage volume could be required if ships with larger cargo sizes are introduced in the chain. Land area for future storage volume has been identified.
- **Jetty:** The import jetty is designed to receive ships of up to 130m length. For future expansion an additional import jetty will be required to allow for higher frequency of ship arrivals and potentially larger ships. Location for a future import jetty no. 2 has been identified.
- **Pipeline:** The pipeline concept has been selected based on a cost vs. benefit evaluation and can handle a range of volumes. Flow assurance simulations based on the expected reservoir pressure indicates that the

pipeline has an upper limit of 5 MTPA. This will be adjusted based on actual reservoir properties and performance.

- **Subsea facilities:** The first well will be drilled from a satellite structure with tie-in points for future extension.
- **Wells:** The strategy is to drill the number of wells required for injection of available volumes of CO_2. For future expansion, additional wells may be required depending on reservoir performance and management. Drivers for additional wells are the need to appraise storage, to add injection capacity, storage capacity or to increase system availability in line with customers' requirements or economic drivers.
- **Subsurface:** The strategy is to select a storage location which gives a significant potential storage for future 3rd party business.

Expansion of the infrastructure to realize a scenario of 5MTPA will consist of developing a logistics chain to bring the CO2 from capture projects to Naturgassparken, together with an expansion of Phase 1 infrastructure to utilise fully the capacity installed with the pipeline from Naturgassparken to Aurora.

Depending on location of capture projects and the volumes to be shipped, the optimum fleet of ship will be defined including size of cargos, thermodynamic transport conditions and number of ships. This optimisation includes the costs of liquefaction and intermediate storage on the capture side, and the size of intermediate storage and scope for process integration with Phase 1 infrastructure in the Northern Lights onshore plant.

Development of an optimised ship fleet will decide the requirement for new jetty facilities in Naturgassparken, both with regards to ship size and frequency of ship arrivals. The capacity expansion of the onshore facilities will include new process equipment for the increased throughput. Due to the higher injection rates the friction pressure in the pipeline will increase and require a higher injection pressure. Export pumps for Phase 2 will thus operate at a higher pressure than what Phase 1 pumps are designed for. The process integration of Phase 2 will be a key subject for the technical studies required to develop the infrastructure.

The intermediate storage capacity in Naturgassparken which is necessary for Phase 2 will largely depend on the cargo size of the optimised ship fleet and the operational flexibility determined by frequency of ship arrivals and available injection rates to the storage complex.

The extension of the subsea infrastructure to reach new well targets will mainly require maturation of the subsurface, to optimise location of new wells with regards to well performance and reservoir management. Subsurface maturation is a continuous process, with important information to be collected in the confirmation well to be drilled early 2020, and later through monitoring of the injection after start of Phase 1 operation.

Several technical studies are required to mature a development of infrastructure to realise the 5MTPA scenario leading up to an investment decision for the Phase 2 development by the project owners. These include feasibility, concept and FEED studies. The expansion of infrastructure is also likely to require a new zoning plan, as well as an amended impact assessment and PDO/PIO.