



## CSLF PROJECT SUBMISSION FORM

### PROJECT TITLE:

Northern Lights - Development of open-source CO<sub>2</sub> transport and storage infrastructure

### PROJECT LOCATION:

Please provide the city (or nearest town), the state/province/region, and the country.

- Head office: Byfjordparken 15, Stavanger - Norway
- Onshore CO<sub>2</sub> receiving terminal: Energiparken Øygarden Municipality - Norway

### PROJECT GOAL:

Please provide a simple and to-the-point explanation in one or two sentences that can be easily understood by someone with no prior knowledge of the project.

Northern Lights is developing the world's first cross-border, open-source CO<sub>2</sub> transport and storage infrastructure. It will help industrial emitters to reduce emissions, by providing flexible ship-based transport and permanent offshore geological storage for captured CO<sub>2</sub>.

### PROJECT OBJECTIVES AND ANTICIPATED OUTCOMES:

Please provide a breakdown of the Project Goal into the constituent steps comprising the whole project. Use bullet points to separate the steps and indicate key anticipated outcomes of the project.

Northern Lights is the transport and storage component of 'Langskip' (Longship), the Norwegian Government's full-scale carbon capture and storage project. Longship aims to contribute to national CO<sub>2</sub> reduction targets and establish a new value chain and ecosystem for storage of CO<sub>2</sub>, and to facilitate low carbon energy for the future - in Norway and around the world.

The Norwegian government is funding a significant part of the first phase of the infrastructure development to demonstrate the potential in using carbon capture, transport and storage technology to decarbonise industry, and to kickstart a commercially viable CO<sub>2</sub> transport and storage industry that can scale up as needed. It has explicitly opened access to European industry, will share knowledge and encourage EU member states to replicate its efforts.

Phase one of the Northern Lights project will be ready by mid-2024, with a capacity of up to 1.5 million tonnes of CO<sub>2</sub> per year, with the ambition to expand capacity to over 5 million tonnes per year in Phase 2.

Both phases will offer flexibility to receive CO<sub>2</sub> from European sources, in addition to the 800,000 tonnes of CO<sub>2</sub> per year, which will come from Longship, assuming both of the initial Norwegian capture projects are realised.

- Project Phase 1:
  - start operations: mid-2024
  - Start-up capacity: 1.5 million tonnes per year
  - 12" pipeline
  - 12 onshore temporary storage tanks
  - 2 ships with capacity to transport 7,500 m<sup>3</sup> of CO<sub>2</sub>
- Project Phase 2:
  - Start-up: depending on market demand in Norway and Europe, and commercial viability
  - Volume CO<sub>2</sub>: < 5 million tonnes per year (subject to final investment decision)
  - 3 or more wells

- 12” pipeline
- Additional onshore temporary storage tanks
- More ships

#### PROJECT DESCRIPTION AND RELEVANCE (non-technical):

Please provide a concise synopsis of the project (who, what, why, where and how) with an easily understandable description of relevance of the project and the associated science, technology and areas of industrial application. Target audience: policy makers, press, non-scientific community

Northern Lights is an independent joint venture company, drawing on the technical competence of its owners, Equinor, Shell and TotalEnergies. The company is responsible for development and operation of CO<sub>2</sub> transport and storage facilities, open to third parties, as part of the Norwegian Government’s Longship CCS project.

When it starts operations in 2024, Northern Lights will be the first ever cross-border, open-source CO<sub>2</sub> transport and storage infrastructure network, shipping liquefied CO<sub>2</sub> to an onshore receiving terminal at Øygarden on the Norwegian west coast, before being transported by pipeline for permanent storage in a reservoir 2600m under the seabed. Northern Lights will use specially designed ships that can travel flexibly between any port.

Northern Lights is developing a CO<sub>2</sub> transport and storage infrastructure where the CO<sub>2</sub> will be stored in pressurised tanks before being pumped offshore through a pipeline to one or more injection wells located on the seafloor.

In Phase 1, Northern Lights will provide CO<sub>2</sub> storage capacity for 1.5 million tonnes per year, taking just over half from two Norwegian sources, Fortum Oslo Varme (waste) and Norcem Brevik (cement), while finding European customers for the remaining capacity. Construction of this infrastructure and the ships began in 2021 and will be completed in mid-2024. It is funded 80% by the Norwegian State.

In Phase 2, Northern Lights will expand capacity to over 5 million tonnes of CO<sub>2</sub> per year. This phase will be largely commercially funded; some funds have already been agreed from the European Union, as a designated Project of Common Interest. The ambition is for Phase 2 to be operational by 2026. Due to significant interest from customers, the project plan has accelerated with early investments in infrastructure needed to ensure continuity of service.

Northern Lights is experiencing significant demand for storage capacity from industrial players in Norway and Europe, as both companies and countries start to implement net zero strategies. There are ongoing conversations with potential customers representing waste incineration, cement, steel and other metals, refinery, fertilisers, ammonia, power from natural gas, biomass, biofuel and direct air capture.

In particular, please include information about the following:

- How is your project adding to the global body of CCUS knowledge? What do you anticipate learning from this project?

The Northern Lights project has a new approach to CCS: it offers a ship-based CO<sub>2</sub> transport and storage service, open to multiple capture sites across Norway and Europe. CO<sub>2</sub> transport by ship offers a flexible solution to reach many and large carbon emission points. Together with pipeline solutions, it provides the backbone for a European network for CO<sub>2</sub> management across Europe. CO<sub>2</sub> storage is not new, but the Northern Lights shipping component and commercial models are new. Northern Lights is sharing its experience and knowledge, supporting realisation of similar projects elsewhere in the world. This is done through information published on the Northern Lights website ([www.norlights.com](http://www.norlights.com)), publication of its annual report, participation at workshops and webinars, and through the Northern Lights annual Summit which is held in June each year (more information about the 2022 Summit is available [here](#)).

- How is this project leading toward commercialization of CCUS?

The Northern Lights project is designed to develop an open-source value chain, while sharing its learnings proactively and transparently with the world. Northern Lights has brought a new dimension to CCS by modularising the value chain through shipping and kickstarting the industry with government support. As such, it is acting as a pathfinder project, and its experiences are being drawn on in Europe and globally to understand how best to commercialise CCS, build scale and leverage CCS as an effective decarbonisation tool.

#### PROJECT DESCRIPTION (technical):

Please provide a more detailed technical description of the project with all significant information. Target audience: engineers and scientists. In particular, please include information about the following:

- What stage is this project at? [If this is a fully integrated demonstration projects, has a FEED study been completed?]

This is a fully integrated demonstration project, a FEED study has been completed and the infrastructure is being constructed.

The European Commission has announced that EU countries have agreed to award Northern Lights €4 million under the Connecting Europe Facility (CEF) funding scheme. The funding is earmarked for Front-End Engineering Design (FEED) studies for the expansion of the Northern Lights CO<sub>2</sub> transport and storage capacity to over 5 million tonnes per year.

Northern Lights will be awarded the funding based on its designation as a Project of Common Interest (PCI) in Europe under the 4th PCI list, a key cross border infrastructure project that supports the EU's climate policy objectives.

The planned expansion will include subsea facilities and capacity increase of the onshore receiving terminal in Øygarden:

- A second jetty to cater for additional volumes of imported CO<sub>2</sub> from larger ships
- Additional intermediate storage for CO<sub>2</sub> with additional volume
- Additional CO<sub>2</sub> export pumps

What Technology Readiness Level (TRL) level is this project demonstrating? Please provide a description and explanation of how the project meets this TRL. [Information about TRLs can be found at <https://www.bnl.gov/techtransfer/TMFP/definitions.php>]

In accordance with the Australian Renewable Energy Agency classification system (<https://arena.gov.au/assets/2014/07/ARENA-IGEG-main-report.pdf>), the Northern Lights project will have a Commercial Readiness Indicator (CRI) at 3 or 4. It is a full scale commercial project.

#### NOVEL ASPECTS OF PROJECT

Please provide information about the following:

- What, if any, new or novel project aspects are you anticipating in the policy, legal, or regulatory arenas?

It is important to ensure that emerging regulatory and business models develop hand in hand to open up storage capacity in an efficient and commercially compatible manner. Northern Lights is working closely with Norwegian regulators and government officials and contributes actively to policy discussions on a European level, through interest groups like the Zero Emission Platform and directly with the European Commission. The cross-border elements of the Northern Lights value chain have triggered bi-lateral discussions between countries in respect of the London Protocol article 6.2, and changes to the European Trans-European-Network for Energy regulations, as well as including CO<sub>2</sub> shipping in the ETS Directive. As we see this new business being developed in Europe, continued

engagement and involvement in policy discussions will be critical, and there are now increased interest in finding practical solutions to regulatory challenges by corporations and nations across Europe.

- What, if any, new or novel project financing mechanisms or business models are you engaging?

For CCS to become a successful climate mitigation measure, Northern Lights' business model - maximising value creation while meeting the rapidly increasing storage demand - needs to be successful. To scale up, Northern Lights will need effective support mechanisms, a high CO<sub>2</sub> price, willingness to invest, smart regulations, technical standardisation, and certification and metering standards. Digital innovation will also help drive value creation.

The EU has designated Northern Lights as a Project of Common Interest (PCI), a key cross border infrastructure project that will help the EU achieve its climate policy objectives, including contributing to a climate-neutral economy by 2050. The Northern Lights PCI is a commercial ship-based CO<sub>2</sub> cross-border transport network. It connects European carbon capture initiatives with permanent carbon storage infrastructure under the Norwegian North Sea.

PCI projects and participants can benefit from simplified permitting and the right to apply for EU funding from the Connecting Europe Facility programme.

The Northern Lights PCI is linking project promoters located in seven European countries.

- What technological contribution is this project making?

Northern Lights is actively participating in industry bodies addressing standardisation on CO<sub>2</sub> specifications (composition, pressures, temperatures, etc), as well as ship design and specifications (loading and off-loading, for example).

The Northern Lights owners are working together with Gassco and DNV to study the development of low-pressure solutions for ship-based CO<sub>2</sub> transportation (technology qualification of a low-pressure ship design and scale up of CO<sub>2</sub> transportation volumes, while reducing associated risks).

The Northern Lights owners are also involved in an initiative conducting intensive engineering analysis to formulate an optimum design for the vessels' containment system and cargo handling systems, bearing in mind the specific nature of liquefied CO<sub>2</sub>.

#### PROJECT TIMELINE:

Please provide the project start date, any milestone events (listed chronologically), and the end date. Use most realistic timeline available. Use official (contract signing, etc.) start date. End date should reflect contractual timeline if possible. Use bullet points.

- 2 October 2017: Statoil (now Equinor), Shell and Total (now TotalEnergies) enter into a partnership to work on the Northern Lights project
- September 2019: first MoUs signed with Air Liquide, Arcelor Mittal, Ervia, Fortum, Preem, HeidelbergCement, and Stockholm Exergi
- March 2020: confirmation of Northern Lights' reservoir characteristics and storage capacity, following exploration well drilling
- 6 May 2020: Equinor, Shell and Total (now TotalEnergies) finalise their investment decision
- December 2020: the project gets the go-ahead with an historic approval vote in the Norwegian Parliament
- 5 February 2021: Northern Lights JV DA is born: a joint venture between Equinor, Shell and Total (now TotalEnergies) to build and manage the project
- March 2021: Northern Lights enters into a partnership with Switzerland's Climeworks, a direct air capture company

- May 2021: Norway's Prime Minister Erna Solberg lays a foundation stone at the construction site at Øygarden
- June 2021: Northern Lights and other partners announce the launch of the CCS+ Initiative
- 7 June 2021: Northern Lights becomes the operator of EL001, the first licence awarded for exploitation of subsea reservoirs for injection and storage of CO<sub>2</sub> on the Norwegian Continental Shelf
- September 2021: Northern Lights opens its first official office and commits to raising its storage ambition to well over 5 million tonnes/year
- October 2021: Northern Lights JV awards contracts for two dedicated CO<sub>2</sub> carrier ships, with expected delivery by mid-2024
- November 2021: European Innovation Fund award announced funding for four European carbon capture projects with a total capture capacity of 3-4 million tonnes of CO<sub>2</sub> per year from 2026
- December 2021: Construction on the Northern Lights facilities is around 30% complete
- February 2022: EU awards funding to Northern Lights for FEED studies of Phase 2 expansion, as a Project of Common Interest
- *Mid-2022*: Drilling of second well
- *Mid-2024*: Northern Lights will officially begin operations with injection of the first CO<sub>2</sub> shipment from a Norwegian cement factory

#### INFORMATION AVAILABILITY:

How will you share results of your project with the broader CCUS community? Please provide a description of the types of information that will be made available from the project and the outcomes that would be achieved by the project. (Note: It is anticipated that an update on the project will be requested annually by the CSLF. Information provided by the project will be made available at the CSLF website.)

- Northern Lights website: [Northern Lights \(norlights.com\)](http://norlights.com)
- Social media: LinkedIn, Twitter, Facebook

Sharing of knowledge and best practice is part of Northern Lights' core values. Memberships and collaboration with industry associations and interest organisations are an important part of Northern Lights' collaboration, providing a valuable platform to engage with governments, regulators and communities.

#### PROJECT CONTACTS:

Please provide name and contact information (including telephone and e-mail) for the project manager or coordinator. If relevant, please also provide name and contact information (including telephone and e-mail) for the person who will handle any requests for site visits.

- Managing Director: Børre Jacobsen
- Communications & Government Relations Director: Kim Bye Bruun, telephone: +47 46 92 01 26, e-mail: [kim.bruun@norlights.com](mailto:kim.bruun@norlights.com)

Please also provide an answer to the following question:

*What restrictions, issues, or costs will be assumed by any visitors to the project site?*

Northern Lights is receiving visitors at onshore facilities in Øygarden based on requests. The visitors centre will open officially in October 2022

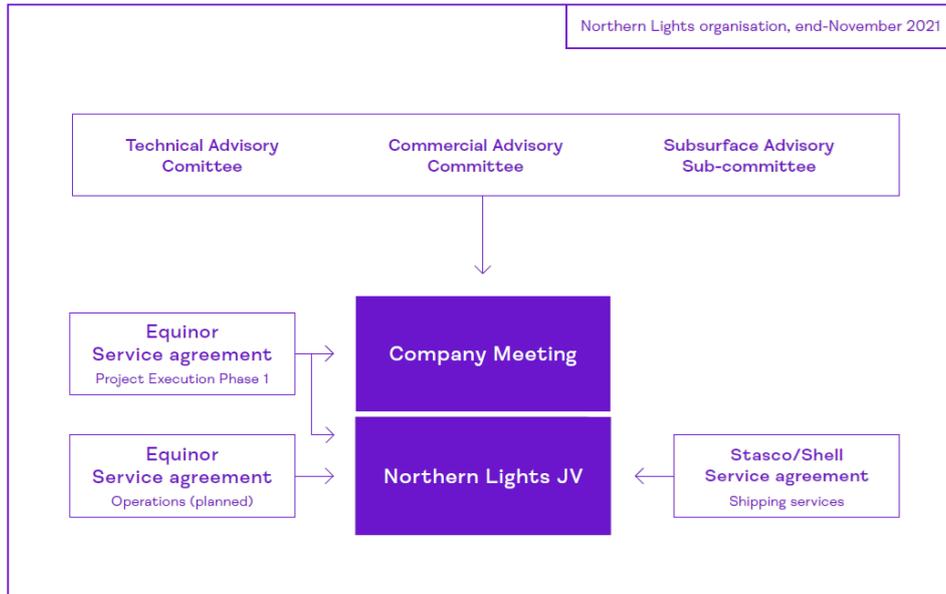
#### OTHER PROJECT PARTICIPANTS:

Please provide a listing of all entities who are participating in this project. If available, please also include a management structure diagram or otherwise indicate the role of each participating entity.

Northern Lights JV DA is a registered, incorporated unlimited liability partnership with shared liability (DA), with three owners: Equinor Refining Norway AS, A/S Norske Shell and TotalEnergies EP Norge AS, all holding equal ownership shares of 33,3%.

The Company Meeting is the governing body of the Company and makes decisions regarding Northern Lights and its activities. Each owner company appoints one member and one deputy member. The Company Meeting is chaired by a member appointed by the Company Meeting.

Northern Lights JV management structure diagram:



#### PROJECT WEBSITES:

Please provide the web address of the main project website, if one exists. If available, please also provide the web addresses of other project-related websites such as workshops, project presentations, etc.

- [Northern Lights \(norlights.com\)](http://norlights.com)
- [Langskip – 79/5000 A project for CO<sub>2</sub> management that includes capture, transport and storage of CO<sub>2</sub> \(regjeringen.no\)](http://regjeringen.no)
- [Full-scale CCS project in Norway - Longship | Reaching the climate goals \(ccsnorway.com\)](http://ccsnorway.com)

#### PROJECT NOMINATORS:

*Delegates from at least two CSLF Member countries must inform the CSLF Secretariat ([cslfsecretariat@hq.doe.gov](mailto:cslfsecretariat@hq.doe.gov)) that they support the nomination of the project for CSLF recognition.*

# CSLF Project Elements Checklist

(Please check all of the following areas that your project will address.)

## GENERAL

Project Scale	
Feasibility	
Pilot	
Demonstration	X
Commercial	X

## CAPTURE TECHNOLOGIES

Capture Type	
Pre-combustion capture	
Post-combustion capture	
Oxyfuel combustion	
Industrial applications	
Technology	
Advance the capture technology	
Advance plant design for capture efficiency (e.g., boiler, turbine design)	
Improved fuel handling and air separation processes technology	
Improved combustion and flue gas science	
Advance purification and compression technology	
Polygeneration optimization	

## TRANSPORT

General	
Tanker Transport	
Pipeline Transport	X
Ship transport	X
Specifications for impurities from various processes	
Regulations, standards and safety protocols, including response and remediation	

## STORAGE AND MONITORING

Storage Complex Type	
Saline formations	X
Unconventional reservoirs (e.g., basalt, shale)	
Unmineable coal formations	
EOR and/or EGR	
Depleted oil and gas fields	
Storage complex characterization	
CO <sub>2</sub> -water-rock (or coal) interactions	
Impact of the quality of CO <sub>2</sub> on storage	
Improved modeling of complex	
Effects of CO <sub>2</sub> rock/water interactions and induced changes in temperature, pressure and stress on permeability, injectivity, migration, trapping and capacity.	X
Pressure management (e.g. production of formation water)	
Monitoring the storage complex including risk assessment	
Development of new or improved CO <sub>2</sub> monitoring technologies	X
Improve baseline monitoring and distinguish between natural and anthropogenic CO <sub>2</sub>	
Development of risk minimization/mitigation methods and strategies, including leakage	
Improve well integrity, well abandonment practices, and/or remediation of existing wells	

# CSLF Project Elements Checklist

(Please check all of the following areas that your project will address.)

## CARBON UTILIZATION TECHNOLOGIES (MUST PROVIDE A VALID LCA INDICATING ACTUAL NET REDUCTION COMPARED TO A BASELINE)

<b>Utilization Type</b>	
Thermochemical	
Electrochemical	
Mineralization	
Biological	
<b>Technology</b>	
Advance catalysis	
Advance electrochemistry	
Process intensification	
Mineralization-building materials	
Mineralization-novel designs	
Mineralization-increased CO2 uptake	
Biological-Algae-open system	
Biological-Algae-closed system	

## CARBON DIOXIDE REMOVAL TECHNOLOGIES (MUST PROVIDE A VALID LCA INDICATING ACTUAL NET REDUCTION)

<b>CDR Type</b>	
Direct air capture (DAC)	
Bioenergy with CCS	
Mineralization (Surficial and Ex Situ)	
<b>Technology</b>	
DAC-solid sorbent	
DAC-solvent	
DAC-Novel or hybrid	
BECCS-power	
BECCS-fuels and chemicals	
Mineralization-mine tailings and wastes	
Mineralization-minerals	
Mineralization-Improved kinetics	
Mineralization-processing	
Mineralization-products	