equinor

An EU Strategy for Energy System Integration

Introduction

Equinor appreciates the opportunity to provide input to the Direct Contribution process for the EU Energy System Integration Strategy (ESIS). Our company supports the EU's ambitious climate targets, and the European Commission's efforts to position the European Green Deal at the heart of the post-pandemic recovery plan. Our updated Equinor climate roadmap presents a series of new short, mid- and long-term ambitions to reduce our own greenhouse gas emissions and to shape our portfolio in line with the Paris Agreement. Equinor already has one of the industry's lowest upstream carbon intensities, and we have the ambition of i) further reducing the net carbon intensity (from initial production to final consumption) of energy produced by at least 50% by 2050, ii) growing renewable energy capacity tenfold by 2026, iii) strengthening our industry leading position in carbon-efficient production with the aim of reaching carbon-neutral global operations by 2030.

We are well positioned for the energy transition as one of the world's most carbon efficient oil and gas producers and as a significant player in renewables. To accelerate the speed of the transition we collaboratively work with partners and stakeholders and therefore we value the opportunity to contribute to the strategic development of the ESIS.

Key Messages

- Reaching Europe's 2050 climate neutrality ambition necessitates a massive deployment of clean molecules on top of further electrification. To incentivise the necessary investments in GHG abatement technologies investors need to see a conducive policy framework and strengthened market signals.
- A European standard classifying renewable and decarbonised gases based on a lifecycle GHG emissions assessment is essential.
- Including GHG content as a mandatory field on guarantees/certificates of origin enables consumer choice and serves as a passport to support the interchangeability of energy vectors from clean molecules to clean electrons and back on the basis of transparent GHG accounting.
- Sectoral demand-side measures are needed to stimulate the uptake of clean energy vectors.
- Industrial clusters are ideal incubators enabling immediate synergies and sizeable CO_2 reductions, but industrial-sized demonstration projects require clear support through e.g. the Environmental and Energy State Aid Guidelines and other EU financing mechanisms. It could also be valuable for member states to explore how the IPCEI framework can used to advance such industrial clusters.
- The Gas Directive can serve as a template to develop the legislative framework for clean hydrogen.
- TEN-E Regulation should have CCS and clean hydrogen as a new thematic area.
- The EU ETS & CCS Directives should recognise maritime CO2 transportation solutions.
- The development of a European methane regulation is an important component in the development of clean hydrogen value chains.

Consultation Questions

In this part of the consultation response we concentrate on four of the proposed questions:

- Q1) Main features of a truly integrated energy system to enable a climate neutral future
- Q2) & (5) Barriers to Energy Sector Integration & policy actions and legislative measures which the Commission could take to foster an integration of the energy system
- Q4) Best practices or concrete projects for an integrated energy system

Q1. Main features of a truly integrated energy system to enable a climate neutral future

The 2050 climate neutrality ambition represents a major milestone for the EU's global climate leadership and provides clear guidance for the policy agenda while demanding an unprecedented level of cooperation between member states. **The Energy System Integration Strategy should set a vision to reach this goal via cost-efficient decarbonisation of the economy, gradually increasing the use of renewable, low carbon and decarbonised energy carriers and obtain synergies by linking different economic sectors (building, transport and industry), as well as energy carriers (electricity, gas and hydrogen).**

Ideally the ESIS should set out a vision like the one in Figure 1that is flexible enough to be interpreted and adapted to regional economic, industrial, demographic and geographic realities rather than striving for a "one-size fits all" solution.

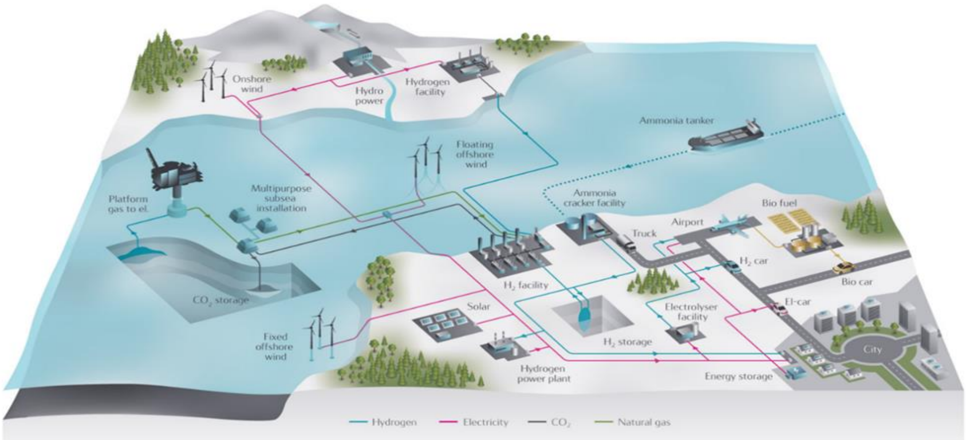

Figure 1 Low carbon solutions: a vision for future energy systems, Source Equinor

The realisation of a carbon neutral society by 2050 is ambitious. Any increase in the EU's 2030 GHG emissions reduction commitments would necessitate further accelerated efforts. The current EU's Long-Term Strategy scenarios should be reviewed and updated to reflect any increased ambition of the EU's climate commitments and Europe's future energy framework.

1. The need for technology neutral, flexible and efficient solutions

The ESIS should encompass a broad range of technological solutions that can rapidly scale up to deliver GHG emissions reduction. The parallel development of renewable and decarbonised energy solutions will render more scalable options and should therefore be central to the strategy.

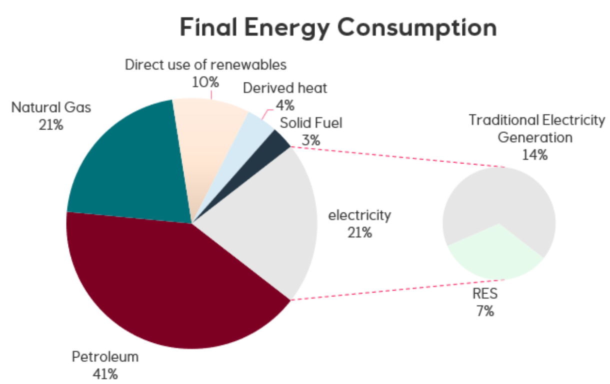

Figure 2 Final Energy consumption in Europe (2018)

Fossil fuels today provide system integrity, stability and seasonal storage but are not sustainable if left unabated. Renewable based electricity is clean, but system resilience, long range transport and seasonal storage are challenging. Figure 2 illustrates the system's reliance on fossil fuels today. Fortunately the existing energy infrastructure, which represents a huge cumulative investment over decades, can play an important role in achieving the overall decarbonisation objective by creating pathways to cost-efficient system integration. Clean decarbonised solutions can continue to offer system integrity, stability and seasonal storage and complement renewables in the energy system in the medium- and long-term. Carbon capture and storage (CCS) will be an essential tool in combination with clean hydrogen[1] and will enable large-scale decarbonisation, in particular in the energy intensive sectors.

[1] For the sake of clarity: the term clean hydrogen used throughout the document refers to both blue and green hydrogen as we see both technologies as being compatible and even interdependent.

As a clean energy carrier, hydrogen can be produced through electrolysis in combination with renewables or from natural gas through methane reforming with CCS at an abatement rate of 94,1%.[2] Equinor, together with partners, is currently looking into technology with a potential capture rate up to 99% CO_2.

Hydrogen produced through methane reforming offers a secure, but flexible back-up, while hydrogen from electrolysis offers opportunities to transform excess renewable electricity into hydrogen. It avoids curtailment of a clean energy carrier, can be stored for later use or transported for use in a different sector, but will be as volatile in production as its energy source, e.g. electricity produced with offshore wind. Looking at the 2030 and 2050 GHG emissions reduction targets, the real challenge lies in replacing half of the oil and gas Europe consumes today. No one track will alone deliver the amount of clean hydrogen needed and the ESIS should recognise and promote a diverse set of projects in both strands. This way the system integrity, resilience and cost-effectiveness of both the electricity and gas sector can be secured over time.

2. *Industrial clusters as a lever for a decarbonised European economy: exploiting synergies, large-scale decarbonisation potential and job opportunities*

Exploiting synergies and large-scale decarbonisation:

Decarbonising the EU's industrial backbone should be a centrepiece of the ESIS. As a large consumer of energy, the industrial sector will need integrated large-scale decarbonisation solutions to reduce its emissions in a manner that is cost-efficient and allow it to stay globally competitive. Energy intensive clusters operate in highly interdependent production environments and have vast potential for cost optimisation and circular synergies through shared infrastructure and services. This includes port infrastructure, terminals, storage & transport, shared railroad access, energy infrastructure and pipelines. They are in a sense an example of system integration today already. This makes them particularly attractive for large-scale decarbonisation pilot projects, something that should be reflected in the ESIS[3].

This model is further supported in projects currently under development such as the Porthos project in Rotterdam, Ervia's Vision 2050 project in Ireland, the Belgian project North Sea Ports CUST or the Northern Lights carbon transport and storage project in Norway. For a project developer, an industrial cluster offers industrial-sized demand, enabling a business case for large scale hydrogen production through methane reforming in combination with CCS as well as large scale electrolysis by linking to offshore wind parks. From a cluster perspective, the combined offering of CCS and hydrogen (blue and/or green) gives optionality to either decarbonize through the choice of fuel/feed-stock or direct implementation of CO_2 capture at the industrial plant. There is also a higher chance for spill-over effect to other sectors such as heavy-duty transport and maritime transport.

Job opportunities

The EU's post-COVID-19 economic recovery plan will necessitate affordable decarbonisation solutions that can create new and preserve existing jobs in Europe without compromising the EU's climate ambitions. Transitioning to a hydrogen-based economy offers a low-carbon pathway for several hard-to-abate industrial sectors across Europe, including steel, cement, and chemicals. Large-scale hydrogen projects, combined with CCS, such as those being developed by Equinor, demonstrate the viability of such an approach (see Q4). A clean hydrogen economy represents considerable employment potential for European industries. The FCH JU estimated that the EU hydrogen industry could provide employment for about one million highly skilled workers by 2030 and some 5.4 million by 2050. The same study shows that the export potential in 2030 is estimated to reach EUR 70 billion. CCS deployed at a wide scale, delivers a potential for 150.000 direct and indirect jobs in 2050[4], in addition to high skilled jobs retained in hard-to-abate and energy intensive industrial sectors and contribute to the development of a hydrogen economy.[5]

As DG GROW's Masterplan for Energy Intensive Industry brings out, **industrial energy-intensive clusters could be used as incubators for decarbonized energy integration with industrial sized demonstration projects that enable immediate and sizeable CO_2 emission reduction**s by combining Blue Hydrogen, CCS and Green Hydrogen projects.

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[2] IFPEN & SINTEF (2019) "*Hydrogen for Europe" pre-study*: www.sintef.no/globalassets/sintef-energi/hydrogen-for-europe/hydrogen-for-europe-pre-study-report-version-4_med-omslag-2019-08-23.pdf, page 98

[3] According to the *European Observatory for Clusters and Industrial Change* 2020 report there are some 51 exporting industry sectors and 2950 regional clusters, which represent 1 in 4 European jobs.

[4] SINTEF (2018): *Industrial opportunities and employment prospects in large-scale CO_2 management in Norway*. Available here

[5] High-Level Group on Energy-intensive industries (2019): *Masterplan for a Competitive Transformation of EU Energy-intensive Industries Enabling a Climate-neutral Circular Economy by 2050.* Available from: https://ec.europa.eu/docsroom/documents/38403

3. The need for cross-border infrastructure and a European/global market:

In order to further leverage the well-connected European energy market and create exponential positive economic effects regionally, additional infrastructure is needed between energy intensive clusters as they develop. The need for a hydrogen backbone and a CO_2 transport network has been well illustrated in the ENTSOG 2050 Roadmap for gas.

Alongside the development of a hydrogen infrastructure it will be equally necessary to develop carbon transport and storage infrastructure either as an integral part of a cluster or with the opportunity of shared access from different clusters thereby becoming a 'reverse cluster' across different industrial clusters as well as single companies outside clusters.

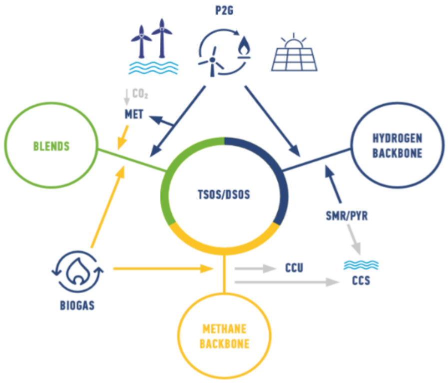

Figure 3 Principles for new gas transportation. Source: ENTSOG 2050 Roadmap for gas.

Clean hydrogen has the potential of being mass-produced and traded regionally and even globally, as demonstrated in reports by renowned international organizations like IEA[6] and IRENA[7], but also Member States like the Netherlands with their recently released hydrogen strategy[8] or the UK CCC Progress Report[9] have identified that international cooperation is essential for creating a hydrogen market. Such international transport of hydrogen will require strategic thinking on geopolitical, ethical (ensuring the imported hydrogen is clean) practical and technical issues[10], but also how to organize a traded market, reliability and security of supply. It will be important to hold on to the well-functioning transparent gas market benefitting customers across Europe. The Gas Directive should be the template by which to develop the framework for clean hydrogen, i.e. the organisation and functioning of the market, access to the market, the criteria and procedures applicable to the granting of authorisations for transmission, distribution, supply and storage of hydrogen. However, one will have to consider how and when to regulate the different value chain segments and avoid overregulation.

Q2 & 5. Barriers to Energy Sector Integration & policy actions and legislative measures which the Commission could take to foster an integration of the energy system

1. Incorporate the life-cycle emissions approach into the EU's Energy Sector Integration Strategy

The EU's ESIS should promote technologies on the basis of an objective GHG emission reduction criteria. The origin of a product is not the only sustainability criterion: life-cycle emissions and the efficient use of resources are equally important as they actively contribute in reaching the 2050 targets.

Lifecycle emissions of carbon abatement technologies across the value chain should be the basis for categorising different technologies and evaluating their potential contribution in a low carbon energy system. This includes renewable, low-carbon and decarbonised gases, and could take the form of a carbon accounting system. Such a system would enable the retention of the green characteristic beyond the conversion of electricity into gas and back.

A potential tool to safeguard this information could be the Guarantees of Origin enabled under RED II. However GHG or CO_2 content is currently not a mandatory field in the (online) European-wide trading form. If CO_2 content were to be included as a mandatory field, based on life-cycle-analysis, it could ensure that the low carbon characteristic follows the product throughout the carbon accounting system irrespective of its state (gaseous form or electricity). It would follow the carbon abatement potential rather than the molecule or electron thereby further supporting energy system integration and its decarbonisation. The failure to follow such an approach risks creating gaps in the CO_2 accounting system resulting in the loss of the carbon abatement information of the product or even double counting. This is especially important in the transformation from Power to-X and back, where otherwise the potential for sector coupling could be reduced or even lost.

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[6] IEA, *The future of hydrogen, seizing today's opportunities* (2019)

[7] IRENA, *Hydrogen from renewable power: technology outlook for the energy transition* (2018)

[8] NL Government, EZK, *Government Strategy on Hydrogen* (April 2020), www.government.nl/documents/publications/2020/04/06/government-strategy-on-hydrogen

[9] Reducing UK emissions – 2019 Progress Report to Parliament available here: www.theccc.org.uk/publication/reducing-uk-emissions-2019-progress-report-to-parliament/

[10] ENTSOG, *Roadmap to 2050*, 2020

2. Create a framework for decarbonised solutions to contribute to achieving the EU's climate targets

The development of decarbonisation solutions such as hydrogen and CCS is currently hindered by several **barriers** within the EU's climate & energy framework. While CCS is recognised as an important decarbonisation technology, the relevant legislation is in parts outdated and does not reflect new project and market development concepts[11]. Clean hydrogen on the other hand, is not treated as an energy carrier in the EU's legislation and is therefore not recognised as a valuable contributor to decarbonisation. The ESIS should target these legislative imbalances across the EU's climate & energy framework to enable the deployment of these technologies in the context of EU's climate targets.

The EU's policies should support and incentivise the development of **cross border CO_2 transport and storage networks** in Europe as exemplified by the Northern Lights project. Financial support and grants will be key to achieving early deployment of the CCS value chain in Europe. Ensuring that CCS projects in Europe[12] are eligible for the EU's and national public support and funding schemes should therefore be an important element in the Commission's approach to promoting economic recovery.

For a robust legal framework to be developed it is essential that a **European standardised classification for renewable and decarbonised gases** is developed. This classification should reflect net CO_2 emission levels based on a life-cycle assessment and be used in a consistent way throughout energy-related legislation developed by the EU.

Guarantees of Origin. It is essential that the CO_2 content is included as a mandatory field on the GoO irrespective of the product being renewable or not. If not, one risks creating gaps in the CO_2 accounting resulting in the loss of the carbon reducing factor of the product or even double counting. This is especially important in the transformation from Power to-X and back, where otherwise the potential for sector coupling could be reduced or even lost.

Clean hydrogen certificates. To incentivise the uptake of decarbonised products alongside renewable products the ESIS should establish a certification system that recognises the carbon emission reduction that is achieved through the use (consumption or production) of decarbonised products on a life cycle basis. It will allow an accelerated uptake of hydrogen which provides the appropriate signal for hydrogen infrastructure investment.

Sectoral targets under the REDII and other legislation. Once emissions from the easy-to-decarbonize parts of the European economy have been reduced, origin-based sectoral targets (such as for renewable energy) and incentives will likely come to their limits in driving further reductions in GHG emissions. As a result, policies and trajectories will increasingly need to reflect non-renewable decarbonisation solutions. In the decade leading to 2030, large-scale deployment of enabling technologies, including CCS and CCS-enabled clean hydrogen solutions, should be a priority for the EU's decarbonisation policy in order to demonstrate their viability in the long-term. To realise their scale-up potential, sectoral targets should not be limited to renewables only but encompass all cost-efficient decarbonisation technologies in the mid- to long-term. The ESIS should create a framework to recognise all low carbon solutions under the sectoral GHG emissions reduction targets for the power, transport, heating and other applications, irrespective of their origin.

Guidelines on State aid for environmental protection and energy and IPCEI. The Environmental and Energy State Aid Guidelines should enable member states to offer proportional support for low carbon technologies to take off, including for clean hydrogen. The review of EEAG should be coordinated with the IPCEI initiative and create conditions to remunerate cost-efficient, scalable clean hydrogen solutions and related network infrastructure development based on their GHG emissions reduction potential.

Gas Directive. The directive and its related regulations can be the template for the development of a legislative framework for clean hydrogen, i.e. the organisation and functioning of the market, access to the market, the criteria and procedures applicable to the granting of authorisations for transmission, distribution, supply and storage of hydrogen. It should create enabling conditions for phase-in of hydrogen from a regulatory perspective, set quality standards, enable separate hydrogen networks through conversion of the existing natural gas network (retrofitting) and new dedicated pipelines where needed. As is the case today in the gas directive, regulated and unregulated hydrogen infrastructure should be possible under similar conditions. In the case of regulated hydrogen infrastructure, one possibility would be to empower current NRAs to conduct the necessary regulatory oversight and determine the role of TSOs and DSOs. There is a similar requirement to consider CO_2 transportation, either under the Gas Directive or by developing ties to the CCS Directive which currently does not provide 3rd party access to transport pipelines,

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[11] IOGP, *CCS in the current and future legislation*, 2020 https://www.oilandgaseurope.org/wp-content/uploads/2020/04/CCS-in-the-current-and-future-EU-legislation-paper.pdf

[12] IOGP CCS Map of existing and planned Carbon Capture and Storage facilities in Europe http://www.oilandgaseurope.org/wp-content/uploads/2020/02/IOGP_Map-of-EU-CCS-Projects.pdf

etc. As is for the case of hydrogen, this is a regulatory gap that acts as a barrier for the development of carbon capture and carbon storage projects, especially when these are de-linked from a development perspective.

TEN-E Regulation. CCS and clean hydrogen technologies will play a pivotal role in decarbonising the EU's energy system. First, hydrogen should be added to the scope of the TEN-E Regulation as a new thematic area in order to create conditions for kick-starting the development of networks for renewable and decarbonised hydrogen. In addition, the TEN-E Regulation should reinforce the governance system around infrastructure planning for CCS and hydrogen. In line with the TYNDP framework or in parallel to it, member states should be asked to list and report planned CCS and hydrogen interconnection projects on the national level in order to facilitate network planning and long-term visibility of low carbon infrastructure development across Europe. Furthermore, the TEN-E Regulation should be updated to better integrate Europe's new CCS project development concepts, which aim at building a cross-border European CO_2 transport network. A CO_2 transport network should not be limited to pipelines but encompass maritime, road and railway transport that can be part of a shared CO2 transport network. It is particularly relevant during the pilot project and scale-up phases of CCS deployment in Europe, where pipeline construction might not be feasible or economic. Finally, the sustainability dimension of gas as defined in the TEN-E Regulation should not be limited to renewable gas solutions only. Art 4(b)(iv) of the Regulation states that the sustainability criteria for projects of common interest in gas relates to 'enhancing deployment of renewable gas'. Non-renewable low-carbon gases should be added to the scope to recognise their potential for the gas sector decarbonisation.

EU ETS & CCS Directive. The transport network as defined under the CCS Directive currently limits CCS transport to a network of pipelines, which effectively excludes maritime CO_2 transportation solutions. The definition of a CO_2 transport network, as defined in the CCS Directive, is used in other EU legislations, including the EU ETS Directive as well as the TEN-E Regulation. It creates ambiguity in the EU ETS Regulation, where the CO_2 captured and transferred to ships for transport to permanent storage may not be considered verified as captured emissions. If such an interpretation is correct, the emitter who chooses to transport CO_2 by ship would lose the right to retain emission allowances and therefore the financial incentive to capture CO_2 for permanent storage. It is important that the CCS Directive and the EU ETS Directive are updated to encompass maritime CO_2 transport as several pan-European CCS projects in the planning are based on shipping solutions to transport CO_2 to permanent storage.

Methane emission regulation for the Energy sector. Managing methane emission in upstream operations is critical for the climate credentials of hydrogen derived from natural gas. We have estimated Equinor's methane intensity for the upstream and midstream parts of the value chain that we control to be as low as 0.03%. It is our ambition to maintain this very low methane intensity, by further developing and implementing technologies and procedures to detect and reduce methane emissions. We participate in industry efforts to reduce methane emissions across the oil and gas value chain, as well as increase the quality and transparency of reported data. We support the development of sound methane policies and regulations and shared our experience and the Norwegian best practice as input to the upcoming European methane emissions strategy for the energy sector. The European Commission's suggestion to establish an independent verification institute could provide additional credibility, enhance trust in methodologies and it can be a driving force to harmonize and underpin existing efforts to contain methane emissions.

3. Support Energy Sector Integration through EU and national funding

The integration of decarbonised European energy systems will necessitate substantial funding, for production, transport, storage and end-use infrastructure. This relates to decarbonising gas production and repurposing of the existing infrastructure for transport and storage of low carbon gases as well as guaranteeing that end-user equipment – whether in industrial or household applications – is fit for purpose. In this context, it is important to recognise that the EU's shift towards low carbon gas networks will be gradual and take into account regional discrepancies. The ESIS should create an enabling framework for the EU's forward-leaning regions to fast-track piloting large-scale low carbon projects, including for production of clean hydrogen as well as repurposing of natural gas networks to transport of hydrogen. In this context, both European as well as national funding will be needed to incentivise projects in the absence of adequate market remuneration mechanisms. The ESIS should spearhead regional initiatives for hydrogen network development, clustering forward-leaning member states to work on developing regional plans for hydrogen production, network infrastructure conversion and proportionate remuneration schemes for clean hydrogen. That could involve developing competitive mechanisms – such as contracts for difference – to remunerate clean hydrogen supply in the market. Active member state engagement will prove crucial for the transformation of the EU's energy systems and their integration and we encourage the Strategy to focus extensively on the member state and regional dimension.

Industry will prove an important part of the ESIS, and particular attention should be paid to industrial decarbonisation policies. The EU ETS is a primary tool for industrial decarbonisation on the EU level. Industrial emissions have decreased very little compared to GHG emissions reduction in the power sector. The Union and Member States should streamline efforts to invest in industrial sector low carbon solutions, which can be facilitated through the forthcoming revision of the EU ETS. The revision could create a framework for intensified cooperation between

Member States on GHG emissions reduction in the energy-intensive sectors, earmarking national EU ETS auction revenue for large-scale industrial decarbonisation projects, to complement the Innovation Fund. Therefore, the EU ETS should further incentivise the maturation of innovative large-scale industrial sector decarbonisation technologies based on electrification or carbon removal technologies. The reform of the EU ETS should create improved conditions for both EU-level (Innovation Fund & Modernisation Fund) and national funding to be targeted towards the development of industrial decarbonisation. To give guidance to industrial investors, EU ETS revenue use (on a national level) should be reported in NECPs. Member states should also consider setting spending targets in harmony with the economic weighting of industry in their economy.

4. Work on long-term carbon pricing visibility

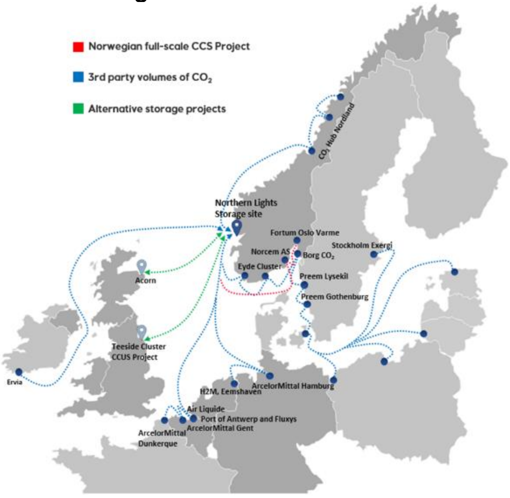
Between 2018 and 2019, the EU ETS prices of around €30/ tCO_2 put downward pressure on the most polluting fuels. It effectively reduced the consumption of coal in the EU's power sector by a reported 25% (to 431 TWh). At the same time, natural gas consumption in the power sector increased by some 17% (to 520 TWh), which together with renewables contributed to emissions reduction in the power sector over the period by an estimated 13.9%. The EU ETS price levels seen between 2018-2019 was largely a result of the start-up of the Market Stability Reserve (MSR) mechanism as well as the changed projected Linear Reduction Factor (LRF), both of which now are designed to remove the oversupply of the EU emissions allowances (EUAs) in the market. Both mechanisms have proved effective to trigger decarbonisation during times of relatively high economic activity (and therefore emissions generated) in the EU.

However, neither of them is well designed to 1) cater for economic shocks of significant nature and prevent sudden collapses in EUA prices; 2) adjust to GHG effects triggered by parallel EU (such as the REDII; EED; Fuel Quality Directive) and national (coal exit) initiatives. As a result, continued emissions reductions in the EU ETS sectors risk being slowed down when external shocks occur or by accumulated GHG effects of other policy initiatives. While undue market interventions generally should continue to be avoided, it will be important for the transition to a climate neutral EU that the EU ETS provides mid- to long-term credible price signals for investors. In the near-term existing EU ETS tools for market adjustment should be activated to ensure swift reaction to market developments. In doing so it will be important to carefully consider issues pertaining to verification. Onwards it will be important to review these mechanisms to provide improved responsiveness to market developments.

Q4. Best practices or concrete projects for an integrated energy system

Equinor, together with selected partners, is working on a suite of projects that can deliver substantial CO_2 emissions reductions as early as 2024, actively contributing to the 2030 GHG emissions reduction targets. We include here a selection of these projects: Northern Lights, H2morrow steel, H2M, H21 North of England study, ZeroCarbonHumber and HyDemo Norway.

Northern Lights



Under the Northern Lights Project of Common Interest CO_2 captured from industrial sites in Europe will be collected by ship and transported to the Norwegian Continental Shelf for permanent subsea storage in a dedicated saline aquifer, resulting in a full-scale CCS value chain. Equinor, Shell and Total announced on 15 May 2020 that they have decided to invest in the Northern Lights transport and storage solution. The investment decision is subject to final investment decision by Norwegian authorities and approval from EFTA Surveillance Authority (ESA).

Cross-border collaboration is one of the strongest assets of Northern Lights. Given positive investment decisions, the value chain could be **operational in 2024**, establishing an 'open source' network for transport and storage of CO_2, protecting and creating jobs while capturing emissions. The project is also in dialogue with around 15 additional European companies in different sectors and countries that also are exploring the option of having their CO_2 stored. Most of the projects are estimated to create around 1200 – 1500 full-time equivalents (FTEs) in total each over a 3-4 years period during the most job-intensive phase, the detailed engineering and construction phase. This in turn will create new permanent jobs ranging from 50 to 350 in each of the CCS operations.

The Northern Lights project is planned to be developed in two phases. Phase 1 consists of developing the capacity to transport, inject and store up to 1.5 million tons of CO2 per annum. Phase 2 would see the development of capacity to receive, inject and store an additional 3.5 million tons of CO_2 per annum, adding up to a total of 5 million tons of CO_2 per annum. Information on the Northern Lights project can be accessed here and in Annex 1 the Northern Lights PCI Memorandum – Value of a European Ecosystem in Green Recovery.

H2morrow steel

H2morrow steel, a consortium consisting of Equinor, OGE and thyssenkrupp Steel Europe (tkSE) is working on a joint feasibility study for producing clean steel, with a view to effectively decarbonising tkSE's steel production by up to 7 million t/y in a **2025/30 perspective**. This represents up to 10.5 million tons of CO_2 emission savings per year compared to the conventional production process. In a climate-neutral future, this project would help to preserve no less than 25 000 jobs, which corresponds to tkSE's current employment level in the Ruhr area, without considering related jobs in supporting industries.

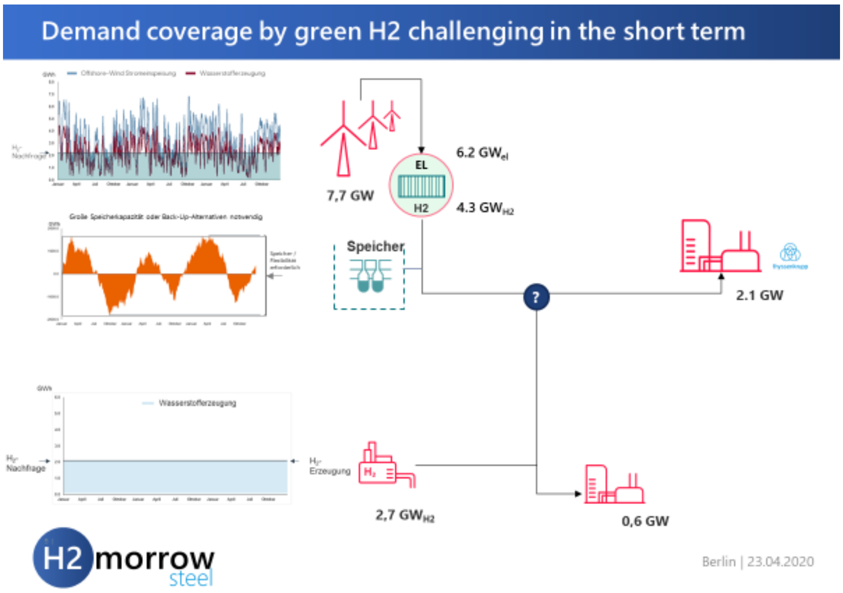


Figure 4 Short- to mid-term coverage of demand with green H2 challenging

The project partners are considering both blue and green hydrogen for the production of clean steel. The delivery of this clean hydrogen has to be reliable and available 24/7. For the time being, partners have concluded that hydrogen produced through electrolysis from renewable power (green hydrogen) will not be available at a quick enough pace nor at sufficiently high volumes.

Figure 4 Short- to mid-term coverage of demand with green H2 challengingillustrates the comparison between the two production methods and their potential in the context of the H2morrow steel project. The scenarios show that a green hydrogen pathway would require doubling the totality of Germany's existing offshore wind capacity within the next 8 years. In addition, significant investments in the electrolyser capacity and hydrogen storage would be needed, further exacerbating the associated costs.

Instead, the H2morrow steel project plans to produce CCS-enabled clean hydrogen from natural gas on Germany's North Sea coastal area or the Netherlands Groningen area and to transport it to Duisburg replacing coal in the clean steel production process. In a second stage the project could connect to the energy intensive industry cluster in North-Rhein-Westphalia. The H2morrow steel example demonstrates that CCS-enabled hydrogen will be an important building block of the future energy system and for the realisation of the hydrogen economy. Scalable clean hydrogen solutions are needed to create an initial market for hydrogen within this decade, avoiding carbon leakage and the loss of industrial jobs in Europe.

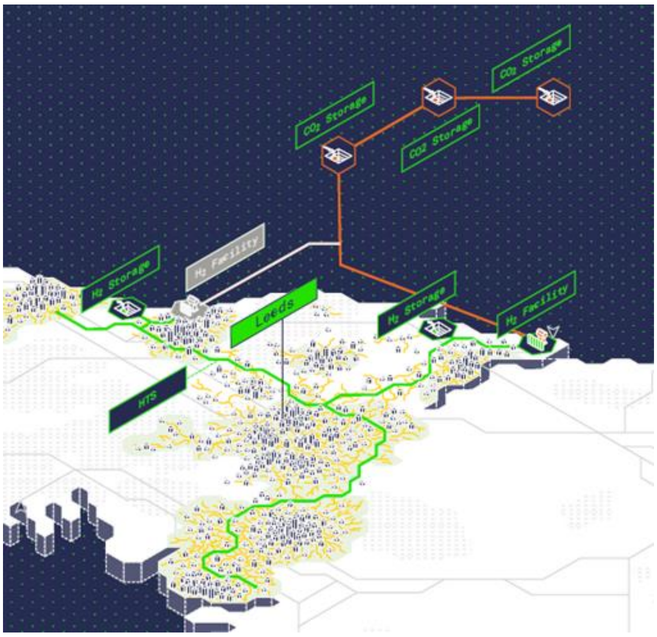
H2M

Vattenfall, Equinor and Gasunie have formed a consortium to explore the large-scale production and off-take of carbon-neutral hydrogen in the Eemsdelta area and to establish a hydrogen value chain that paves the way for a sustainable hydrogen economy. This H2M-project has the potential to reduce Dutch CO2 emissions by 2 million tons per year from 2024 onwards.

H2M includes the conversion of Vattenfall's Magnum power plant from natural gas to hydrogen, making Magnum the launching customer for the offtake of climate-neutral hydrogen. In the to-be-built hydrogen plant in Eemshaven, the CO2 will be separated and stored offshore in Norway. This can be done safely and permanently, based on Equinor's more than 20-years' experience from operating several carbon capture and storage (CCS) projects in Norway. The H2M-project also provides storage of hydrogen in the Zuidwending caverns for balancing purposes and targets the supply of hydrogen to third-party (industrial) off-takers.

The H2M project can be developed and realized within a 6-7 year timeframe and can thus be the first step towards establishing a renewable hydrogen economy. The H2M project can be developed and realised within a 6-7-year timeframe and it would be the first step in developing hydrogen infrastructure today and thereby pave the way for future renewable hydrogen production from electrolysis. In addition, it would support the integration of larger shares of renewable electricity as it provides flexible, clean back-up capacity for intermittent renewable energy. In the future, this backbone could be the start of a larger network, even connecting across borders.

H21 North of England study



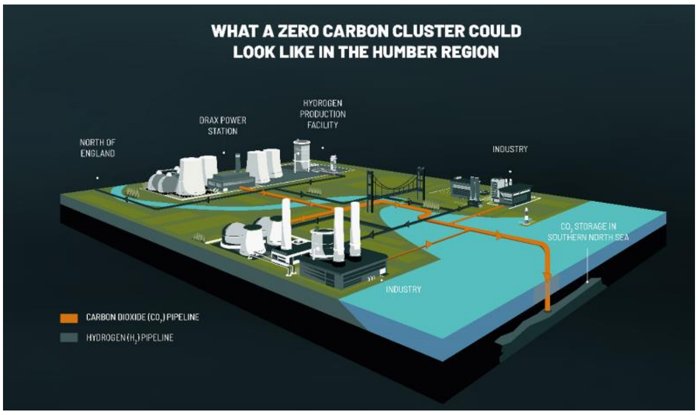
The report 'H21 North of England' sets out how 3.7 million homes and 40,000 businesses in **the north of England**, currently heated by natural gas, **could be converted to hydrogen and made emission-free by 2034**. It is a feasibility study carried out by Northern Gas Networks in partnership with Cadent and Equinor. The study examined all available clean hydrogen technologies and concluded on a self-powered 12-gigawatt production facility with carbon capture technology as the most technically credible solution whereby natural gas is converted to hydrogen to decarbonise the heating sector in the future. The captured by-product of the process, CO2, can be stored safely in saline aquifers far below the seabed, such as those off the north east coast of England.

The report, which contains a full cost overview, outlines that a new high-pressure transmission system designed with extra capacity to enable future supply for industry, power and transport, will be required to transport hydrogen to the local city grids. The hydrogen can also be safely stored until required, ensuring there is more than enough to meet demand during the coldest times of year.

The report proposes this could be achieved through a phased rollout enabling a further 12 million homes across the rest of the UK to be converted to hydrogen by 2050. The H21 North of England report finds that converting the entire UK gas grid to hydrogen has the ability to deliver deep decarbonisation of heat as well as transport and power generation, with minimal disruption to customers. H21 North of England also sets out how this initial hydrogen conversion could then be rolled out across the UK with a combined potential to reduce carbon emissions by over 250 MtCO2/year by 2050.

The full report which containing a comparison between technologies and project cost can be accessed here.

Zero Carbon Humber



Zero Carbon Humber represents a plan to decarbonise industry and power within the largest industrial cluster in the UK, The Humber. The scheme proposes both a large fuel switch strategy (to hydrogen) alongside a carbon capture and storage system facilitating a transition to a net zero industrial cluster by 2040. New hydrogen transmission pipelines would facilitate the fuel switch whilst CO2 Pipelines would capture CO2 and transport these emissions to permanent storage in naturally occurring aquifers under the southern North Sea.

The capture technology is already under development at Drax Power Station's pioneering bioenergy carbon capture and storage (BECCS) pilot, which could be scaled up to create the world's first carbon negative power station in the 2020s. Similarly, Equinor has been operating CCS projects since the 1990s.

In early 2019 Drax Group, Equinor and National Grid Ventures signed a Memorandum of Understanding (MOU) to explore how a large-scale carbon capture usage and storage (CCUS) network and a hydrogen production facility could be constructed in the Humber region.

This original consortium has worked alongside other partners across the Humber as part of phase 1 of the UK Governments Industrial Strategy Challenge Fund (ISCF). This fund aims to work in partnership with industry to support development of at least one low carbon cluster in the UK by 2030 with a net zero cluster by 2040. Phase 2 of the fund is due to open for bids in summer 2020 with £131m available as a match fund from UK government for development of 'anchor projects' within Industrial clusters. These projects will act as the anchors for the initial CO2 Transport and storage system to the region.

The production of hydrogen at a large scale is a key component in decarbonising the Humber as it offers a low or zero carbon fuel that can be applied to power, transport, heating and even serve as energy storage. Furthermore, fuel switching the Humber to hydrogen is a low regrets way to establish the initial hydrogen infrastructure in the UK. This can then be expanded alongside UK Government policy for example, to facilitate the conversion of UK heat to hydrogen as set out in the H21 North of England Report.

More information available at www.zerocarbonhumber.co.uk.

HyDemo Norway

The objective of the HyDemo project is to demonstrate a clean hydrogen value chain in Norway at realizable scale and cost based on natural gas from the Norwegian Continental Shelf. HyDemo Norway is an enabler to develop and supply a hydrogen market, meet climate ambitions and drive clean energy technology development. The project is a combination of hydrogen production through **methane reforming in combination with CCS and hydrogen production through electrolysis.** The produced hydrogen would then be used at Equinor onshore plant sites through industrial integration, as marine fuel for transportation and for technology qualification purposes. The project will have a carbon capture capacity of 150 000- 200 000 tonnes CO_2 per year assumed to be connected to Northern Lights for sequestration. The scale of the project is such that it will be sufficient to demonstrate and showcase a clean H_2 value chain delivering the equivalent of 100 MW Higher Heating Value (HHV) to a variety of industrial and commercial consumers by the end of 2025.

ANNEX 1 – Northern Lights PCI memorandum

Please refer to the attached PDF document “CCS and the EU COVID-19 Recovery Plan. The positive economic impact of a European CCS ecosystem.

CCS and the EU COVID-19 Recovery Plan

The positive economic impact of a European CCS ecosystem

MAY 2020

Northern Lights PCI
https://northernlightsccs.com

A memorandum by the Northern Lights Project of Common Interest (PCI), consisting of projects from: Acorn, Air Liquide, ArcelorMittal, Borg CO2, Ervia, Eyde Cluster, Fortum, Fluxys, H2 Eemshaven, HeidelbergCement, Net Zero Teesside, Nordland CO2 Hub, Northern Lights, Port of Antwerp, Preem, and Stockholm Exergi

What this memorandum aims at demonstrating:

CCS is a proven technology, necessary to decarbonise and safeguard European industry and jobs in a low-carbon economy

The industrial projects that together make up the Northern Lights PCI have an extraordinary potential to reduce Europe's CO2 emissions and create and protect thousands of jobs

The Northern Lights PCI partners are ready to quickly move into execution, given the right political and financial framework – we can do it with your help

CCS has a key role to play in Europe's green economic recovery

Europe is facing an unprecedented socio-economic crisis due to the COVID-19 outbreak, whose real impact is still to unfold. As the EU seeks solutions to reboot the economy and lead Europe out of the recession, we are presented with a unique opportunity to put the fight against climate change at the centre of the economic strategy. **Carbon Capture and Storage (CCS) projects that can rapidly move into implementation should be considered in any economic recovery plan**, due to their capacity to deliver quickly in terms of jobs and economic growth while delivering on the EU emission reduction targets.

CCS is a proven technology, necessary to achieve the EU's 2050 climate neutrality objective

CCS has great emissions reduction potential, as it prevents CO2 from being released into the atmosphere. Analysis by the most prominent international bodies, including the IEA and the IPCC, have consistently shown that CCS is an essential part of **the lowest cost path towards meeting the Paris Agreement goals.** Similarly, in the EU's Clean Planet for All[1], CCS is listed as one of the strategic building blocks to achieve climate neutrality. Moreover, when paired with bioenergy used for power generation or biofuel production, it is one of the few technologies that can deliver negative CO2 emissions.

CCS technologies are proven and commercially available today; they have been in operation since the 1970s with 19 large-scale CCS facilities currently operating globally. Geological permanent storage is safe and secure, with over 260 Mt of CO2 emissions from human activity already captured and stored[2]. Global estimates show that there are vast geological storage resources to meet the highest requirements for CCS to achieve climate change targets, including within Europe[3].

CCS can help safeguard existing industrial activity and jobs while decarbonising the economy

According to a 2018 Endrava report, emissions from power and heat plants, industrial sites and waste management installations in Europe account for two thirds of all CO2 emissions[4]. Decarbonising these sectors with renewables and energy efficiency alone will not suffice, as energy-intensive industries require high-temperature heat that cannot be easily or cost-effectively electrified and sectors such as cement or steel emit CO2 as part of their manufacturing process. CCS can play a crucial role in decarbonising European industry while maintaining its productivity, **both through the capturing of CO2 emitted by industries and through the manufacturing of clean hydrogen for transport, heat and power**.

Estimates show that European jobs linked directly and indirectly to the emergence of a market for CCS can reach 150,000 in 2050[5]. However, and crucially, by far the largest job and value creation effect of CCS is that **it enables a successful and just transformation of existing industrial activity into a low-carbon industry**, avoiding 'carbon leakage' and therefore protecting existing jobs. CCS can enable industrial regions in Europe to transform into low carbon regions, also with cleaner air and improved health. These reinvigorated regions will also attract new, low-carbon industries and the associated jobs and be central in the transition to a zero emissions economy.

[1] COM (2018) 773 – A Clean Planet for All: A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy
[2] 2019 Global Status of CCS Report, Global CCS Institute, 2019.
[3] The potential for CCS and CCU in Europe. Report to the thirty second meeting of the European Gas Regulatory Forum, IOGP, 2019
[4] Cauchois, G., Rambech, E., Vandenbussche, V. (2018). Potential for CCS in Europe: Report for NOROG. Endrava report 2018.
[5] Størset, S. Ø., Tangen, G., Wolfgang, O. and Sand, G. (2018). Industrial opportunities and employment prospects in large-scale CO2 management in Norway. SINTEF Report 2018:00450. Accesible here

CCS supports a clean hydrogen and circular economy

Decarbonisation of key sectors such as electricity generation, transport (particularly heavy-duty vehicles) and industrial processes that use high-grade heat and hydrogen as chemical feedstock will require the use of hydrogen in large quantities**.** Today, around 70% of hydrogen production comes from natural gas; if decarbonised with CCS, it will accelerate the establishment of clean hydrogen value chains. Such a development would create **a new low-carbon industry and jobs, with the potential to account for 24% of final energy demand and 5.4m jobs by 2050[6].**

As renewable electricity capacity continues to grow, electricity grids will have to be equipped to cope with intermittent generation and effectively meet rising electricity demand. **Hydrogen with CCS or CCGT with CCS, allows for low-carbon production of energy and can be easily stored to provide reliable clean power**

Finally, the development of CO2 capture facilities and transport solutions can speed up the industrial re-use of carbon, thus **acting as an enabler of carbon capture and utilisation (CCU) to deliver a circular economy**, since the deployment of these services is mutually beneficial for both CCS and CCU and will help bring costs down and create even more jobs.

A European CCS value chain to drive CCS development and industrial success

The Northern Lights Project of Common Interest (PCI) is a CO2 cross-border transport connection project where CO2 captured from industrial sites in Europe will be collected by ship and transported to the Norwegian Continental Shelf for permanent storage subsea, resulting in a full-scale CCS value chain. **Equinor, Shell and Total announced on 15 May 2020 that they have decided to invest in the Northern Lights transport and storage solution.** The investment decision is subject to final investment decision by Norwegian authorities and approval from EFTA Surveillance Authority (ESA).

The development of a European CCS ecosystem can be a powerful driver for carbon capture in Europe and globally

It is only after providing a secure and reliable CO2 transportation and storage network that European industries can start considering capturing their carbon. By offering an open source CO2 transport and storage network, **Northern Lights opens the possibility for any industrial site interested in capturing its CO2, to permanently store it safely**. Furthermore, the ship transport solution provides flexibility to reach multiple carbon emission points across Europe. **This will enable the first European full-scale CCS value chain, paving the way for cost reductions and a scale-up of CCS**. Northern Lights could also act as a reciprocal storage alternative to other CCS projects in Europe, making a European CCS network more robust and flexible. The Northern Lights PCI includes three projects with ambition to develop storage, in addition to the one in Norway: Acorn, Ervia and Net Zero Teesside.

Northern Lights can rapidly move into execution, delivering jobs, growth and emission reductions across Europe

Cross-border collaboration is one of the strongest assets of Northern Lights. Given positive investment decisions, the value chain could be operational in 2024, establishing an ‘open source’ network for transport and storage of CO2, protecting and creating jobs while capturing emissions. As it will be shown in the next section, the Northern Lights PCI is maturing several projects in many industries across Europe. The project is also in dialogue with around 15 additional European companies in different sectors and countries that also are exploring the option of having their CO2 stored.

[6] Hydrogen Roadmap Europe: A sustainable pathway for the European Energy Transition. FCH JU Report 2019. Accessible here.

CCS projects to kick-start European industrial decarbonisation

This section demonstrates how the Northern Lights PCI can contribute to Europe's economic recovery and accelerate the just transition to a net-zero future economy. It provides best available estimates of the effects that can arise from positive investment decisions in these CCS projects in the form of climate mitigation, timing of project phases, and job creation in each of the phases.

Climate mitigation and job creation potential

As can be observed in the table on the next page, **most of the projects are estimated to create around 1200 – 1500 full-time equivalents (FTEs) in total each over a 3-4 years period during the most job-intensive phase,** the detailed engineering and construction phase. The Ervia power/industrial cluster projects in Ireland may possibly create as much as 3500 FTEs jobs and the Net Zero Teesside cluster in England around 5500. **This in turn will create new permanent jobs ranging from 50 to 350 in each of the CCS operations**. The analysis shows that the transport and storage solution project, and the two most mature CO2 capture projects within the Northern Lights PCI network, Fortum Oslo Varme and Heidelberg Cement Norcem, are ready to move into the job-intensive detailed engineering and construction phase which follows immediately after positive investment decisions, which then would enable the start of operations as soon as 2024.

Crucially, the analysis demonstrates that there is a wave of CO2 capture projects in several European countries and several sectors which are being matured to start detailed engineering and construction in 2022 – 2025, thereby becoming ready to start operations in 2025-28. **These projects can provide considerable climate mitigation effects with annual CO2 emission reductions ranging between 500 – 6000 kilotonnes of CO2 per annum**. Several of the projects plan to capture CO2 of biogenic origin, thereby providing negative emissions.

Together, all the projects for which values have been provided, **are estimated to be able to provide CO2 reductions of up to 15 000 kilotonnes per annum, to create around 18 600 full time equivalents (FTEs) jobs in total over the development period and around 1170 permanent positions when in operation**. The job creation estimates focus solely on the jobs created in the specific projects. Many of these jobs (e.g. civil engineering) will be local/regional in nature, while others (e.g. studies and fabrication) will be relevant for the broader European industry.

Seven of the projects plan to be operational already in 2024-25, with the detailed engineering and construction phase starting about three years earlier, in 2021-22. The other five projects plan to be operational by 2028, also starting the job-intensive detailed engineering and construction phase about three years earlier, in 2024-25.

Further benefits

Most importantly, **these projects enable a successful transformation of existing industrial activity and tens, potentially hundreds of thousands of jobs into low carbon activity and jobs,** enabling a zero and low-carbon industry.

The estimations of employment creation above do not include the multiple jobs that will be created through the construction of equipment and technologies, such as those for capture, intermediate storage and ships. Furthermore, the large number of jobs will also generate consumption effects, resulting from the employed people's and companies' consumption, payment of taxes, etc. These are not estimated in the table above. In case there are any Competition Law concerns, costs and the levels of public support required are not included here. Such estimates are, however, being developed by the individual projects and can be communicated separately.

As can be seen in the PCI map on the previous page, there are also a few additional projects in the Northern Lights CCS PCI that are not presented here. Some of these are being developed with timelines that are equally ambitious as the ones presented and can be communicated by the individual projects.

Some of the projects being developed within the Northern Lights CCS network and PCI

	Transport & storage	CO_2 capture projects									Reciprocal Storage / Full-chain projects		
Company	**Equinor, Shell, Total**	**Fortum**	**Heidelberg Cement**				**Arcelor Mittal**	**Borg CO_2**	**Ervia**	**Stockholm Exergi**	**Pale Blue Dot**	**Net Zero Teesside**	**TOTAL**
Project	Northern Lights	Oslo	Norcem	Cementa Slite	Hannover	CBR Lixhe	Gent Carbalyst	Borg	Clusters	Stockholm	Acorn	Clusters	
Country	Norway	Norway	Norway	Sweden	Germany	Belgium	Belgium	Norway	Ireland	Sweden	Scotland	England	
CO_2 emissions													
Total ktpa	N.A	460	800	1800	640	1200	390	700	3500	900	N.A	6300	
Biogenic part	N.A	50%	35%	12%	6%	20%	100%		5%	100%	N.A	2100	
Capture rate	N.A	90%	50%				90%	90%	95%	80-95%	N.A	95%	
CO_2 avoided emissions, Total Biogenic Fossil & process	N.A N.A N.A	410 205 205	400 140 260	1600 180 1420	500 25 475	1000 180 820	350 350 0	630 430 200	3325 166 3160	720-860 720-860 Zero	N.A N.A N.A	6000 2000 4000	≈15 000 ktpa
Direct CCS Jobs													
Early studies,Start Months FTEs		2017 15 19		2020 36	2021 24	2021 24	2021 24 15						
FEED study, Start Months FTEs	2018 18 120	2018 16 50	2018 24 100	2022 36 100	2023 24 75	2022 36 100	2023 10 15	2020-21 18 15	2021 36 25	2021 12-18 25-35	2020 12 80	2020 24 20	
Det. eng.&constr, Start Months FTEs	2020 36 1200	2021 48 1440	2021 36 1050	2025 36 1200	2025 36 800	2025 36 1000	2025 24 150	2022-24 36 1000+	2024 48 3500	2022 24-36 1000	2021 36 1000	2022 36 5500	
Total Development FTEs	1320	1509	1150	1300	875	136	180	1000+	3525	1025-35	1080	5520	≈18 625 FTEs
Operations, Start Months Permanent jobs	2024 240 90	2024 120 56	2024 240 20	2028 240 60	2028 240 60	2028 240 60	2027 300 16	2025 120 30-50	2028 240 300	2025 Min. 240 10-20	2024/5 240 110	2025 240 350	≈1177

Table 1: Some CO_2 capture projects being developed within the Northern Lights CCS network and PCI. The estimates have been made by the companies that are developing the specific projects. "FTEs" is Full Time Equivalents, showing the total number of FTEs over the period in question. CO_2 emissions are measured in kilotonnes per annum (ktpa). "Biogenic" is CO_2 emissions resulting from combustion of biomass. The table does not include all the CO_2 capture projects that are being developed within the Northern Lights CCS network and PCI.

Recommendations

EU policy can support and incentivise the development of cross-border CO2 transport and storage networks in Europe, including Northern Lights. Financial support and grants will be key to achieving early deployment of the CCS value chain in Europe. **Ensuring that CCS projects in Europe are eligible for EU and national public support and funding schemes should therefore be an important element in the Commission's approach to promoting economic recovery.**

In addition to financial support, regulatory frameworks such as the Energy System Integration, EU ETS, and the TEN-E Regulation will provide opportunities to develop the CCUS value chain in Europe. Under TEN-E, CO2 storage should be integrated into overall European infrastructure development and permitting procedures. **Additional methods of CO2 transport, such as by ship, should be recognised in key EU legislation like the EU ETS and TEN-E, in order to facilitate a greater range of CO2 transport solutions in Europe.** By creating a cross-border network of open-access CO2 transport and storage infrastructure, EU industrial plants and clusters can connect their CO2 emissions to shared infrastructure – and this common approach should be supported.

Supporting CCS now will not only stimulate new infrastructure projects and jobs, it **will also help to develop a more optimised energy and industry system, with shared CO2 transport and storage infrastructure connecting different industrial facilities and processes, all while making significant cuts to European CO2 emissions and helping to deliver on the Green Deal objectives.**

The Northern Lights PCI looks forward to working with EU and national policymakers to make this vision a reality.