Call for evidence: Non-pipeline transportation and cross border networks

Offshore Energies UK is the leading trade body for the UK's integrated offshore energies industry. Our membership includes over 400 organisations with an interest in offshore oil, gas, carbon capture and storage (CCS), hydrogen, and wind. From operators to the supply chain and across the lifecycle from production to decommissioning, they safely provide cleaner fuel, power, and products to the UK. Working together with our members, we are a driving force supporting the UK in ensuring the security of energy supply while helping to meet its net zero commitments.

OEUK and our members are committed to working with the UK Government, industry, and regulators to help deliver net zero by 2050 in an efficient, affordable and timely manner. As a sector, we are equally committed to producing the cleaner oil and gas that the UK will continue to need in the decades to 2050 and beyond – with lower emissions than imported options. Achieving this will bring huge economic and environmental benefits across the UK.

The UK's offshore energy sector we represent makes a huge contribution to the UK economy, and it has the potential to:

- Contribute to an energy transition which leaves no individual, community, or sector behind.
- Secure over 200,000 high-value jobs in the UK whilst growing the skilled and diverse workforce of the future.
- Deliver £200 billion of private investment over the next decade, spurring economic growth and fostering UK technology and innovation across the energy mix.
- Meet the UK's net zero commitment by 2050 or sooner, decarbonising offshore energy production to power homes and businesses across the breadth of the country.

The offshore energy industry is a fundamental pillar of the UK economy, supporting hundreds of thousands of jobs and contributing billions of pounds to the exchequer annually while powering homes and businesses across the breadth of the country. Our sector has the potential to spend almost £200 billion over this decade in the energy sector and continue to support hundreds of thousands of jobs across the UK. The majority of this could be spent in offshore wind, CCS, and hydrogen in the right investment environment. Companies investing in and supporting nascent opportunities like floating offshore wind and CCS will require cash flow from a stable and predictable oil and gas business to fund these opportunities.

The UK has a significant opportunity to be an energy transition leader while retaining its core function of supporting energy security. To do this, we need a long-term, stable, and competitive policy that gives investors, companies, and the supply chain the confidence to commit to the UK. The carbon budget is a key pillar, reinforced with policy decisions, to attract this investment.

OEUK fully supports the development of non-pipeline transportation (NPT) methods in the UK. These methods will be crucial for decarbonising emitters with no viable alternatives other than carbon capture and storage. NPT will also be essential for emitters with limited access to the pipeline network due to their geographical location. According to the 2021 Industrial Decarbonisation

Strategy, dispersed sites (those outside industrial clusters) emit 33.6 $MtCO_2e$ annually, roughly half of all industrial emissions. Decarbonising these emitters is vital for achieving our net-zero ambitions.

Equal to this will be the ability to develop cross-border CO_2 networks and create a market for international CO_2 storage services, which will be essential to maximising our vast storage capacity (estimated at 78Gt). A supply chain study commissioned to Rystad Energy by OEUK[1], in 2024, outlines the financial opportunities for the UK's supply chain from the expansion of domestic CO_2 storage to include emissions from Europe. The analysis includes a scenario that shows that the upside potential for UK supply chain companies could be in the region of £7bn over the course of the next 15 years if 30% of emissions from European emitters were stored in the UK. With the annual upside potential reaching £1bn per year by 2040. Delaying the process of unlocking cross-border transportation for the UK would reduce our ability to compete internationally for European emissions. Failing to develop a market for international CO_2 storage services could hinder the ability of supply chains to capitalise this opportunity.

[1] https://oeuk.org.uk/product/uk-og-supply-chain-opportunities-in-the-energy-transition/

Respondent data

1. Who are you responding on behalf of, and what is your interest in this call for evidence?

As the leading UK trade association for offshore energies, Offshore Energies UK (OEUK) is responding on behalf of its 400+ members, who represent operators, supply chains, and professional services from across the offshore energy sector. Many of our members are involved in the development of carbon capture and storage (CCS), with OEUK members involved in each of the 27 carbon storage licences awarded.

2. If you consent to members of the team reaching out for clarifications on responses provided, please provide contact details.

Enrique Cornejo, ecornejo@oeuk.org.uk

3. Do you give permission for your anonymised evidence to be shared with external advisors for the purpose of technical analysis?

Yes, OEUK gives permission for our anonymised evidence to be shared with external advisors.

Vision for NPT

View on the potential vision for the NPT Sector

4. Please provide views on the potential long-term vision for the NPT sector.

NPT will be crucial to maximise the UK's storage potential by providing more choice and flexibility to emitters to connect to CCS networks. NPT and pipeline solutions should develop in parallel and not be seen as competitors. Both methods are complementary and essential for a comprehensive deployment of CCS. NPT provides the flexibility to access hard-to-reach emitters, while pipelines offer a direct and efficient transport method for emitters located in the same geographical area such as an industrial cluster. Together, they create a robust and flexible transport network that enhances the overall efficiency and reach of CCS technologies.

According to the UK's Industrial Decarbonisation Strategy, dispersed sites, which are located outside of industrial clusters, emit 33.6 $MtCO_2e$ annually—roughly half of all industrial emissions. These sites often lack direct access to pipeline networks due to their geographical location. By implementing NPT methods, such as road, rail, barge, and ship, CO_2 can be efficiently captured from these dispersed emitters and transported to storage facilities. This flexibility ensures that CCS technologies can be deployed across the nation.

Industry needs clear frameworks for the introduction of NPT well ahead of their planned operation in 2030, even if the sector will not be economically regulated. Establishing these frameworks early is crucial to address supply chain lead times and define commercial arrangements. The development of NPT infrastructure involves complex logistics, coordination, and investment. Clear frameworks will provide the necessary certainty for industry to invest in and develop NPT solutions, ensuring they are operational by 2030.

The economic benefits of enabling NPT extend beyond the immediate value associated with the construction and operation of these networks. NPT networks will help create a market for low-carbon goods in the UK, such as green cement and green steel, by providing the necessary infrastructure to capture and store CO_2 emissions from their production processes. This will contribute to the UK's decarbonisation goals and protect thousands of existing jobs in the UK's industrial heartlands, ensuring economic stability and growth in these regions.

OEUK supports the proposed principle of non-economic regulation for NPT of CO_2 as it does not share the monopolistic characteristics associated with pipeline transportation. Unlike pipelines, which often require significant investment and infrastructure, NPT methods such as road, rail, and ship are expected to have lower barriers to entry. This should make it feasible for multiple operators to run parallel operations, fostering a competitive regional market. Given this potential for competition, economically licensing all forms of CO_2 seems unnecessary. Non-economic regulation should allow for market-driven development, encouraging innovation and flexibility without the constraints of an economically regulated regime. This approach can lead to more efficient and cost-effective solutions for transporting CO_2, ultimately supporting the broader goals of CCS by making it accessible to a wider range of emitters and helping to capitalise on the UK's significant CO_2 storage potential.

Nevertheless, we encourage government to consider the views in response to the consultation "Duties and Functions of the Economic Regulator for Carbon Dioxide Transport & Storage Networks", where some respondents outlined the potential disadvantages of non-economic regulation for NPTs. For example, some form of economic regulation can ensure cost transparency and standardisation, delivering more predictable cost structures that may facilitate investment and financial planning. Some form of regulation can also help create a level playing field between NPT and the licensed pipeline transport and storage (T&S) network, preventing a two-tier system. Moreover, there may be specific circumstances when a specific NPT provider is the only option for an emitter to connect to the network, in which case there need to be provisions in place to prevent potential monopolistic behaviours.

5. Which regions and sectors of the economy will benefit most from NPT solutions unlocking CCUS? Which regions and sectors of the economy will continue to struggle to deploy CCUS? Should the government look to prioritise any particular regions or sectors of the economy for NPT?

OEUK recommends that the UK government pursues every attempt to decarbonise through reducing process emissions and failing this alternative carbon abatement methods are considered such as direct air capture (DAC). When considering which regions and sectors would benefit most from NPT solutions the government should prioritise those that offer the greatest opportunity for a net-reduction in carbon emissions. The following table highlights some regions and sectors that will benefit the most from NPT solutions.

Type	Region/cluster/sector	Detail
Region	South Wales	• With over 16MtCO_2e per annum the South Wales Industrial Cluster is one of the largest emitters in the UK • With no local storage sites for the region, accessing storage sites in the East Irish Sea and/or the North Sea will be vital for the decarbonisation of the region and retaining jobs in the industrial sector
Region	Peak Cluster	• While there are plans to connect the Peak cluster to storage sites through pipelines there is the opportunity to connect the region with storage sites by utilising existing transport infrastructure such as railways and roads.
Region	Solent Cluster	• The Solent Cluster are seeking permission to install an underground pipeline to transport CO_2. Should this not go ahead the region would benefit massively from non-pipeline alternatives.
Sector	Cement	• Hard-to-abate sectors such as cement will not be able to decarbonise without the implementation of CCS.
		• NPT options will offer greater access to carbon stores for cement production sites

Sector	Steel	• Decarbonisation technology options will determine the need for CCS, for example electric arc furnaces will rely on electrification and will not need CCS etc.
Sector	Energy from Waste (EfW)	• Energy from Waste sites may benefit from NPT solutions through greater access to carbon storage sites. Many EfW are located in dispersed sites outside of clusters.
Sector	Power generation	• In the UK, there are currently 32 active gas-fired combined cycle power plants. Many of these plants are situated outside industrial clusters. To transition to low-carbon power suppliers, they can adopt carbon capture technologies with the help of NPT.

Costs

10. What are the expected transport emissions and fugitive emissions expected within the NPT value chain? Please provide any information on how these emissions can be minimised.

Transport and fugitive emissions should be considered in the broader context of carbon capture transport and storage so as not to discourage NPT projects from proceeding. A significant number of emitters in the UK and Europe will be able to accelerate decarbonisation efforts or will only be able to decarbonise through NPT solutions. Therefore, an assessment of the entire CCS value chain is necessary to evaluate the net emissions impact of NPT, not just the gross emissions of the NPT solutions.

Research from the Oxford Institute for Energy Studies, 2024, highlights the associated cost of transportation and emissions intensity of carbon capture and transport from energy from waste (EfW) plants in the UK. Results from this research indicate that NPT solutions are on average 4-12 times more carbon intensive than piped solutions. However, these emissions intensities are dependent on factors such as volumes, distances, method of transportation, proximity to other emitters, etc. In some instances, it is more cost-effective and less carbon-intensive to use NPT. This reassures us that NPT solutions have the potential to be both cost-effective and less carbon-intensive in certain instances. On the whole, we can expect onshore transportation emissions to be in the region of 0.5-1.5% of the emissions transported.

OEUK member Altera Infrastructure are working together with Wintershall DEA to install the Stella Maris project in the Norwegian North Sea. This project aims to transport CO_2 from an onshore terminal to a floating Direct Injection Unit (DIU) for direct injection into the seabed. Assuming that the project consists of 2 CCSOs, four shuttle tankers of capacity 50,000m^3 and 2 FIU (Floating Injection Units), we can expect the total annual emissions for the system to be 428,420 tonnes of CO_2 in the worst-case scenario. This implies that the emissions associated with the operations of the Stella Maris project are 4.3% of the total CO_2 tonnage injected per annum (10 million tonnes of CO_2).

11. Could the costs associated with the full NPT value chain prevent investment and deployment of NPT solutions? If so, why?

The costs associated with the full NPT value chain could indeed prevent investment and deployment of NPT solutions.

12. If available, please provide any assessments that have been carried out to show an NPT solution is more economically viable than a piped solution for your NPT value chain, or that a piped solution is not technically viable

Under specific circumstances, NPT solutions may be more economically viable than piped solutions. For example, in instances where NPT solutions have lower lead times, they should be considered a necessary means to accelerate the decarbonisation of an emitter-base. The distance between the emitter and storage site, operational costs, and volumes may also play a role in the economics of transport and storage. The following assessments on the cost competitiveness of NPT attempt to quantify the impact of such variables on the economics of transport and storage solutions.

- The cost of CO_2 transport and storage in global integrated assessment modelling, MIT.
- Carbon capture from energy-from-waste (EfW): A low-hanging fruit for CCS deployment in the UK, Oxford Institute for Energy Studies (OIES).

Several overseas projects are looking at NPT solutions as an economically viable option for the transport and storage of CO2. Altera Infrastructure is working alongside Wintershall DEA to install the Stella Maris project in the Norwegian North Sea. This project aims to transport CO2 from an onshore terminal to a floating Direct Injection Unit (DIU) for direct injection into the seabed. This project expects the cost of transportation between the onshore terminal and DIU to be cost-comparable to pipeline solutions. Equinor's Northern Lights project is also planning to operate through NPT solutions.

Financing

14. What are the main financing risks with a disaggregated chain, and how do these differ to the full chain piped approach?

A disaggregated chain approach to a CCS project separates the capture, transportation, and storage stages, resulting in different contracts, companies, and possible financing arrangements at each stage. This can present risks not found in a full chain piped approach. It is crucial for stakeholders to carefully assess and manage these risks to ensure the successful implementation of the project.

Coordination risk

Operational risks associated with synchronising financing, supplier deadlines and operations of the differing stages of the project cycle are at a higher probability of occurring in a disaggregated chain. A failure to align processes at each stage of the disaggregated chain would delay the overall project. This risk increases when you expand the number of partners in a CCS project, which is essential to consider when connecting industrial emitters outside of clustered emitters. In the market creation phase described in the government's CCS Vision, many of these cross-chain risks are covered by the various support mechanisms.

Contractual complexity risk

There is an increased legal and administrative cost associated with the disaggregated chain approach; each project stage will need to hold and manage contractual agreements to operate. The risk associated with project delays also increases with the number of contractual parties involved in the chain. If one party in the chain experiences delays, the progress of the entire CCS value chain could be at risk.

Regulatory aspects

In a disaggregated chain compliance to regulations may be a lengthier process than that of a full chain piped approach with each member of the chain needing to meet regulatory requirements. An increased administrative burden could increase the likelihood of delays to the CCS project and risk the loss of financing/suppliers. Ensuring that the whole chain is advanced through the regulatory phase in an efficient manner is vital for avoiding delays and their associated costs.

Insurance

The insurance cost of a disaggregated chain is expected to be greater than that of a full chain piped approach. Each component of the disaggregated chain must obtain insurance coverage tailored to its specific risks. This can result in higher costs as the insurer will need to assess the maximum loss at each chain stage, likely resulting in a greater cumulative value than that of the full chain piped approach. A linear full chain piped approach also allows stores to have more certainty of the volumes flowing into the network.

15. What are the main financing risks associated with operational flexibility, and how do these differ to the full chain piped approach?

Intermittency of CO_2 flow

A significant risk associated with operational flexibility is an intermittent flow of CO_2. Unlike pipelines, NPT methods deliver CO_2 in larger quantities at regular intervals, creating peaks and troughs in the flow of CO_2 being delivered. This irregularity in CO_2 flow could increase the operational costs associated with the transportation and storage of CO_2. Sufficient buffer storage can mitigate the impact intermittency has on the finances of an NPT value chain. If the UK were to look abroad for an example, the Northern Lights projects expect to see 200 deliveries of 7,500m^3 CO_2 per year in phase 1. To mitigate the risks associated with intermittency, Equinor has installed a buffer storage capacity of 8,250m^3, equivalent to 110% of the capacity of a shipment.

Operational flexibility

Operational flexibility risks the long-term assurance of a consistent flow of CO_2 from emitters to carbon store operators. Under the proposed capture-lead model, this risk is heightened as the emitter is able to choose between competing storage sites. Shorter-term contracts may also pose a challenge when attempting to secure financing for transportation and storage companies as the certainty about their long-term ability to transport and store CO_2 can be reduced. This may result in the underutilisation of carbon stores.

Leakage liabilities

Liability of leakages remains a hurdle to be overcome. While the probability of leakage occurring remains low, the financial impact of a leakage would be huge and may impose a significant burden on transportation and storage companies through insurance. Therefore, there needs to be consideration for financial risk exposure in the event of a leakage, especially as the sector transitions from the current market creation phase into a future self-sustaining sector. Some OEUK members have proposed that in a future scenario where cross border flows of CO_2 are enabled leakage risks may be mitigated through the implementation of a mutual insurance fund for storage sites developing in the North Sea. Such an approach would allow for an earlier transfer of funds and reduce the financial security requirements for developers, making the investment more attractive. By reducing upfront financial burdens, this fund could accelerate investment and development in the sector. In combining these approaches, a robust and attractive financing environment that supports the development and scaling of NPT value chains can be created.

16. Which archetype do you think would be most attractive to investors? Why?

OEUK believes that government should not prioritise one NPT archetype over another but ensure that all archetypes are considered in the development of the UK's NPT market. Different archetypes will be best suited for different value chains and projects based on their individual situation.

17. What types of financing are best placed to deliver NPT value chains?

Financial products used will be conditioned according to the companies' risks which we expect to evolve over time. The conditions best placed to deliver NPT value chains include long-term contracts between emitters and storage developers, which are crucial for providing a stable and predictable revenue stream. Additionally, new market solutions and financial products, such as insurance, need to emerge to cover cross-chain risks currently managed by government support mechanisms. These products would mitigate risks related to the entire value chain, enhancing investor confidence, and attracting private capital into the sector.

CCUS Policy Landscape

TRI Model

18. Do you agree the rationale for economically licensing NPT service providers does not exist? Or do you believe that some elements in the NPT value chain may still require some kind of economic licencing?

OEUK supports the approach of non-economic regulation for non-pipeline transportation (NPT) of CO_2, we agree that it does not share the monopolistic characteristics associated with pipeline transportation. Unlike pipelines, which often require significant investment and infrastructure, NPT methods such as road, rail, and ship are expected to have lower barriers to entry. This should make it feasible for multiple operators to run parallel operations, fostering a competitive regional market. Given this potential for competition, economically licensing all forms of CO_2 seems unnecessary. Non-economic regulation should allow for market-driven development, encouraging innovation and flexibility without the constraints of an economically regulated regime. This approach can lead to more efficient and cost-effective solutions for transporting CO_2, ultimately supporting the broader goals of CCS by making it accessible to a wider range of emitters and helping to capitalise our significant CO_2 storage potential.

Nevertheless, we encourage government to consider the views in the response to the consultation "Duties and Functions of the Economic Regulator for Carbon Dioxide Transport & Storage Networks" where some respondents outlined the potential disadvantages of non-economic regulation for NPTs. For example, some form of economic regulation can ensure cost transparency and standardisation, delivering more predictable cost structures that may facilitate investment and financial planning. Some form of regulation can also help create a level playing field between NPT and the licensed pipeline transport and storage (T&S) network, preventing a two-tier system. Moreover, there may be specific circumstances when an NPT provider is the only option for an emitter to connect to the network in which case there may need to be provisions in place to prevent potential monopolistic behaviours.

CCS Network Code

20. Please provide details on how you believe that the CCS Network Code would need to be updated to facilitate NPT.

The CCS Network Code will need to be updated to facilitate the incorporation of NPT. The current draft of the CCS Network Code includes references to NPT, indicating that provisions are in place to allow for its future incorporation. The consultation on the Code's heads of terms (February 2024) indicates:

> *"Given the nascency of the CCUS sector, it could occasionally be appropriate for the SoS to take a role in Code modification, particularly during the early years of*

the industry. These provisions seek to enable timely and efficient modification of the Code to respond to learnings from early networks and allow for new types of networks, such as those involving non-pipeline transport or separate onshore and offshore licences. This will ensure the Code remains responsive to the needs of future T&S Co and Users so that expansion and diversification of networks is facilitated."

However, to fully integrate NPT into the CCS network, several updates and enhancements will be needed. Firstly, while the text referenced above mentions NPT, the code must be regularly updated to reflect market dynamics related to its incorporation. This includes developing clear charging and network use mechanisms that are specific to NPT. These mechanisms should address the unique operational and logistical challenges associated with NPT, ensuring that the costs and benefits are appropriately allocated and transparent to all stakeholders.

The code should provide a detailed framework for the integration of various NPT methods, such as shipping and other transport modes, into the network. This framework should outline the technical, regulatory, and commercial requirements for NPT operators, ensuring interoperability with pipelines.

21. What changes to the Track-1 capture BMs do you envisage being required to make the capture BMs work for NPT solutions? What considerations would be required for power-BECCS and GGR BMs when developing for NPT? Please flag in your response which of the capture BMs you are answering in reference to.

22. How important should consistency in approach between capture BMs be? How important is consistency between NPT users and piped users within a specific BM (e.g. ICC via pipeline and ICC via NPT)?

OEUK combined response to Q21&22

To incorporate NPT within power BECCS and GGR business models, several changes will be needed. The models should include provisions for all NPT methods adapting the framework to account for logistical, regulatory, and operational elements. For example, NPT will require developing necessary infrastructure, such as ports and loading facilities. Therefore, cost and revenue structures must reflect the unique characteristics of NPT. Also, areas such as risk management solutions and financial products like insurance to cover cross-chain risks need to be considered to increase investor certainty and mitigate uncertainties. The business models should outline specific regulatory compliance and relevant standards for NPT, ensuring integration into the network.

International CO_2 volumes can play a supportive role in the development of the UK CCS market, increasing the volumes stored and unlocking additional storage sites. Business models should therefore be adjusted to take into account the role of cross-border transportation and storage. Cost and revenue structures must reflect the unique characteristics of international volumes of CO_2. In particular, business models must allow for domestic and international CO_2 volumes to be valued equally as to not discourage storage domestic CO_2 storage.

Consistency of business model design will be key as to allow the market to choose the most cost-effective means of transportation.

Future allocation processes

23. If NPT solutions are assessed against pipeline solutions, would this raise any concerns?

Assessing pipeline solutions against NPT solutions would raise concerns in cases where it is not feasible to build a pipeline. In many cases piped solutions offer a cheaper and less carbon intensive method of transporting CO_2 between emitter and storage site. However, in such instances where NPT solutions allow for earlier connection of emitter to storage sites, pace of developing domestic CCS capabilities should be the main priority. Allowing for the intermediary use of NPT solutions to connect emitters would reduce the net emissions of emitter projects and aid the UK's ability to decarbonise. Delaying this process to wait for the development of a piped solution would result in additional emissions.

When assessing NPT solutions against pipeline solutions the following criteria should be considered:

- Cost of transportation
- Emissions
    - Transportation of CO_2
    - Net emissions reduction (total emissions reduction – transport emissions)
- Timings
    - Pace at which projects can be developed
    - CCUS Market phase as outlined in the CCS Vision (Market creation, Market Transition, Self-sustaining)
    - Risk of delays
- Maturity of technologies
- Region
- Volumes of CO_2
- Local content

24. If government is to allow all archetypes of NPT, how should an assessment of an NPT value chain be considered to allow comparisons?

Each of the proposed NPT value chains are suitable for the development of NPT solutions under different conditions. Therefore, the ability to compare NPT value chain archetypes' suitability for a project is vital for the efficient development of NPT. When comparing the archetypes, OEUK recommend considering the following parameters in the assessment process.

- Cost
    - Transport costs in varying models
    - Additional logistic/administration/insurance costs
- Emissions

        - At terminals and intermediaries
        - Transportation of CO_2
- Timings
    - Pace at which projects can be developed
    - CCUS Market phase (Market creation, Market Transition, Self-sustaining)
    - Risk of delays
- Planning considerations
    - Number of parties in value chain
        - Risk associated
        - Impact on timelines

Cross-border CO_2

25. Please provide views on the potential vision for cross-border CO_2 T&S networks in the UK.

OEUK is supportive of a cross-border CO_2 transport and storage network. According to the British Geological survey, the UK has 78Gt of storage capacity spread across the North Sea, West of Shetlands, East Irish Sea and English Channel. This represents enough storage capacity to service the UK's current annual CO_2 emissions for hundreds of years. With decarbonisation efforts significantly reducing the UK's emissions already and ambitions to continue this trend the UK is unlikely to need the entirety of its storage capacity. Opening cross-border transport and storage networks will enable the UK to capitalise on its vast storage capacity.

OEUK envisage the primary method for cross-border transportation to be via shipping. There are several cross-border transportation projects in Europe that utilise ships for cross border transportation of CO_2. The Northern Lights Project in Norway which is expected to start operations imminently will use four CO_2 carriers of 7,500m^3 capacity to transport 1.6mtpa of CO_2 from emitters in Norway, the Netherlands and Denmark in phase 1 of its development. This will expand in phase 2 with expectations of 400-600 shipments of CO_2 per annum to be delivered annually.

Current lead-times for the production and delivery of CO_2 carriers are expected to take between 3-4 years, most of which are expected to be built in Asia. Ordering ships at the earliest available opportunity will enable the quick and efficient creation of a cross-border CO_2 transport and storage market for the UK. T&S companies are not willing to take the financial risk of commissioning ships unless they have reached a Final Investment Decision (FID). Failing to capitalise early on the UK's cross-border potential will result in losses of CO_2 opportunities to countries such as Norway and Denmark.

There is an opportunity for the development of cross-border pipelines given the UK's proximity to mainland Europe. However, OEUK is not aware of any cross-border pipelines in the process of being developed at this stage but would welcome the concept.

26. With regard to Questions 18 and 19 and in the context of establishing cross-border CO_2 T&S networks, do you have a view on:

I. whether an economic licensing framework for CO_2 T&S might need to evolve to accommodate cross-border T&S networks?

II. how cross-border CO_2 volumes should be viewed within a commercial landscape currently designed for domestically captured CO_2 volumes?

III. how service providers could manage the risks on a commercial basis that would allow for a merchant delivery model?

IV. whether there are any specific changes needed to the current suite of capture business models if CO_2 cross-border T&S networks are established?

For each answer please provide further explanation.

I.

The current economic licensing framework for CO_2 T&S will need to evolve to accommodate cross-border T&S networks. Considerations will need to be made for the following areas of interest:

CO_2 standards for transport and storage including a potential realignment with EU standards

A lack of defined uniform standards between the UK and EU for cross-border CCS projects could pose a stumbling block for the cross-border trade of CO_2. OEUK notes that under current circumstances governments may choose to amend national standards on an ad hoc basis. This may result in instances in which standards misalign and cause conflict. For example, a technical standard relating to transport infrastructure may conflict in each jurisdiction, delaying or even preventing cross-border trade of CO_2.

The UK CCS standards were initially based on the EU CCS Directive. When the UK was part of the European Union, it adhered to the EU's regulatory framework, including CCS guidelines. The EU CCS Directive provides a comprehensive framework for the safe and effective capture, transport, and storage of carbon dioxide (CO_2) to mitigate climate change. After EU exit, the UK transposed the EU CCS standards into UK regulations. This means that the existing EU-based rules were incorporated into UK law. The standards themselves have remained largely aligned with the EU version.

There is a risk of misalignment between the UK and EU CO_2 standards, as the UK's regulatory framework is no longer dynamically linked to the EU's updates. As a result, any future changes to EU CCS rules will not automatically apply to UK regulations. When the EU introduces new standards or modifies existing ones, the UK will not adopt these changes promptly. This divergence would lead to misalignment between the two systems. Ongoing dialogue between the UK and the EU is required to harmonise CCS standards. This would facilitate smoother cross-border operations. Alternatively, the government may look to mutually recognise standards in each jurisdiction, doing so would accelerate the development of CCS infrastructure between the UK and EU.

OEUK is part of the European Union's Industrial Carbon Management Forum, previously known as the EU CCUS Forum and participates in its Infrastructure Working Group that in 2024 is focusing on network planning, value chain risks and permitting. OEUK will monitor developments under this group and will identify any potential divergence with UK regulations that may risk the development of a future cross-border market.

Liability of CO_2 leakage

The long-term definitions of liability for parties involved in cross-border transportation and storage of CO_2 are yet to be laid out clearly with context to the UK. OEUK recognise that the liability and point of exchange will likely be governed by the commercial contracts between the relevant parties. However, there is a role for the government to play in supporting the development of liability regulations and standards that clearly outline the point of exchange in addition to supporting those that increase their liability exposure, to encourage the development of projects in the North Sea and accelerate the UK's storage capabilities.

OEUK have engaged with the Northern Lights project, in Norway, to further understand where the liability lies for emitters and those transporting and storing CO_2. The current exchange of liability occurs at the discharge port, we are expecting this to change in the near future to the load port, reducing the length of time for which the emitter is liable. However, this is a single case, and it should be advised that the exchange of liability may differ for individual projects across Europe as they are largely governed by commercial agreements. To ease the regulatory burden the UK may consider setting a national standard for the exchange of liability.

II.

OEUK believes that UK-based CCS projects should prioritise storing domestic CO_2 volumes to achieve the UK's net-zero goals. However, international CO_2 volumes can play a supportive role by increasing the overall volumes stored and unlocking new storage sites in the UK, thus enhancing the commercial viability of these projects.

The market must account for the impact of cross-border CO_2 volumes on supply and demand during the market transition and self-sustaining market phases. The CCUS Vision suggests a merchant delivery model in the self-sustaining market, where storage sites compete for CO_2 volumes. It is essential to ensure that international CO_2 volumes are valued equally with domestic CO_2 volumes. This equal valuation is vital to prevent domestic emissions from losing out on storage opportunities, which could compromise the UK's ability to meet its net-zero targets.

III.

There are a number of risks that are associated with the progression of the market into a merchant model in the self-sustaining market concept. Below are risk categories associated with developing the merchant model and methods of mitigation.

Market Risk

Market risk involves uncertainties and potential financial losses caused by fluctuations in domestic and international CO_2 markets. This risk is heightened when considering non-pipeline transportation methods, where the supply of CO_2 is typically more intermittent than piped solutions.

Mitigation methods

1. **Long-term Contracts:** Establish long-term contracts between emitters and storage providers to ensure stable and predictable revenue streams. These contracts can help secure consistent CO_2 supply and demand, reducing market volatility.
2. **Market Diversification:** Diversify the customer base and sources of CO_2 by targeting various sectors (such as energy, manufacturing, and transportation) and expanding geographically. This reduces dependency on any single market segment and spreads the risk.

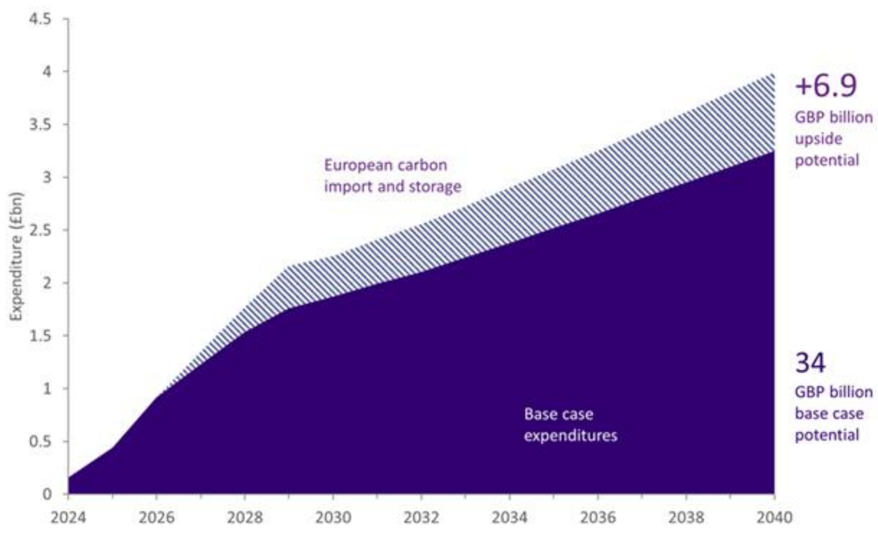
Operational Risk

Operational risk includes the potential for losses due to failures in the daily operations of capturing, transporting, and storing CO_2. Mitigation methods of operational risk include:

1. Regular maintenance and upgrades to infrastructure
2. Implementation of best practices produced by trade associations and industry

Economic and supply chain benefits of enabling cross-border transportation of CO_2

A supply chain study commissioned to Rystad Energy by OEUK[2], in 2024, outlines the financial opportunities for the UK's supply chain from the expansion of domestic CO_2 storage to include emissions from Europe. The analysis includes a scenario that shows that the upside potential for UK supply chain companies could be in the region of £7bn over the course of the next 15 years if 30% of emissions from European emitters were stored in the UK. With the annual upside potential reaching £1bn per year by 2040. Delaying the process of unlocking cross-border transportation for the UK would greatly reduce our ability to compete internationally for European emissions. Failing to develop a market for international CO_2 storage services could hinder the ability of supply chains to capitalise this opportunity.



[2] https://oeuk.org.uk/product/uk-og-supply-chain-opportunities-in-the-energy-transition/

Storage

28. To what extent would enabling NPT users and cross-border users incentivise storage exploration and appraisal activity? If not, why doesn't it?

Enabling NPT and cross-border users can significantly incentivise storage exploration and appraisal activity. According to the NSTA, more than 100 CO_2 licenses will be required by 2050 to meet net zero targets. Currently, the UK's CCS framework offers limited incentives for investors to develop storage capacity and a market for CO_2 storage as a service.

Enabling non-pipeline transportation mechanisms, such as shipping, will increase the CO_2 volumes available in the market. Combined with mechanisms like carbon pricing, this will incentivise the acceleration of store development. It will also enable stores to compete for storage on a merchant model basis, achieving the UK government's CCS Vision of a self-sustaining market. More available CO_2 volumes will reduce the risks and costs associated with developing stores, and increased storage capacity will be critical for incorporating imported CO_2 if regulatory barriers preventing cross-border transportation are removed.

NPT modes will allow for a significant number of dispersed emitters to gain access to CO_2 storage sites that would not be feasible otherwise. The Industrial Decarbonisation Strategy, 2021, outlines the industrial emissions of sites in clustered and dispersed sites. It outlines that 47% of industrial emissions come from emitters outside of clustered sites.

- Clustered sites, 37.6mtpa
    - Non-iron and steel industry, 25.6mtpa
    - Iron and steel, 12.0mtpa
- Dispersed sites, 33.6mtpa
    - Dispersed cement sites, 4.2mtpa
    - Energy intensive (excluding cement), 12.3mtpa
    - Less energy intensive, 17.1mtpa

Providing dispersed sites access to storage sites will be crucial in the UK's efforts to decarbonise and to protect the thousands of jobs in manufacturing sites across the country that have no viable decarbonisation alternative without CCS. Increasing the volumes of CO_2 available to be captured would incentivise storage exploration and appraisal activity.

29. Could a store which is solely reliant on NPT users be viable? What are the technical challenges to operating a store solely reliant on NPT users? How would this operating model impact the risk profile of the project?

30. Please provide evidence for the potential viability of shipping CO_2 straight to the wellhead for CO_2 injection. Please expand on the risks/barriers and benefits of straight to wellhead shipping.

OEUK combined response to Q29 & Q30

Carbon storage sites could feasibly rely solely on NPT users for its source of carbon dioxide. OEUK recently visited Northern Lights, the first large-scale cross-border CCS project in Europe to be developed, to gain insights into the project and understand the lessons learned that the project could provide to the UK.

The project is jointly owned by TotalEnergies, Equinor, and Shell. Phase 1 of the project, 80% funded by the Norwegian government, is expected to become operational in 2025 with a capacity of 1.6 million tons of CO_2 annually (mtpa). The initial volumes will come from the Heidelberg Materials cement plant in Norway (400,000 tpa), followed by volumes from commercial contracts, including a bioenergy plant in Denmark (430,000 tpa) and an ammonia and fertilizer plant in the Netherlands (800,000 tpa). Phase 2 will follow, entirely funded by private investment, and will have a capacity of over 3.7 million tons per year.

The Northern Lights project is only viable by incorporating international volumes of CO_2 and it is a clear example of how Norway is maximising its potential by developing a market for the provision of international storage services. This showcases the feasibility of developing a large-scale carbon storage site based on NPT users.

There are a number of industrial clusters in the UK that will look to utilise NPT to connect to storage sites. A number of these storage sites may operate solely from emissions derived from NPT users. The South Wales Industrial Cluster (SWIC) is an industrial cluster that is looking to utilise NPT solutions to connect to storage sites. With estimated emissions from SWIC exceeding 10mtpa it is more than feasible on a quantity of emissions basis alone for a storage site to operate solely on emissions supplied by SWIC via NPT solutions.

Shipping CO_2 direct to the wellhead for CO_2 injection can be very challenging unless it is from a fully pressurised (i.e. CO_2 stored at ambient temperature) ship. Alternatives to a fully pressurised ship would require a significant level of offshore power to prepare the CO_2 for direct injection.

For example, OEUK member Altera Infrastructure are developing the Stella Maris project together with Wintershall DEA. This project aims to transport CO_2 from an onshore terminal to a floating Direct Injection Unit (DIU) for direct injection into the Havstjerne reservoir. This project expects the cost of transportation between onshore terminal and DIU to be cost-comparable to pipeline solutions. Test injections planned for Q1 2025 will provide greater feedback on the feasibility of a project solely reliant on NPT users and the viability of shipping CO_2 straight to the wellhead for CO_2 injection.

Wider deployment considerations

Other regulatory controls

31. What regulations need to be considered or amended for NPT value chains to deploy (excluding those regulations which are covered in the CCUS policy landscape section)?

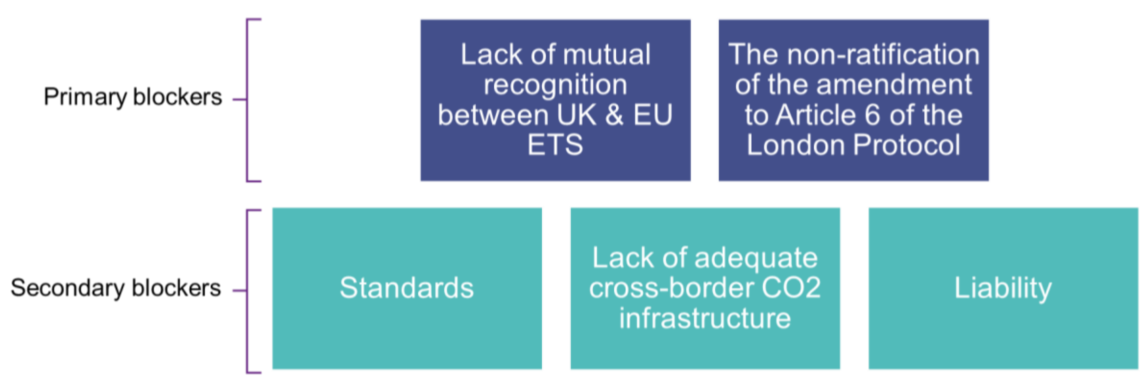
The following regulations should be considered or amended:

- An agreed methodology of assuring that cross-border transportation can be achieved and how the appropriate transport and storage costs can be allocated to remote emitters.
- Amendments to T&S business models to take into account cross-border transportation of CO_2.
- Alignment/mutual recognition of regulations between parties in future bilateral agreements between the UK and European nations for the cross-border transportation of CO_2.
- Acceleration of the permitting process to reduce the time taken to process projects from concept to injection.
- Unbundling of licences will be required to support the interaction between economically regulated onshore networks with unregulated and unlicensed NPT solutions.
- Confirmation of the ability and potential approach to providing a licence exemption would reduce policy risk and would be viewed as a positive step towards enabling cross-border CO_2.

33. Are there any specific changes to UK legislation, existing regulations or permitting processes which are necessary to support the development of cross-border CO_2 T&S networks?

34. What do you see as the biggest regulatory barriers to the growth of cross-border CO_2 T&S networks?

OEUK combined response to questions 33&34



London Protocol

The main international legal instrument governing the disposal of CO_2 in sub-seabed geological formations is the London Protocol, a treaty that aims to protect the marine environment from pollution by dumping wastes and other matter. The UK is a party to the London Protocol, which means that it has to comply with its provisions and obligations. The London Protocol was amended in 2006 to allow for the export of CO_2 for sub-seabed storage, subject to given conditions and requirements.

The London Protocol was further amended in 2009 to create a mechanism for cross-border transportation of CO_2. The countries exporting and importing the CO_2 must enter into an agreement confirming permitting responsibilities as between the countries and, where the import country is not a London Protocol party, which import country must store the CO_2 in compliance with London Protocol standards. This amendment has not yet entered into force, as two-thirds of the London Protocol contracting parties are required to ratify the amendment. So far, only the following countries have deposited an instrument of acceptance: Norway, the UK, the Netherlands, the Islamic Republic of Iran, Finland, Estonia, Sweden, Denmark, South Korea and Belgium.

In 2019, the parties to the London Protocol adopted a resolution to allow the provisional application of the 2009 amendment, pending its entry into force. If a party deposits a declaration with the International Maritime Organization (IMO) it can act as if the 2009 amendment is in force and make use of the ability to export CO_2 in compliance with the London Protocol.

Therefore, the current situation is that as the UK has deposited a declaration with the IMO, it may export CO_2 to any country provided it complies with the requirements in the 2009 amendment and any country which has itself deposited a declaration with the IMO may export CO_2 to the UK. This can be done under a simple bilateral agreement which only covers permitting obligations. The countries that currently have deposited a declaration with the IMO and can export CO_2 to the UK are Belgium, the Netherlands, Denmark, Norway, Sweden and South Korea.

Lack of mutual recognition of Emissions Trading Schemes

Another challenge for cross-border transportation of CO_2 is the UK's carbon pricing policy, which is based on the UK Emissions Trading Scheme (UK ETS). The UK ETS is a cap-and-trade system that covers around a third of the UK's greenhouse gas emissions, mainly from the power and industrial sectors. The UK ETS replaced the UK's participation in the EU Emissions Trading Scheme (EU ETS) on 1 January 2021, after the end of the EU exit transition period. Under the UK ETS, emitters must purchase allowances for their emissions, with each allowance representing the right to emit one tonne of CO_2 equivalent.

There is a carveout in the UK ETS legislation which allows emitters not to surrender ETS allowances in relation to emissions that are captured and stored in accordance with the UK CCS. This may provide emitters subject to the UK ETS regime participation in carbon storage. However, there is no mutual recognition of emission trading schemes between the UK and a third-party country, for example, the EU. Therefore, EU emitters seeking sub-seabed storage in the UKCS would not benefit from the exemption to surrender allowances in relation to stored carbon dioxide under the EU ETS.

This could be resolved by a linking agreement or agreement of mutual recognition between the UK and EU emissions trading schemes. In 2017, the EU and Switzerland signed an agreement to link their systems, the agreement entered into force on 1st January 2020 following the exchange of the instruments of ratification or approval between the EU and Switzerland. This is an approach that was considered between the EU and Australia but dropped due to the repeal of the Australian system in 2014.

Liability

The long-term definitions of liability for parties involved in cross-border transportation and storage of CO_2 are yet to be laid out clearly with context to the UK. OEUK recognise that the liability and point of exchange will likely be governed by the commercial contracts between the relevant parties. However, there is a role for the government to play in supporting the development of liability regulations and standards that clearly outline the point of exchange in addition to supporting those that increase their liability exposure, to encourage the development of projects in the North Sea and accelerate the UK's storage capabilities.

OEUK have engaged with the Northern Lights project, in Norway, to further understand where the liability lies for emitters and those transporting and storing CO_2. The current exchange of liability occurs at the discharge port, we are expecting this to change in the near future to the load port, reducing the length of time for which the emitter is liable. However, this is a single case, and it should be advised that the exchange of liability may differ for individual projects across Europe as they are largely governed by commercial agreements. To ease the regulatory burden the UK may consider setting a national standard for the exchange of liability.

CO_2 standards

A lack of defined uniform standards between the UK and EU for cross-border CCS projects could pose a stumbling block for the cross-border trade of CO_2. OEUK notes that under current circumstances governments may choose to amend national standards on an ad hoc basis. This may result in instances in which standards misalign and cause conflict. For example, a technical standard relating to transport infrastructure may conflict in each jurisdiction, delaying or even preventing cross-border trade of CO_2.

The UK CCS standards were initially based on the EU CCS Directive. When the UK was part of the European Union, it adhered to the EU's regulatory framework, including CCS guidelines. The EU CCS Directive provides a comprehensive framework for the safe and effective capture, transport, and storage of carbon dioxide (CO_2) to mitigate climate change. After EU Exit, the UK transposed the EU CCS standards into UK regulations. This means that the existing EU-based rules were incorporated into UK law. The standards themselves have remained largely aligned with the EU version.

- *Risk of Misalignment*
  - The challenge arises from the fact that the UK's regulatory framework is no longer dynamically linked to the EU's updates. While the initial transposition ensured alignment, any subsequent changes to EU CCS rules will not automatically apply to UK regulations.

- If the EU introduces new standards or modifies existing ones, the UK may not adopt these changes promptly. This divergence could lead to misalignment between the two systems.

- *Implications for CO_2 Transfer*
  - The risk of misalignment may have several consequences, including potentially affecting the transfer of CO_2 across borders. For instance:
  - Cross-Border Projects: If an EU-based emitter stores its CO_2 in a UK store, differences in standards could hinder seamless CO_2 transfer.
  - Investment Uncertainty: Investors may face uncertainty due to divergent regulations, impacting cross-border CCS investments.
  - Operational Challenges: Companies operating across both regions may need to navigate varying compliance requirements.
- *Potential Solutions*:
  - Alignment of standards: Ongoing dialogue between the UK and the EU is required to harmonise CCS standards. This would facilitate smoother cross-border operations.
  - Mutual Recognition: As an alternative to aligning standards across member countries, the governments may look to mutually recognising standards in each jurisdiction. Doing so would accelerate the development of CCS infrastructure between the UK and EU.
  - Monitoring and Adaptation: Regular monitoring of EU and UK CCS developments is crucial. The UK should be prepared to adapt its regulations if necessary.

Lack of existing infrastructure

There is an urgent need for a fit-for-purpose EU regulatory framework for cross-border CO_2 transport infrastructure, focused on the development of non-discriminatory, open access and multimodal CO_2 transport infrastructure. Such a framework would establish a clear legal and regulatory basis for planned projects and would enable coordinated CO_2 infrastructure planning, regional cooperation and harmonised standards on the transport part of the CCUS value chain.

A regional approach for discussions around CO_2 infrastructure could trigger more efficient infrastructure cooperation and deployment, with a particular focus on integration between cross-border CCS systems. Applying this logic for CO_2 infrastructure could be facilitated by the EC and policymakers in Europe.

As the first cross-border CCS opportunities are currently being developed, there is an opportunity for the EU and the UK to coordinate in developing CCS infrastructure between the jurisdictions. There is a risk that without prompt action, key transport networks are set up that exclude the UK and the EU. By aligning on this infrastructure now, the jurisdictions could optimize the CCS infrastructure in the North Sea for their purposes.

Delivery

36. How should the UK design the standards and specifications for CO_2 T&S which offers network users sufficient flexibility in store choice but also provide sufficient protection to core T&S infrastructure? How can the UK ensure that its T&S network design does not impede access to an interconnected and interoperable European system?

OEUK refer back to combined answer for questions 33&34

37. Are there any technical or operational limitations that may exist that could be a barrier to domestic NPT or cross-border T&S network deployment? Please explain.

The current time lags associated with major infrastructure for carbon transport and storage projects could provide barriers to the efficient deployment of a cross-border T&S network. OEUK are aware that the current lag-times for the development of cross-border CO_2 ships can exceed 4 years. Ensuring that Final Investment Decisions (FID) are met at the earliest possible date for the UK's cluster projects will allow for cluster projects to access CO_2 transport ships earlier. Any delay to the FID process will hinder the UK's position in a cross-border CO_2 market.

Onshore CO_2 buffer storage tanks also hold a potential lag-period, the Northern Lights project, in Norway, experienced a lag in excess of 18 months for the manufacturing and delivery of 12 buffer storage tanks (cumulative capacity 8,250m^3). These lags can largely be mitigated by the development of domestic capability and capacity. OEUK and Rystad's Supply Chain capabilities report outlines the strengths and weaknesses of the UK's supply chain in meeting the needs of the new energies.

OEUK refer back to the combined response to question 33 & 34 for notes on additional limitations.

38. Is there any specific foundational infrastructure that must be operational in the UK before UK stores can offer storage to domestic NPT or international customers? If so, what should the UK prioritise?

OEUK recognises CO_2-ready ports as a foundational infrastructure that must be in operation before UK stores can offer storage to international customers. CO_2-ready ports should be prioritised to position the UK as a leader in cross-border transportation and storage of CO_2. While piped solutions offer the cheapest form of CO_2 transportation over long distances, shipping allows greater flexibility for both emitters and storage providers. Reducing operational risk and minimising the dependence on a single store or emitter.

An example of a CO_2 port that is mechanically complete ahead of first injection can be seen in Norway at the Northern Lights project. This project's "receiving terminal" is ready to begin taking shipments of CO_2 from European emitters ahead of the scheduled first injection date of May 2025. From OEUK's engagements with the Northern Lights project, we can advise that the infrastructure within a port that holds the greatest lead times and should thus be prioritised are buffer storage tanks and CO_2 transport ships, with estimated minimum lead times of 18 months and 36 months, respectively.

41. Does the UK have the relevant skills and capability to deliver NPT? Does the UK have a competitive advantage to deliver certain elements of the NPT value chain?

The OEUK commissioned 'UK oil and gas supply chain and opportunities in the energy transition' report reveals that approximately 80% of the domestic UK CCS market is targetable by the oil and gas supply chain. The not addressable segments include carbon capture equipment, maintenance and CO_2 shipment services from specialised supply chains.

UK vessel demand is expected to skyrocket throughout 2040. A significant scaling up of the UK's fleet would be required to control a competitive advantage as currently the market is largely made up of vessels owned by foreign entities and flying foreign flags.

The base assumption is that vessels that will be used for the emerging industry of CO_2 ship transport will continue to be built overseas. Fabrication and construction of CO_2 carriers are highly likely to be served by yards in Asia, as with most ship construction. There is very limited UK capability, and the fabrication and construction of such vessels are considered as currently not addressable by UK entities.

Notably, offshore pipelines emerge as a promising target for the UK's oil and gas supply chain. Drawing parallels with the industry's existing strengths in oil and gas, particularly in subsea installation and survey capabilities, the UK is well positioned to assume a significant role in the installation and commissioning of offshore pipelines for CCS.

UK ports will be critical for delivering NPT and CO_2 shipping requirements, with UK ports in strategic locations for industrial clusters and CO_2 storage sites. Whilst several ports have had large investments in infrastructure, the DESNZ 'Shipping CO_2 – UK Cost Estimation Study' states that existing ports could impose constraints on CO_2 shipping projects, including ship length, ship draft, berth availability, and storage space requirements. For instance, very large CO_2 ships (e.g. >30 $ktCO_2$) may not be able to meet the specific maximum length and draft requirements of some UK ports.