Department for
Energy Security
& Net Zero

Carbon capture, usage, and storage (CCUS): Call for evidence on non-pipeline transport and cross-border CO_2 networks

Summary of responses

November 2024

Any enquiries regarding this publication should be sent to us at: NPTandCrossBorderCO2@energysecurity.gov.uk

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Executive Summary

The call for evidence on non-pipeline transport (NPT) of carbon dioxide (CO_2) and cross-border CO_2 networks opened on 7 May 2024, under the previous administration and closed on 16 July 2024. The call for evidence sought views on the government's vision for NPT and evidence on potential NPT value chains and cross border CO_2 networks.

Topics covered included:

- Views on the potential vision for the sector, as set out in the call for evidence
- NPT value chain data
- Carbon capture, usage, and storage (CCUS) policy landscape
- Wider deployment considerations

In total, we received 85 responses. The largest respondent groups included 25 prospective capture projects deploying via NPT, 14 trade associations and 8 advisory groups.

There were several key themes emerging from the analysis of responses:

- **Overwhelmingly, it was made clear that NPT is a necessity for the successful expansion of CCUS across the UK:** the reasons cited for this included that NPT would accelerate decarbonisation and expand CCUS to more regions of the UK, support the transition to a self-sustaining CCUS market and deliver flexibility and resilience to existing CCUS networks
- **Cross-border networks will play a vital role in delivering economic benefits, increasing storage appraisal activity, and supporting deployment of domestic CCUS projects:** but these benefits can only be unlocked with consistent CO_2 standards, political agreements and overcoming regulatory barriers
- **There is a high level of interest in NPT from a range of stakeholders and information was provided on a range of projects representing significant volumes of CO_2 that are ready to be captured from the end of 2030:** significant progress has been made by industry on developing a variety of technical solutions across shipping, road and rail
- **There was a clear call for fairness in assessing NPT projects:** government should consider the wider value offered by NPT when comparing potential projects to pipeline alternatives
- **NPT deployment will require a number of changes across business models, the CCS Network Code and the T&S economic licence:** but industry have signalled that they would like to freely organise themselves in a way that allows them to manage risk appropriately
- **High capital and operational costs were cited as a potential barrier to NPT deployment, alongside other challenges including the uncertainty on long-term CO_2 supply for stores and planning and consenting processes impacting delivery timelines:** domestic NPT projects stated a greater need for government support than those considering merchant imports

Next steps

Respondents called for greater clarity to allow projects to mature. Government therefore intends to publish a consultation on NPT in H2 2025, intending to cover support for NPT costs, risk allocation and economic licensing.

We will continue to engage with industry in the run up to the consultation, through a series of workshops.

For cross-border CO_2 T&S networks, we will be carrying out separate engagement to better understand the opportunities to accelerate the deployment of associated projects in the UK, recognising the desire to move towards a self-sustaining market.

If you would like to be added to the distribution list for future NPT-related communications, please email NPTandCrossBorderCO2@energysecurity.gov.uk.

The government would like to thank all respondents to this call for evidence. The views and evidence provided will continue to help government develop future NPT policy and wider CCUS policy.

Introduction

Carbon capture, usage, and storage (CCUS) is critical to the delivery of net zero by 2050, with the Climate Change Committee stating that CCUS is a 'necessity not an option'[1]. CCUS is important in the decarbonisation of industry (e.g. cement, chemicals, and refining) where, in many cases, the process emissions mean that it is the only viable route to decarbonise at the scale required to meet our carbon budget and net zero targets. Our Clean Energy Superpower mission is based on the twin objectives of delivering clean power by 2030 and accelerating towards net zero, to boost energy independence, protect consumers, and support jobs across the country. CCUS is key to decarbonising the power sector, reducing the impact of residual waste management, and kick-starting low carbon hydrogen production and engineered greenhouse gas removal (GGR) sectors.

Alongside this, CCUS is vital to this government's commitment to delivering growth and creating good jobs in Britain's industrial heartlands, ensuring a just transition for the industries based in the North Sea. The CCUS Vision[2] published in December 2023, under the previous administration, set out an ambition to create a competitive market in CCUS by 2035. It aimed to unlock investment and drive economic growth, potentially supporting up to 50,000 jobs and adding up to £5 billion to our economy each year by 2050.

We will need to expand the CO_2 transport network for both pipeline and non-pipeline solutions to facilitate decarbonisation across multiple regions and sectors of the economy, and to meet the evolving needs of users. NPT will allow for the deployment of CCUS in areas where a pipeline is technically and/or commercially unfeasible. This will be particularly important as roughly half of the industrial emissions in the UK sit outside industrial clusters, and not all clusters have access to a piped T&S solution (e.g. South Wales) to where it will be permanently stored.

This document provides a summary of responses to the call for evidence on non-pipeline transport and cross-border networks that was published in May 2024. That call for evidence sought views on government's vision for NPT and sought evidence on the role that government will need to play within a new NPT sector deploying during the market transition phase (2030-2035), only intervening where it is necessary.

Views and evidence on four key areas, listed below, were requested. The responses to these topics have been summarised by question and will be used to inform government's next steps.

- Views on the potential vision for the sector, as set out in the call for evidence
- NPT value chain data
- CCUS policy landscape
- Wider deployment considerations

[1] The Climate Change Committee. 'Net Zero - The UK's contribution to stopping global warming' 2019
[2] Department for Energy Security and Net Zero. 'Carbon capture, usage and storage: a vision to establish a competitive market' 2023

Responses received

We would like to thank all stakeholders that responded to this call for evidence, with detailed and insightful views that will inform future policy. In total, we received 85 responses. The call for evidence was available on GOV.UK from 7 May to 16 July 2024 and responses were received through email and Citizen Space. The call for evidence was also advertised through our NPT mailing lists, and DESNZ held a stakeholder engagement session in May 2024 for the call for evidence.

We received responses from a variety of stakeholders, broken down as follows:

- Capture project deploying via NPT: including industrial, waste management, sustainable aviation fuel (SAF), bioenergy and power projects – 25 responses
- Trade associations and industry bodies: including business/industry representative organisations – 14 responses
- Advisory groups: including consultancies, advocacy groups and charities – 8 responses
- Cluster representative organisations – 7 responses
- Transport and storage companies (T&SCos) – 7 responses
- Intermediary service providers: including temporary storage providers and/or liquefaction services – 7 responses
- Transport service providers – including road, rail, and shipping solutions – 6 responses
- Other CO_2 service providers – including other carbon capture technologies and CO_2 measurement service providers – 5 responses
- Public sector organisations and Arm's Length Bodies: including devolved administrations, local authorities, and government agencies – 4 responses
- Research: including academia and research institutions – 2 responses

Summary of responses

In this section, we summarise the responses provided for each question, highlighting key themes and points.

We received a total of 85 responses for this call for evidence. Whilst most responses directly noted which questions they were responding to, some did not. For these responses we have addressed them within our response summaries where we believed they most appropriately fit.

Questions 1-3 requested personal respondent data. This will not be summarised here.

Vision for NPT

This section of the call for evidence set out a potential vision for a mature NPT sector during the self-sustaining market phase, and we sought views on this vision.

The vision for NPT in the self-sustaining phase, as set out in the NPT call for evidence, articulated the following:

- **Variety of NPT chains**: NPT is expected to be delivered by all NPT transport modes (ship, road, rail, barge), with a range of different connections between NPT emitter and store, alongside the associated commercial arrangements, the various commercial entities in these chains would organise themselves in a way that allows them to best manage the NPT solution operations and risks
- **Operational flexibility:** each CCUS cluster would have NPT connectivity, creating the potential for a web of different connections to clusters, unlocking flexibility between each one, their NPT users, and their stores, this web of interconnected NPT users, third-party intermediaries and stores could then connect with fixed piped T&S networks
- **Competition fuelling system growth:** NPT service providers are not expected to be economically regulated as it is anticipated there would be sufficient competition, driving down costs throughout the NPT service provider network and supporting CCUS expansion

Since the publication of the call for evidence, the government has set out its missions of being a clean energy superpower, delivering clean power by 2030 and accelerating towards net zero, alongside a commitment to delivering growth and creating good jobs. The government is clear that the vision for NPT in the self-sustaining phase would sit within the context of these missions.

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

Question 4 received 70 responses.

23 respondents specifically stated their broad agreement with the government's vision for NPT, compared with 1 respondent who specifically disagreed. Though numerous respondents did not specifically state that they agreed with the vision, there was widespread agreement with the different elements set out within it. In addition, significantly more noted their agreement with the necessity for NPT and stated that NPT will be critical in supporting decarbonisation,

both across the UK and in specific regions of the country. In total, 59 respondents were in broad agreement with the future benefits that NPT can deliver.

Some respondents set out additional themes that government should take into consideration when developing the long-term vision for NPT. These include the jobs and wider economic benefits that NPT could support and the resilience that a diverse transport system can provide to the wider CCUS landscape.

A number of respondents noted concerns about the feasibility of achieving the outcomes set out in the vision. These included concerns about the longer-term certainty on domestic and international CO_2 volumes, minimising legal and policy blockers, different regional challenges, relative costs compared to pipeline transport, the need for standards for operators in an unregulated sector and the need for all CCUS clusters to have NPT connectivity.

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?**

Question 5 received 59 responses.

18 respondents highlighted the benefits that NPT can bring to regions far from planned CCUS pipeline networks. Examples of these include South Wales, Isle of Grain, Southampton, Northern Ireland, the Midlands, south-east England, Severn/Bristol, and Scottish Highlands. In addition, regions with storage capacity but limited local emitters like Bacton, north-east Scotland, and Shetland were noted.

10 respondents discussed the potential to utilise existing infrastructure, for example regional pipes and railheads. Regions with established port infrastructure will also benefit from the ability to export captured emissions to offshore storage clusters potentially benefiting from reduced capex costs.

8 respondents highlighted the economic and job benefits of NPT solutions. Respondents mentioned the benefits linked to NPT port development which could stimulate positive economic development in less developed regions. Respondents also acknowledged that CCUS deployment across different sectors can play a crucial role in reducing the UK’s overall carbon emissions and supporting the transition to a low-carbon economy.

30 respondents discussed the geographical and infrastructure challenges associated with deploying NPT, stating the economic challenges for projects situated further away from onshore pipeline networks that could transport their CO_2.

19 respondents highlighted that geographically remote areas will continue to struggle to deploy CCUS. Isolated emitters and sites with limited access to infrastructure in these regions may struggle to attract investment at scale.

5 respondents highlighted the opportunities unlocked for the CO_2 utilisation sector by NPT.

NPT value chain data

This section of the call for evidence sought views and evidence on prospective NPT projects, costs, and financing risks.

Project Data

6. **Please provide details of your potential NPT or cross-border solution. Please provide any information on the timing of the project through the initial phase and into the future, and the minimum viable project.**

Question 6 received 52 responses.

These responses set out detail on 24 unique projects (as a number of responses referred to the same project):

- **NPT value chain** (includes capture, relevant intermodal hubs (temporary storage and/or liquefaction equipment), transport and storage solutions) – 17 responses, of which:
    - shipping – 7 responses
    - undecided NPT mode (includes exploring multimodal solutions) – 6 responses
    - road – 3 responses
    - rail – 1 response
- **Intermodal hub only** (temporary storage and/or liquefaction equipment) – 3 responses
- **Storage solution only** (includes cross border solutions) – 3 responses
- **Transport solution only** – 1 response

31 respondents are anticipating that they would be able to take Final Investment Decision (FID) in 2027/2028. With an average time between FID and Commercial Operation Date (COD) expected to be three years, most projects expect to come online around 2030/2031.

7. **Please provide the technical and operational considerations for the major pieces of infrastructure, equipment, and transportation. Considerations may include information on the sizes and numbers of the above, CO_2 temperature and pressure conditions, loading/un-loading times and NPT journey lengths and duration. Please also provide the rationale for the technical and operational decisions.**

8. **For the above NPT chain, please provide information on the expected ownership/operatorship (e.g. leasing, owned, shared ownership, etc) and expected commercial/contractual arrangements. Please include when equipment is to be shared between multiple entities or for sole use.**

9. **Please provide information on the elements in the NPT chain with the longest lead times which could be rate determining in the deployment of the NPT chain. Please provide any information that you have on timelines for delivery of your NPT chain (e.g. project delivery Gantt charts).**

Question 7 and 8 both received 43 responses each and Question 9 received 37 responses. Given commercial information noted in responses for these questions, a detailed summary will not be provided. The following elements in the NPT value chain were noted as those with the longest lead times:

- jetties – 36-60 months
- ships – 36 months
- CO_2 capture and liquefaction facilities – 24-48 months
- specialised shipping containers – 24-36 months
- rail cars – 24 months

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.

Question 10 received 40 responses.

The transport and fugitive emissions data varied among respondents, as each defined which emissions to include differently. General trends observed based on the data provided indicate that CO_2 emissions from transport are typically less than 2.5% of the total quantity of CO_2 transported. Respondents highlighted that in addition to the emissions associated with the transport fuel, the energy required to liquefy CO_2 for transport would be significant and important to be considered.

8 respondents indicated that fugitive emissions for NPT value chains should be negligible as they will be much lower compared to transport and process emissions for NPT value chains and due to systems being fully sealed.

To minimise transport emissions, respondents suggested a range of technologies, some dependent on the mode of transport being used. Lower emission fuels or electric vehicles were mentioned as alternative technologies. For road and rail transport, alternative fuels such as biofuel and compressed biogas were suggested. For shipping, alternative fuels such as ammonia, liquefied natural gas (LNG) and methanol were suggested.

3 respondents also suggested that ship design features and technologies such as wind propulsion, hull air lubrication and Becker Mewis Ducts, which improve hydrodynamic efficiency by optimising the inflow to the propeller, could improve ship efficiency and reduce associated transport emissions. Respondents noted that carbon capture technology could be retrofitted or included in CO_2 carrier designs to capture gaseous CO_2 that has boiled off during shipping. However, 2 respondents raised concerns around the readiness level of this technology.

5 respondents noted that other wider decarbonisation initiatives, for example the Renewable Transport Fuel Obligation (RTFO) from the Department of Transport, would help reduce transport emissions without requiring direct action from the projects themselves.

Other suggested initiatives to reduce emissions included: installing accurate monitoring systems and following strict maintenance protocols to identify any leaks early; sharing facilities (e.g. for liquefaction) among capture projects to reduce the amount of infrastructure each individual project needs to build and operate; using renewable electricity for dockside operations and following good practice guidelines.

7 respondents noted that they were unable to share exact figures on expected transport and fugitive emissions at this stage, indicating that it was still too early on in their project development.

1 respondent noted that while transport and fugitive emissions may be more easily identifiable for NPT value chains, regulatory regimes should also take account of less obvious fugitive emissions associated with pipeline transport (e.g. from compressor stations) and make sure that both NPT and pipeline transport are held to the same standard.

1 respondent suggested that conducting a full technical study could be beneficial in furthering understanding of potential emissions from different pathways.

Costs

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

Question 11 received 36 responses.

27 respondents stated that costs associated with the full NPT value chain were a barrier to investment. Respondents highlighted the need for government support to offset the high capital costs associated with building carbon capture equipment and NPT infrastructure. Out of these respondents, a few noted that the high upfront capital expenditure is due to the need for specialised transportation and CO_2 transport and storage infrastructure.

7 respondents did not think costs are a barrier to deploying NPT, despite noting that NPT is likely to be more costly than pipeline solutions. Cost concerns with NPT relate to high initial Capex outlay.

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.**

Questions 12 received 41 responses.

The call for evidence did not receive any specific cost data relating to the economic viability of NPT compared to pipeline. However, respondents noted that pipelines are slower to develop over long distances and/or complex landscapes due to planning and consent challenges. Pipelines crossing into devolved territories might also require cross-authority consent, adding complexity. As such, respondents suggested that NPT may be more economically viable on a timescale basis despite potentially higher costs.

Some respondents noted specific instances in which piped solutions would not be viable. The first of these was for locations which are not proximal to geological storage. The second was at certain rural locations with smaller emitters, as the relatively small volumes of CO_2 requiring long distance pipelines would not make them economically viable. Finally, the third instance was for large urban areas, where pipeline connections for a group of dispersed emitters would face additional challenges such as underground services, road/pavement restoration, and longer construction programmes.

13. **Please provide evidence on the costs associated with NPT. Where possible disaggregated to the nodes delivered by NPT service providers (e.g. after capture plant and before delivery to the T&S network). Where possible, please provide information in relation to the devex, capex and opex of the operation. Please**

include the stage and Association for the Advancement of Cost Engineering (AACE) Cost Class at which this cost data has been generated, and please share the methodologies and assumptions that have been utilised to generate this data.

Question 13 received 35 responses where respondents provided evidence of costs associated with NPT. Given commercial information noted in responses, a summary will not be provided.

Financing

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

Question 14 received 36 responses.

In response to this question, respondents highlighted risks which would impact the investability of NPT projects or their ongoing financial viability.

6 respondents suggested that one of the main financing risks was that government has not yet provided clear guidance as to how NPT projects would be supported or regulated, and that this uncertainty impacts their financeability.

Respondents also noted that the fragmentation of responsibilities and ownership across the disaggregated chain could increase uncertainty regarding investment return. Respondents indicated that the increased number of parties involved lead to increased cross chain risks, including coordination and interface risks. However, 3 respondents stated that they saw the financing risks associated with a disaggregated chain vs a fully piped approach to be the same (or equally challenging). Respondents noted that a full-chain-piped approach has lower operational costs, fewer logistical dependencies and can be financed through one overarching arrangement. However, respondents also noted that a full-chain-piped approach can require more significant upfront investment.

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

Question 15 received 37 responses.

6 respondents answered questions 14 and 15 together, noting that a disaggregated chain enables operational flexibility and therefore the two characteristics are interrelated.

Respondents suggested that they may initially seek to limit operational flexibility in order to provide greater contractual certainty, as provided in a full-chain-piped approach.

2 respondents noted that operational flexibility can increase uncertainty, for example through more variable CO_2 volumes being delivered to the T&S network. This means that revenues for service providers are less certain and may make chains with more operational flexibility less attractive investments.

4 respondents also highlighted the benefits of operational flexibility, including allowing capture projects to use multiple stores and enabling value-dynamic adjustments to market conditions.

2 respondents indicated that they did not anticipate operational flexibility presenting a risk in terms of financing or operational flexibility presented less financing risk compared to a full-chain-piped approach.

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

Question 16 received 37 responses.

Out of the three archetypes presented in the call for evidence (Store Led, Intermediary Led, Capture Led), there was not a consensus as to which particular archetype would be most attractive to investors. 13 respondents indicated that multiple archetypes should be supported, highlighting that the government should let the market determine which archetype is most appropriate as this will vary on a project-by-project basis. 10 respondents did not indicate a preference for any archetype.

6 respondents indicated that a Capture Led archetype would be most attractive to investors. Their suggested reasons for this included: groups of emitters having higher credit ratings than single T&SCos; the market signals being driven by the need to capture carbon at the capture plant; opportunities to create local NPT value chains and overall lower costs due to this model creating competition between different T&S operators.

3 respondents indicated that an Intermediate Led archetype would be most attractive to investors. Their suggested reasons for this included: the increased operational flexibility provided through this model which would help mitigate cross-chain risk; minimal adjustments being required to the TRI model; CO_2 shipping being able to operate as a non-economically regulated activity from day one and NPT transport infrastructure being able to be treated as a separate, smaller, more easily financeable infrastructure package.

5 respondents indicated that a Store Led archetype would be most attractive to investors. Their suggested reasons for this included: fewer parties involved in the value chain which would minimise cross-chain risk and being most like the current cluster model.

2 respondents noted that over time the archetype which is most attractive to investors would change.

1 respondent noted that the archetype they preferred for their project differed from that which they viewed as being most attractive to investors.

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

Question 17 received 30 responses.

All responses mentioned multiple financing types across the four categories below and so add up to more than 30 respondents.

- **Project financing – debt:** the project entity borrows directly, with no/limited recourse for lenders to the project sponsor e.g. non-recourse debt financing (21 respondents)
- **Project financing – equity:** injection of third-party equity directly into the project e.g. venture capital, infrastructure fund investment (15 respondents)
- **Corporate financing – debt:** this includes any direct borrowing by the project sponsor to support the project e.g. corporate bonds (9 respondents)
- **Corporate financing – equity:** this includes any direct funding of equity by the project sponsor (4 respondents)

Alongside the financing options above, financial support was noted as essential to address the financing risks noted in earlier questions. 17 respondents noted that contractual revenue support (e.g. CfD type scheme or PPP/PFI) will be required to deliver NPT value chains. 7 respondents, largely CCUS clusters and industry bodies highlighted the need for regulated revenue support (e.g. regulated asset base (RAB) type support). 5 respondents noted the need for government guarantees and government capital.

CCUS policy landscape

This section seeks to gather insights on how the current regulatory framework will need to be changed to support the deployment of NPT alongside piped T&S networks.

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 licensing?

Question 18 received 53 responses.

26 respondents agreed that there is no rationale for economic licensing as there will be sufficient competition and that NPT does not share the same monopolistic characteristics as piped CCUS. 11 respondents noted economic licensing might be needed in early market stages or for specific infrastructure due to the limited number of initial service providers. Another 11 respondents mentioned that some areas within the NPT value chain may require regulation. The following areas were listed:

- **Intermodal facilities (6 mentions):** high capital entry costs could lead to monopolistic practices
- **Receiving terminals (4 mentions):** potential for regional monopolies due to limited entry points into T&S networks
- **Transport modes (3 mentions):** potential for natural monopolisation due to limited road, rail, and ship transport operators in early market stages
- **Fixed nodes:** ports (5 mentions) and railheads (1 mention) could become monopolistic hubs at export or entry points for CO_2

5 respondents did not state a clear preference.

19. Considering the expected deployment timelines for potential NPT projects within the CCUS programme, can the risks associated with the deployment of an NPT value chain be effectively managed commercially between the different actors within the NPT value chain? If not, please provide evidence and rationale why these risks cannot be managed commercially.

Question 19 received 41 responses.

8 respondents agreed that the risks associated with the deployment of an NPT value chain can be effectively managed commercially. Respondents referenced precedents of commercial risk management in the shipping industry, oil and gas industry, and international projects.

17 respondents agreed that risks can be managed commercially but government involvement may be necessary to mitigate some risks to allow NPT development to be commercially attractive in the early phases of deployment.

Respondents noted the following views as to when government support could begin to fall away: once commercial insurance for post-closure leakage of stores is available; once the NPT market is considered commercially attractive or once there is sufficient system resilience in the NPT market. Respondents also highlighted the following areas where government support may be required:

- **Cross-chain risk mitigation:** respondents suggested that similar protections to those currently provided for Track-1 pipeline users would be needed for initial NPT projects to help address interface risk and coordination failure
- **Creation of regulatory frameworks:** respondents highlighted that such frameworks should set operational reliability standards which may boost investor confidence but noted that frameworks should not restrict the development of optimal commercial agreements
- **Carbon price certainty:** respondents indicated that certainty around the carbon price was needed for effective commercial risk management

CCS Network Code

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

Question 20 received 40 responses.

Respondents suggested the following changes to the CCS Network Code. A few overarching responses have been summarised at the top whilst others have been grouped into the relevant section of the Code.

General

- 6 respondents questioned whether integration of NPT into the current network Code is the correct way to proceed or if having a separate transportation of CO_2 code, or a voluntary code of practice for transport providers might suffice. The Code could be split into separate Storage and Use of Network frameworks.
- 5 respondents also noted that the NPT user does not need to be party to the Code under a store or intermediary model. Any compliance with CO_2 specification and validation of measurement equipment required by the NPT user should be handled commercially rather than codified.
- 1 respondent noted that the Code administrator or secretariat will need to be capable of dealing with a larger volume of user accessions, nominations, and other administrative procedures as the number of individual users can be significant.
- 1 respondent suggested that new provisions will be required to cover specific aspects of delivery by ship. For example, annual programming and shorter-term nomination of berthing slots; specification of safe ships and for the unloading terminal (including aspects of compatibility of ships and terminal). Also, separate procedures for the safe berthing, flange connection, discharge, and completion of discharge of the ships (as well as the safety of T&SCo operations within the terminal).

Specific sections of the Code

- **Section B – Governance:** The Modification Panel should be amended to allow for the specific representation of users connecting via non-pipeline solutions. (5 respondents)
- **Section D – Network structure and planning:** The Code should note additional interfaces with NPT users and relevant infrastructure owned by others such as CO_2 terminal owners, CO_2 ships, storage complexes and other future non-economically regulated infrastructure. As well as recognising T&SCos are likely to be unbundled in future NPT solutions. (10 respondents)
- **Section E – Network use and capacity:**
  - Create new short term interruptible capacity products that incentivise NPT service providers to utilise T&S networks that have available capacity and minimise constraints on local T&S networks. New products should also consider different operating constraints of NPT compared to pipeline and take advantage of intermodal facilities (e.g. buffer storage). (4 respondents).
  - Capacity and nominations processes will need to be amended to accommodate for storage of CO_2 from both domestic UK CO_2 sources and CO_2 from overseas as well as direct to wellhead injection. (3 respondents)
  - In relation to capacity constraints, there were differing views on Code changes. 1 respondent noted that NPT users may require longer notice periods in relation to decreasing or stopping CO_2 delivery, given the lag time during transportation of CO_2. 1 respondent stated that NPT users should be turned down first.
  - Where emitter led models are used, the NPT user may be more exposed to third party risks, which impact the ability of the NPT user to deliver nominated capacity to the T&S network. This should be recognised in the Code. (1 respondent)
  - An additional class of capacity conferring use of unloading terminal may need to be created if the receiving terminal is owned by the T&SCo. The T&SCo would then control the flow of CO_2 into the network and no other nominations are required. (1 respondents)
- **Section F – Network Design and Specification**
  - The Code should set out a UK wide (if not Europe wide) standardised CO_2 specification for transporting CO_2 to enable compatibility between different transportation modes, allow for both greater store optionality but also increased market competition. Minimum standards for CO_2 suggested included standards for: temperature, pressure (depending on transport mode), CO_2 impurity, interface dimensions (e.g. manifold heights), and safety case. (11 respondents)
  - Suggested a review of ISO 27913 noted under section 6.2.2 on CO_2 pipeline specification. CO_2 purity and quality specification required for NPT will be materially higher than a pipeline (i.e. in excess of 99.5% and will differ between medium pressure and low pressure). Impurities may have a greater impact on the whole value chain, especially in relation to the process of liquifying and re-gasifying CO_2 at reduced temperatures. (5 respondents)
  - Stated a need to include specifications for handling contaminants in vehicle returns for NPT. The flue gas composition associated with different capture technologies will have differing levels of impurities which can be introduced into

NPT vessels. Empty vessels returning for further CO_2 transport may require sampling to ensure no interactions between left over CO_2 impurities and new CO_2 occurs, which could be time-consuming and require scrubbing. This would necessitate detailed specifications and processes for vessel returns. (3 respondents)

  - Specifications for metering would need to be relaxed as high levels of accuracy across an NPT value chain through end-to-end metering is not possible. (3 respondents)
  - Measurement provisions should be extended to address measurement of losses during the NPT process. Where delivery points are common to multiple NPT service providers to ensure the operation and maintenance of these delivery points is efficient. (2 respondents)

- **Section G – Common Interface Procedures**
  - Adjustment of T&SCo access rights, in respect of NPT value chain audits (including of measurement equipment), should be provided, given the NPT user will not have the same level of control or ownership over the physical NPT route as compared to pipeline projects on 'self-contained' sites. (1 respondent)
- **Section H – Charges, Invoicing and Payment**
  - Beyond onshore and offshore elements, more complex charging structures may need to be built into the Code for NPT charging parameters, to reflect the varied archetypes that are possible for NPT. (5 respondents)
  - Where NPT CO_2 volumes connect into the Onshore Transportation System, NPT users should be subject to T&S charges only for the part of the Onshore Transportation System utilised (not the entire T&S network mutualised as per the current regime for pipeline users). It is foreseen that charges for (non-economically regulated) NPT users would include an element in relation to T&SCo decommissioning and corrective measures such that all users are paying a fair share. (2 respondents)
  - Should account for international imports in charging. (2 respondents)
  - Recognition that the T&SCo may pay NPT charges for CO_2 to be collected and delivered to another T&S network by an NPT operator during times of capacity constraint. (1 respondent)
  - The infrastructure necessary to link dispersed sites (e.g. pipelines, railheads, hubs, and ships) are similar to the new infrastructure required and associated costs incurred to link cluster emitters (e.g. extending pipelines). Therefore, the infrastructure required to link dispersed sites should be included in the T&SCo infrastructure charges that are aggregated and shared between emitters. (1 respondent)
- **Section I – Data**
  - Consideration as to whether NPT service provider specific data may need to differ from user specific data, and how this should be held and used by T&SCo. (1 respondent)
- **Exhibit B - Construction Agreement**

- 2 respondents note that the construction agreement will need to be amended to reflect that:
  - The NPT value chain will be outside the facility boundary so there are some areas which are unlikely to need this agreement
  - Some of the NPT value chain may not be subject to ‘construction’ such as where existing infrastructure (e.g. railway lines) is to be used and no construction works are required
  - The delineation of works which are necessary to connect the NPT terminal to the T&S network

Capture business models

21. What changes to the Track-1 capture business models (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.

Question 21 received 40 responses.

Respondents proposed changes across all business models (ICC/Waste ICC, DPA, Power BECCS, GGR, Hydrogen). 6 respondents noted that the business model changes required will depend on the chosen archetype.

19 respondents highlighted that NPT is associated with increased costs compared to pipeline transport and that the business models would need to be adapted to account for these extra costs (capital costs, operational costs, etc), including:

- for additional capital expenditure costs associated with NPT (e.g. rail infrastructure or intermediate storage), respondents suggested that support could be provided through a separate grant funding pot
- for the variable operational costs associated with NPT (e.g. liquefaction and heating of CO_2 as well as transport costs) respondents suggested that these costs could be covered within the TRI or capture business models
- respondents also noted the need to develop a clear framework for calculating NPT charges

Respondents made cases for both expanding the scope of the T&S fees as paid in the capture BMs to include NPT costs or having a separate NPT element within the pay mechanics.

8 respondents noted that cross-chain risk protections currently provided under existing capture BMs for piped projects would need to be extended to NPT value chains to ensure that both NPT and piped transport are equally protected. Respondents specifically noted the need to cover risks which were either specific to NPT (e.g. temporary ship unavailability or outage) or more likely to occur in an NPT value chain than a piped value chain.

More generally, 4 respondents highlighted that definitions in current capture BMs would need to be updated (e.g. “Capture Plant” and “Installation”) and new definitions to describe parts of the NPT value chain would need to be created.

A number of other broader contractual changes were noted by respondents as requiring adaptation for NPT projects such as force majeure, change in law, relevant conditional precedents, and milestones.

With regards to GGR and power BECCS business models, respondents specifically highlighted the need to accurately measure CO_2 along the NPT value chain and account for transport emissions to ensure that the GGRs represent a genuine reduction of CO_2 from the atmosphere.

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)?

Question 22 received 45 responses.

13 respondents agreed that there should be consistency between capture BMs. Respondents in favour of maintaining consistency between business models highlighted the importance of cross-chain risk protections being consistently available across the business models.

32 respondents agreed that there should be consistency between NPT users and piped users within a specific business model as this would help create a level playing field. Respondents noted that NPT users and piped users accessing the same business model would be competing in the same market and therefore consistent support was needed to prevent market distortions resulting in one CO_2 transport method being favoured. The simplicity of only having to engage with one set of policies was also highlighted as a benefit of maintaining consistency.

While noting the support for consistency within business models, 3 respondents reiterated that consistent outcomes could be a better focus, and this approach may involve different levels of support being provided to NPT users and piped users.

2 respondents suggested that an alternative approach would be to maintain consistency within each archetype rather than within each business model.

Future allocation processes

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

Question 23 received 53 responses.

36 respondents indicated that assessing NPT solutions against pipeline solutions would raise concerns. 10 respondents indicated that they would not have any concerns with competing against piped projects.

22 respondents stated that they were concerned about NPT solutions being assessed against pipeline solutions predominantly on a cost basis due to NPT solutions being more expensive. 4 respondents also proposed that some money should be ringfenced for NPT projects, separate from pipeline solutions so that they are not in direct competition against one another.

Respondents suggested that a broader range of factors, beyond cost, should be considered when assessing NPT solutions against pipeline solutions. The following evaluation criteria were suggested:

- **Wider decarbonisation benefits**: either for other local emitters or for dispersed sites with no other alternatives

- **Local economic benefits:** securing local industrial jobs
- **Contribution to the development of a self-sustaining NPT and CCUS sector:** as outlined in the CCUS Vision

Respondents highlighted that both NPT and pipeline solutions each have unique advantages and should be seen as complementary rather than competitive. Respondents also noted that sometimes NPT solutions would be the only viable solution for certain sites and that should be considered during future allocation.

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

Question 24 received 36 responses.

Respondents suggested a variety of factors which should be considered when assessing NPT value chains under different archetypes. As with question 23, 26 respondents suggested that cost should only form one part of the assessment of NPT value chains. Respondents suggested the following areas which could be used as part of a broad framework for assessing NPT value chains from different archetypes:

- **Cost considerations**: respondents suggested that when costs are compared this should be done on a full-chain or like-for-like basis to ensure a fair evaluation
- **Decarbonisation impact:** respondents suggested that net emissions reductions could be used to compare projects as well as considering the impact of not decarbonising existing facilities
- **Deliverability:** technical feasibility of a project and likelihood of completing projects within set timescales and budgets were suggested as factors to consider when assessing deliverability
- **Societal benefits:** wider regional benefits such as job retention/creation and support for key industries were given as examples of wider societal benefits that could be assessed

Respondents also mentioned flexibility and scalability of projects as well as government's risk exposure as other factors to consider when assessing NPT value chains.

2 respondents noted the challenges of comparing NPT value chains from different archetypes given that the NPT costs would be included in different parts of the value chain depending on the archetype.

Cross-border CO_2

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

Question 25 received 47 responses.

45 respondents agreed with the potential vision for cross-border CO_2 T&S networks, as outlined in the call for evidence. This included 8 respondents who highlighted the importance of leveraging the UK's potentially vast subsurface storage capacity to establish a robust network. 2 respondents did not outline a clear opinion on the vision. However, 1 respondent raised concerns about the risk of UK de-industrialisation if the ability to store domestic CO_2 volumes was put at risk by the import and storage of international CO_2 volumes.

26 respondents emphasised the importance of importing volumes of CO_2 from EU countries, highlighting that this approach could be a means to higher utilisation of T&S infrastructure, improved system resilience, boosting economic growth and lowering unit costs for UK capture projects. Additionally, a competitive storage market was seen by 24 respondents as important to drive down costs, increase competition and scale up decarbonisation across the region. Although, it was noted to achieve this it would be important to ensure compliance with international standards around CO_2. However, concerns were raised by 1 respondent about establishing such a network due to the potential additional upfront infrastructure costs, reliance on international capture facilities, and increased cross-chain risks.

5 respondents encouraged the government to secure a leadership position for the UK in the international CO_2 T&S market. 11 respondents highlighted the need for political agreements and regulatory solutions to unlock the market potential of cross-border CO_2 networks. The legislative and economic disconnect between the UK Emissions Trading Scheme (ETS) and EU Emissions Trading System (ETS) regimes was also identified as a hindrance by 9 respondents, with many calling for alignment of CCUS storage standards between the UK and EU.

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?

Question 26 i) received 24 responses.

16 respondents agreed that the economic licensing framework needs to evolve to accommodate cross-border CO_2 T&S networks. 13 respondents thought that importing cross-border CO_2 volumes into regulated T&S infrastructure should remain a non-economically regulated activity. These respondents stated that these activities should be handled on a commercial/merchant basis to support market development.

7 respondents highlighted the importance of promoting open-access infrastructure in the framework, with 1 respondent reiterating the importance of adjusting the economic licensing framework to account for co-mingled CO_2 volumes in the same store, i.e. CO_2 captured within the TRI model and from a potentially non-regulated EU import market.

3 respondents were particularly keen to stress the need for strong collaboration with the EU, including to develop commonly recognised delivery and storage certification, and align CO_2 standards, regulations, and specifications for international CO_2. 1 respondent highlighted the strong interest from EU emitters in accessing storage options in the UK with 2 respondents emphasising the need for flexibility in policy and regulatory systems to maximise efficiency.

Question 26 ii) received 25 responses.

There was a wide variety of views expressed in relation to this question. 6 respondents expressed the need to protect domestic CO_2 volumes from being priced out of UK infrastructure by international volumes, with 3 respondents stressing the importance of valuing both equally. Nevertheless, 1 respondent reiterated that there is sufficient capacity in the UK Continental Shelf to manage both sets of volumes.

3 respondents emphasised the need for simplified and/or harmonised regulatory mechanisms that reflect the additional logistical and regulatory complexities of international transport and create an attractive commercial basis for EU emitters. 2 respondents suggested T&S elements may need to be separated out into domestic and international infrastructure to encourage new entrants to the market. 1 respondent also highlighted the need to avoid double taxation on international volumes with 1 other respondent suggesting they be included in the UK CBAM.

8 respondents highlighted the advantages of cross-border networks in creating a competitive market, including increased network utilisation, reduced costs, and economic benefits. 1 respondent also discussed the reduced investment and stranded asset risk, and reduced need for the Government Support Package (GSP). 1 respondent cited the need to focus on cost allocation and cost liabilities. This included the need for cost allocation methodologies to support the non-regulated approach in the TRI model for cross-border networks and a flexible mix of methodologies being appropriate to benefit domestic and international customers.

Question 26 iii) received 21 responses.

All 21 respondents were broadly in agreement that cross-chain risks in a cross-border T&S network could be managed on a commercial basis by service providers. This was highlighted in comments from 6 respondents that long-term contracts between emitters and storage providers ensured stable and predictable revenue streams with established risk allocation. It was also mentioned by 2 respondents that being free to enter commercial arrangements gives choice and benefit from competition. Respondents proposed managing risks through comprehensive contractual agreements (12 mentions), insurance mechanisms (3 mentions), comprehensive risk assessments (1 mention), contingency plans (1 mention), and third-party logistics experts (1 mention) to handle cross-border operations efficiently. It was also mentioned by 1 respondent that being free to negotiate the terms and manage the allocation of risk between entities would deliver the most efficient commercial solution and that fostering strong partnerships with stakeholders across the value-chain will enhance risk management and operational resilience.

2 respondents pointed out that there may be certain risks which cannot be adequately borne by merchant service providers, such as the long-term liability of CO_2 storage risk. In this case, it was posited there could remain a need for government support until a more mature commercial insurance market develops.

Other risks mentioned by 5 respondents include CO_2 standards and specifications, with common standards between the UK and EU being helpful to manage risk. Another was market risk mentioned by 4 respondents, which included uncertainties and potential financial losses caused by fluctuations in domestic and international CO_2 markets. Among these, 1 respondent stated that multi-source, multi-emitter aggregation was one defence against the commercial risks inherent in an international merchant NPT delivery/sequestration model.

Question 26 iv) received 12 responses.

All 12 respondents agreed that the current suite of capture business models would need to be adapted to accommodate CO_2 cross-border T&S networks. Respondents expressed a range of views, emphasising:

- the need for viable models that reflect merchant economics and the impact of an additional revenue stream to the TRI model
- that an evolution to such models would only be required for CO_2 exports to support the transition to a market-led economic model
- that a disposal chain model is more appropriate for CO_2 because of its low to zero commercial value
- that non-UK capture plants could contract with UK 'import companies' who become the users of the T&S network
- import volumes could form a pathway to a subsidy-light market contributing to mutualisation at T&S stores

Respondents also expressed some concerns, including:

- additional costs to UK taxpayers and subsidy flow to international emitters
- the need for prioritisation in T&S capacity and mechanisms for penalties and damages, as well as greater value-chain benefits
- leakage risks and a need to address long-term liability, point-of-liability transfer, charging arrangements for insurance, international protocols, and coverage fees from EU customers

27. With regard to Question 20, do you think any changes will be required to the CCS Network Code to ensure cross-border CO_2 T&S networks can be established?

Question 27 received 24 responses.

22 respondents thought that changes to the CCS Network Code are necessary to accommodate cross-border CO_2 T&S networks and 1 respondent said no are necessary as NPT standards for CO_2 streams would already comply with pipeline specifications. Another respondent (1) said the code would not need apply to operators of a cross-border CO_2 pipeline granted exemption from the Energy Act 2023.

10 respondents highlighted the need for standardisation of CO_2 specifications to enable cross-border interoperability from a variety of sources. 3 respondents emphasised that these should be aligned with international standards and that this is a crucial action that can be worked on now. 1 respondent noted that the CO_2 specification for NPT would be more stringent than the specification for the UK piped networks.

Another topic raised by 5 respondents was separate charging structures for international volumes based on different network usage. This included a comment from 1 respondent who mentioned that such charges could include T&SCo decommissioning and corrective measures to ensure all users are paying a fair share.

Managing capacity through the CCS Network Code was another change suggested by 4 respondents. This included comments on allocation, prioritisation, operating constraints, optimisation, competition for access, and contingents for overcapacity. These were discussed by respondents in more detail in the context of NPT in Question 20, summarised in the 'Network use and capacity' section**.** 3 respondents expressed the need for the Code to manage non-UK volumes delivered into UK systems without adversely impacting opportunities for domestic CO_2 volumes, as well as providing guidelines for potential pipeline and storage site repairs from international volumes.

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?

Question 28 received 36 responses.

35 respondents broadly agreed that enabling NPT and cross-border users would significantly incentivise storage exploration and appraisal activity by expanding the market for CO_2 storage services, increasing demand, and providing an incentive for current and future licence applicants to deliver more storage resources. They highlighted that this would inherently increase demand for storage as volumes increase, and that the pace of CO_2 storage appraisal activity and development in the UK will inevitably be a function of demand from prospective users.

10 respondents suggested that access to cross-border CO_2 volumes and NPT options could provide the economic incentive and viability for the development of such stores. 17 respondents noted that reductions to the perceived risk and enhancement of the potential return on investment would increase investor confidence. 6 respondents also proposed that establishing capability for CO_2 transport by ship in the UK would add resilience to the CCUS system by creating flexibility, fostering competition, and reducing emitters' dependency on specific stores. They also note that demand needs to be underpinned either by UK or EU government contracts or because the carbon price is high enough to cover the cost of CCUS.

6 respondents emphasised the need to address the regulatory framework around licensing of carbon stores to incentivise private entities to undertake storage exploration and appraisal activity. They also highlighted the need to harmonise regulatory frameworks and ensure interoperability between different nations.

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?

Question 29 received 31 responses.

28 respondents believed that a store solely reliant on NPT users could be viable, citing examples like the Northern Lights project in Norway. However, 1 respondent still expressed concerns about the risk of uncertain and variable costs, and variable demand associated with NPT solutions and the risk of the early stage of development of such projects.

5 respondents highlighted technical challenges such as ensuring consistent CO_2 quality, managing variable delivery schedules, and maintaining the integrity of CO_2 during transport. Others suggested that these challenges can be addressed through measures like intermediate storage (5 mentions), contingency planning (1 mention), and robust contractual arrangements (1 mention).

3 respondents mentioned the operating model may increase the risk profile due to dependency on multiple transport modes and potential delays. However, 1 respondent suggested that these risks can be mitigated through standardised measurement and monitoring practices.

4 respondents discussed the potential need for a regulatory framework around unbundling and adaptations to the TRI model to enable such stores. This was reiterated by 3 respondents who raised the potential need for government support should there not be a robust carbon price incentive for investment.

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.**

Question 30 received 22 responses.

21 respondents believed that shipping CO_2 straight to the wellhead for injection is technically feasible and could offer benefits such as reduced infrastructure costs and flexibility in storage site locations. However, 11 respondents also pointed out that despite being technically feasible this method has not been fully demonstrated or costs proven, and that it has a low technology readiness level for full value chain solutions.

Respondents detailed numerous risks and challenges associated with this method. These included:

- the need for conditioning the CO_2 prior to injection and the technical challenges associated with heating offshore
- the risk of intermittent CO_2 delivery to constant injection flow rates and hence the need for offshore buffer storage
- the potential CO_2 losses during transfer and the need for specialised docking and injection facilities
- potential risks associated with the flexible connection between the fixed structure and the moving ship, and the potential for water ingress from some connection systems
- associated systems being susceptible to harsh weather and metocean conditions, potentially disrupting transport schedules

Respondents also detailed the benefits of shipping CO_2 straight to the wellhead for injection. These included:

- bypassing onshore bottlenecks and providing direct access to offshore storage sites, potentially reducing overall costs, and increasing storage options
- reducing the scale of land-based facilities required, such as CO_2 import terminals and storage tanks, and the potential for faster deployment

4 respondents drew attention to Denmark's Project Greensand and the Northern Lights project in Norway that may demonstrate the viability of this method.

Wider deployment considerations

This section seeks to gather insights on the deployment of NPT value chains and the necessary changes within the CCUS policy landscape. The section is divided into three sections: other regulatory controls, delivery, and further comments.

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)?**

Question 31 received 31 responses.

The following regulations were noted by respondents, as regulations to consider and/or amend for NPT value chains to deploy:

- national planning, permitting and consenting processes – to ensure these regulations continue to align with CCUS priorities
- Control of Major Accident Hazard (COMAH) and Pipeline Safety Regulations (PSR) – to provide clarification on whether CO_2 is or is not a dangerous substance or fluid
- Emission Trading Scheme (ETS) – to ensure necessary adaptations to account for NPT-related emissions and negative emissions
- The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 – Clarification on how movement of CO_2 by road would apply
- Highways Act 1980 – for relevant NPT road projects
- National Policy Statements for Energy (e.g. EN-1) - to ensure they are expanded to include NPT solutions
- End of Waste criteria – clarity is required on relevant application to carbon storage
- International Convention for the Prevention of Pollution from Ships – to consider for relevant NPT shipping projects
- Section 17 of the Energy Act 2008: the use of a controlled place for the storage of CO_2 on both a permanent and interim basis is prohibited without a licence – clarity is required on application process
- HSE Regulations linked to offshore maritime infrastructure:
  - Health & Safety at Work Act (1974)
  - Offshore Installations (Offshore Safety Directive) (Safety Case etc) Regulations (2015)
  - Offshore Installations (prevention of Fire and Explosion and Emergency Response) Regulations 1995
  - Offshore Installations and Pipeline works (management and Administration) regulations (1995)
  - Offshore installations and wells (design and construction) regulations (1996)

32. Do the current processes to comply with existing health and safety or environmental regulations or controls create barriers to NPT deployment when transporting CO_2 via road, rail, barge, ship, or processing CO_2 at intermodal facilities? If so, what are those barriers, and what would you suggest as an alternative?

Question 32 received 28 responses.

18 respondents stated that current processes to comply with existing health and safety or environmental regulations or controls do not create barriers to NPT deployment. Respondents did however seek clarification around the categorisation of liquid CO_2 for transportation by the

Health and Safety Executive (HSE) and under the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009.

5 respondents did note barriers linked to current processes around health and safety or environmental regulations. These included:

- administrative burden, cost of compliance and complexity of existing regulation, with harmonisation of regulatory and legislative frameworks suggested as a remedy to this issue
- concerns around overly conservative conclusions from safety studies due to a more conservative approach taken under HSE Land-Use Planning regulations around the frequency of catastrophic rupture of a storage sphere compared to other jurisdictions

More broadly, 6 respondents highlighted the need for sufficient regulatory capacity to ensure NPT projects receive their permits and comply with health and safety and environmental regulations in a timely manner. 2 respondents highlighted that there is a role for government to play in tackling the public perception of CO_2 to ease local planning constraints.

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?

Question 33 received 31 responses.

Respondents detailed a variety of changes to support the development of cross-border CO_2 T&S networks. 12 respondents raised the legislative and economic disconnect between the UK ETS and EU ETS regimes as a significant barrier. They highlighted the need for mutual recognition of cross-border CO_2 volumes stored in respective jurisdictions as legitimate abatement in both regimes, as well as leakage and associated price liability. Respondents stressed the importance of a timely and workable solution to support the development of cross-border CO_2 T&S infrastructure.

10 respondents also raised the need for entering bilateral agreements with neighbouring countries under the London Protocol as essential for the development of cross-border CO_2 T&S networks. This included some comments from respondents on amendments to address 'dumping' of CO_2 at sea, and the status of CO_2 as a waste product. 2 respondents also recommended reviewing and expanding the National Policy Statements for Energy to include NPT solutions.

Many respondents raised the need for more efficient permitting (9 respondents) and consenting (4 respondents) processes for cross-border projects that are seen as inadequate and under-resourced. Respondents called for a separate permitting regime, streamlined processes, and increased capacity. Fast-tracking the permitting process and reducing the number of agencies involved are also recommended to improve project timelines and investor confidence.

Additionally, 1 respondent discussed the potential future inclusion of CO_2 under the Control of Major Accident Hazards Regulations (COMAH), with 4 other respondents mentioning the need for economic licence exemptions.

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

Question 34 received 32 responses.

25 respondents raised the misalignment between the UK ETS and EU ETS regimes as a significant barrier. Respondents stressed the need for alignment and mutual recognition of CO_2 emissions reductions through storage under both regimes. Respondents highlighted that the lack of such alignment undermines investment decisions and the development of cross-border CO_2 T&S networks.

19 respondents mentioned the London Protocol as a barrier to cross-border CO_2 T&S networks. Respondents pointed out that the Protocol's current provisions prohibit the export of CO_2 for sub-seabed storage and that it is important to facilitate the provisional application of amendments to the London Protocol and establish bilateral agreements to allocate permitting responsibilities.

The need for harmonised standards across jurisdictions was also raised by 6 respondents. Respondents advocated for international cooperation to develop standardised regulations and streamlined permitting processes, noting that compatibility and interoperability of standards would facilitate cross-border CO_2 movement and project implementation.

Delivery

35. What are your views on the best approach to creating interoperable CCUS networks?

Question 35 received 30 responses.

23 respondents emphasised the need for a unified set of standards for CO_2 quality, pressure, and temperature to ensure compatibility across different regions and systems. This included establishing common specifications for impurity limits, operating conditions, and materials used in equipment, as well as monitoring and metering to enable accurate reporting and assignment of CO_2 emissions. Respondents mentioned that such standardisation, interoperability, and collaboration between international partners would facilitate more efficient operations across the value chain, reduce risks, and simplify international safety regulations.

A variety of other issues were raised by respondents for efficient interoperable CCUS networks including considerations for shipping, charging structures, multiple entry and exit points, consistent approaches, and early standard-setting.

5 respondents also advocated for collaboration between national and international entities to harmonise CCUS schemes and develop aligned regulatory and commercial frameworks. 2 respondents discussed creating forums for knowledge sharing and to address technical challenges and identify barriers to implementation.

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?

Question 36 received 33 responses.

Respondents gave a variety of views on the design for CO_2 standards and specifications, with all 33 respondents broadly in agreement that standardisation was required in some capacity. Respondents highlighted several technical specifications that may require common standards, including CO_2 quality, impurities, pressure, temperature, containment, final injection, key network component material composition, and connectors.

8 respondents emphasised the importance of considering the entire value chain when determining appropriate standards, including cost implications across the chain to avoid making participation uneconomical. 7 respondents highlighted the need for flexible standards design, whilst also maintaining safety and protecting infrastructure.

10 respondents emphasised that UK standards should be aligned with the EU or internationally with an EU focus, and that government should be engaging in regulatory cooperation to develop a Europe-wide CO_2 transport standard.

Some respondents highlighted the importance of collaboration in developing standards, with 4 respondents suggesting the establishment of forums and/or advisory boards to share technical knowledge and identify barriers. This included 4 respondents who mentioned various European Committee for Standardisation's (CEN) Technical Committees.

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.

Question 37 received 31 responses.

28 respondents identified a variety of limitations with 3 respondents believing there were no technical limitations or no limitations at all.

In terms of operational limitations, 13 respondents identified the lack of comprehensive standards for CO_2 specifications, highlighting also the impact on metering and monitoring, and the barrier posed by any potentially different entry specifications between clusters. 1 respondent, however, did suggest no changes to standards for imported CO_2 volumes were needed where these met either NPT-standards or existing standards like ISO 27913:2024.

A variety of infrastructure-related issues were identified by respondents for technical and operational limitations. These included:

- limited construction capacity for building both onshore and vessel CO_2 storage tanks
- global shipbuilding capacity, sizing constraints around vessels and port upgrades
- added investment from oversizing buffer storage for consistent injection pressure to stores
- gaining critical mass of users before effective start-up of the network

Other operational limitations mentioned by respondents included economic and logistical challenges. Some respondents pointed out the risks of extended timelines, including delays in the FID process, and escalating prices for CO_2 carrier construction, unit cost and project management timing challenges for domestic NPT, and the potential for higher operational costs due to increased train quantities to avoid constraints. Misalignment of technical and regulatory frameworks, and non-recognition of permits were also mentioned.

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?

Question 38 received 30 responses.

25 respondents highlighted various foundational infrastructure requirements for the UK's storage offer. 9 respondents highlighted the need for new or upgraded port and shipping infrastructure, such as jetties (to allow for the transfer of captured CO_2) and terminals to handle CO_2 volumes. 7 respondents mentioned the need for rail infrastructure and 4 respondents for road infrastructure.

9 respondents highlighted the need for buffer storage to be in place and 2 respondents also mentioned the need for intermodal transport facilities. Different types of offloading and loading facilities were also mentioned (6 respondents), primarily rail and ship. Other respondents mentioned the need for pipeline reception or connection equipment (4 respondents). 2 respondents also mentioned faster licensing, certification, permitting, and approvals to enable the pre-use of existing infrastructure.

Other prioritised requirements mentioned included emergency service preparations for uncontrolled escapes of CO_2, sufficient electricity supply to ports, potential new stores, and government support for FEED and pre-FEED activities.

39. Do you foresee any infrastructure innovations which could speed up the deployment of NPT and cross-border T&S networks and/or reduce associated costs? Please provide any supporting evidence.

Question 39 received 27 responses.

24 respondents highlighted various technological advancements that could accelerate the deployment of NPT and cross-border T&S networks with only 3 respondents believing no technology was required.

Respondents emphasised potential future infrastructure innovations in interim and multi-modal storage (5 respondents), liquefaction (4 respondents) including onboard liquefaction, loading, and unloading equipment (4 respondents) including standards and automation for rail, low pressure carriage for larger carrying capacity (4 respondents), multi-lobe cargo tanks (3 respondents), and floating infrastructure (2 respondents). Re-purposing and re-using existing infrastructure were also mentioned by 3 respondents.

Respondents also identified innovations in non-infrastructure related technologies, such as faster licensing, certification, permitting and approvals (4 respondents), regulatory and commercial frameworks (4 respondents), digital tools for monitoring and design (4 respondents), and CO_2 aggregation hubs for cost sharing (2 respondents). Thermal plasma electrolysis was also mentioned by 2 respondents who highlighted the potentially reduced need for NPT solutions via the cheaper transportation and sequestration of its solid carbon product.

40. What are your views on other flexible users of CCUS networks, e.g. flexible use of technologies such as DACCS? Do you foresee that NPT and buffer storage could be complimentary to operate alongside a flexible piped user (e.g. projects that could ramp up or ramp down CO_2 output, potentially including technologies such as DACCS)?

Question 40 received 35 responses.

15 respondents agree that DACCS and NPT CCS can be compatible, especially when DACCS equipment is located near NPT transportation. Flexible users of CCUS networks, including DACCS, can complement NPT and buffer storage by providing additional CO_2 sources.

However, there was some uncertainty about whether DACCS is best suited to operate flexibly or as a baseload user. Some believe DACCS should operate continuously due to its revenue model, while others see operational flexibility as beneficial.

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?

Question 41 received 40 responses.

22 respondents agreed the UK possesses the relevant skills and capabilities to deliver NPT, particularly in engineering, logistics, and regulatory compliance. Respondents highlight the UK's significant experience in oil, gas, and LNG, which can be leveraged for CCUS.

Respondents also agreed that the UK has a competitive advantage in delivering NPT solutions due to its extensive experience in offshore Exploration and Production (E&P) operations, geographical advantages, and vast offshore storage potential. Additionally, the UK excels in ship design, classification, and insurance.

From the respondents who did not agree the UK had the relevant skills and capabilities to deliver NPT, concerns raised included that there was a lack of manufacturing capability. Respondents cited the UK currently lacks enough skilled individuals to deliver the necessary infrastructure for the net zero transition including manufacturing compressors, pumps, and large pressure vessels.

There is a strong consensus among respondents that clear government policy and investment are crucial for the UK to maintain its competitive advantage in NPT.

Further comments

42. What other areas should government be considering for successful deployment of NPT?

Question 42 received 27 responses.

To ensure the successful deployment of NPT, respondents have highlighted having government protections whilst NPT value chains develop. This is to promote competition and investability with protections reducing as NPT markets move to becoming self-sustaining.

Respondents have also said it is crucial that government provides signals for future licensing rounds and design regulations that anticipate future needs and challenges as NPT develops.

Increasing onshore liquid CO_2 storage capacity and ensuring sufficient storage for NPT operators are key concerns raised by respondents. Respondents stress the need for adequate infrastructure to support the development of NPT projects. Considering this, 2 respondents suggested co-locating LNG gasification and CO_2 liquefaction facilities with the possibility of significant energy and cost efficiencies. Respondents advocate for the government to consider the benefits of co-location, which can result in cost savings and schedule benefit.

43. Please respond with any other comments that are not contained in the above questions.

Question 43 received 27 responses of which 13 provided additional context relevant to the aims of the call for evidence not contained in previous questions.

1 respondent raised that the future assessment criteria should favour projects that deliver system resilience, enable wider CCUS rollout, and increase competition.

1 respondent specified that the UK government should prioritise enabling new infrastructure at existing stores. Acknowledging this focus may lead to slightly lower CO_2 capture targets in the short term, they specified that infrastructure will continue to develop naturally with a sufficient carbon price to lay the foundation for rapid, self-sustained long-term growth.

Another 1 respondent also emphasised the importance of developing sufficient offshore carbon dioxide storage through licensing rounds, run by the NTSA, to ensure effective market development. They also highlight the significance of unbundling the T&SCo licence to create opportunities for separate transport companies (TCos) and T&SCos, leading to the development of cross-border CO_2 networks.

Conclusion and next steps

The call for evidence set out to gather views and feedback to assist with the development of the future policy framework for non-pipeline transport and cross-border CO_2 networks. There were several key themes emerging from the analysis of responses:

- **Overwhelmingly, it was made clear that NPT is a necessity for the successful expansion of CCUS across the UK:** the reasons cited for this included that NPT would accelerate decarbonisation and expand CCUS to more regions of the UK, support the transition to a self-sustaining CCUS market and deliver flexibility and resilience to existing CCUS networks
- **Cross-border networks will play a vital role in delivering economic benefits, increasing storage appraisal activity, and supporting deployment of domestic CCUS projects:** but these benefits can only be unlocked with consistent CO_2 standards, political agreements and overcoming regulatory barriers
- **There is a high level of interest in NPT from a range of stakeholders and information was provided on a range of projects representing significant volumes of CO_2 that are ready to be captured from the end of 2030:** significant progress has been made by industry on developing a variety of technical solutions across shipping, road and rail
- **There was a clear call for fairness in assessing NPT projects:** government should consider the wider value offered by NPT when comparing potential projects to pipeline alternatives
- **NPT deployment will require a number of changes across business models, the CCS Network Code and the T&S economic licence:** but industry have signalled that they would like to freely organise themselves in a way that allows them to manage risk appropriately
- **High capital and operational costs were cited as a potential barrier to NPT deployment, alongside other challenges including the uncertainty on long-term CO_2 supply for stores and planning and consenting processes impacting delivery timelines:** domestic NPT projects stated a greater need for government support than those considering merchant imports

Next steps

Respondents called for greater clarity to allow projects to mature. Government therefore intends to publish a consultation on NPT in H2 2025, intending to cover support for NPT costs, risk allocation and economic licensing.

We will continue to engage with industry in the run up to the consultation, through a series of workshops.

For cross-border CO_2 T&S networks, we will be carrying out separate engagement to better understand the opportunities to accelerate the deployment of associated projects in the UK, recognising the desire to move towards a self-sustaining market.

If you would like to be added to the distribution list for future NPT-related communications, please email NPTandCrossBorderCO2@energysecurity.gov.uk.

The government would like to thank all respondents to this call for evidence. The views and evidence provided will continue to help government develop future NPT policy and wider CCUS policy.

This summary of responses is available from: www.gov.uk/government/calls-for-evidence/carbon-capture-usage-and-storage-ccus-non-pipeline-transport-and-cross-border-co2-networks

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