NESO
National Energy System Operator

Networked Carbon

Market design overview developed by NESO Whole Energy Markets Team

June 2025

Note: This guidebook focuses on carbon dioxide as a waste product (capture, transport and storage) and not carbon markets (UK ETS)

Market design guidebook developed by NESO Whole Energy Markets Team

Market design overview:

We have developed market design guidebooks to outline the current market structure and existing policy across each vector. They reflect our deconstruction of holistic market design into its principal component parts, in order to comprehensively represent the status quo design for each vector. This was our first step towards a comparison of holistic market design across the five vectors in our scope to explore opportunities for greater coordination across energy markets. For the avoidance of doubt, the guidebooks' purpose is to depict existing market design and policy, rather than to recommend future changes.

We intend for these vector guidebooks to serve as a point of reference for participants across the energy industry, to share understanding of how markets are structured and outline the latest policy developments as of publication date Q2 2025.

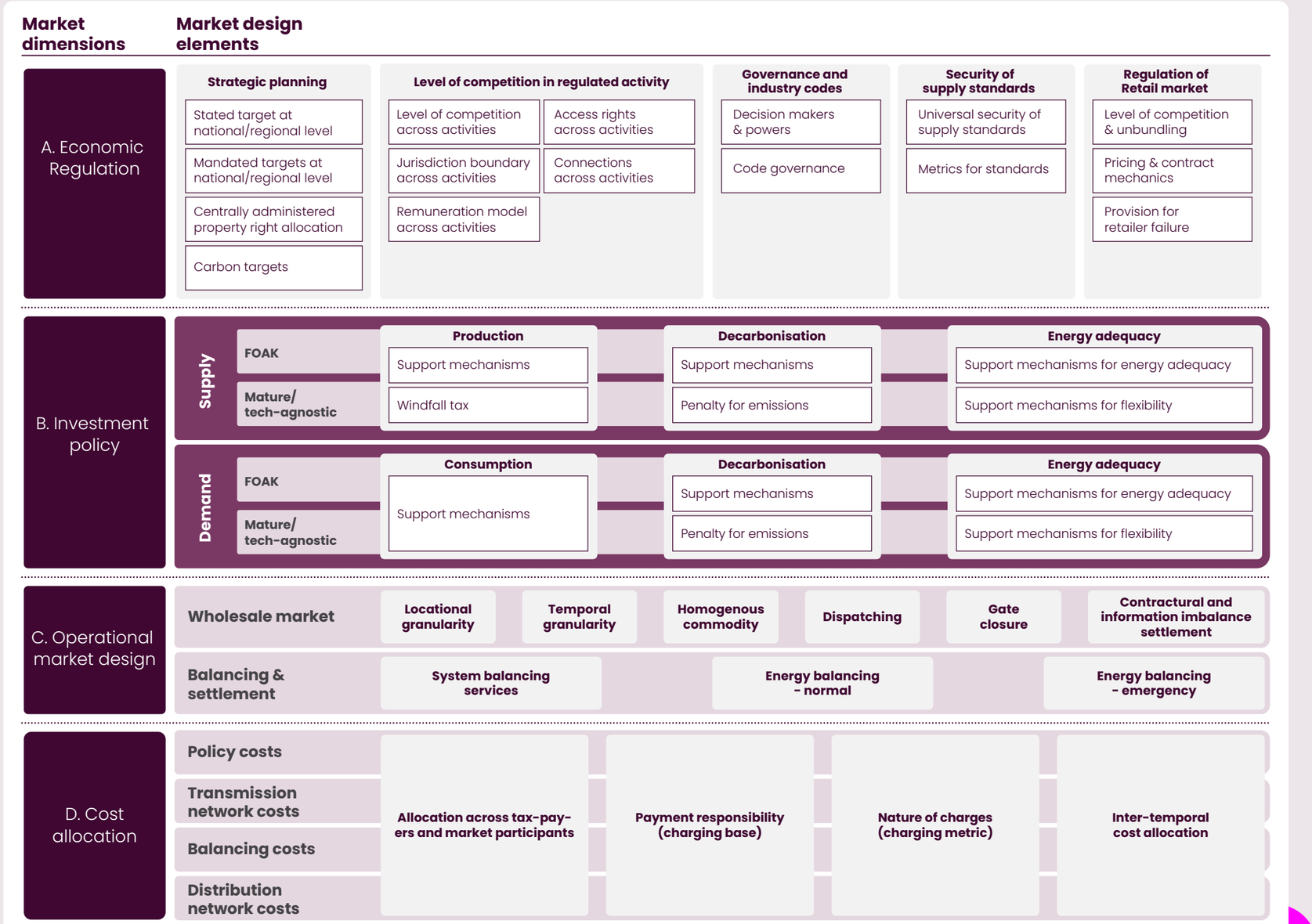
Our Market Design framework is made up of four key dimensions as set out below, and this framework forms the structure of each market design guidebook:

A. Economic Regulation: Structure of the energy market across vectors, value chains and market participants.

B. Investment policy: Market interventions employed to achieve specific policy objectives.

C. Operational market design: The structure of wholesale and short-term operational energy markets to match physical supply and demand.

D. Cost allocation: Cost recovery for networks and investment policy.



Contents

A. Economic Regulation: Structuring of the energy market across vectors, value chains and market participants

Central planning:
Level of government intervention in planning of infrastructure, further specified through the existence of regional & national, capacity or production targets, carbon targets, & centrally administered property right allocation.

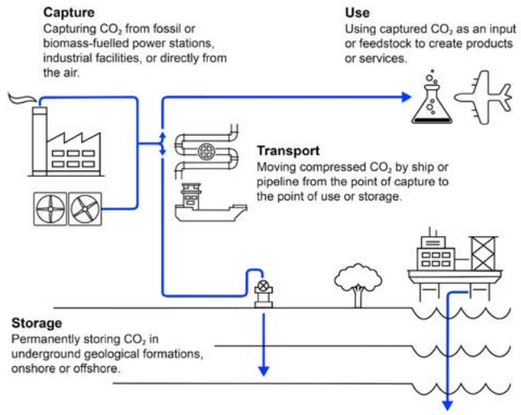
Brief history of Carbon Capture and Storage

We define networked carbon as a distinct market facilitating the capture, and subsequent transportation and sequestration (permanent storage) of carbon dioxide (CO_2) as a waste product. The development of carbon networks, initially via the delivery of industrial clusters, will underpin many decarbonisation technologies and efforts, including electricity generation and the production and use of hydrogen for fuel switching.

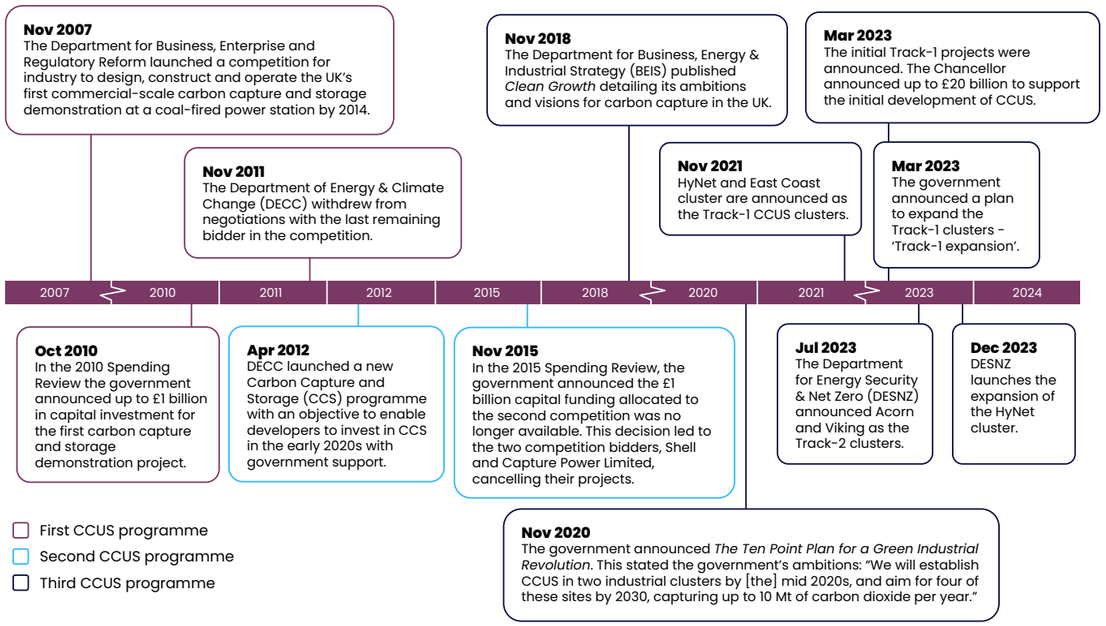
Carbon Capture and Storage (CCS) technologies have evolved significantly since their inception in the 1970s. Initially proposed to enhance oil recovery [EOR], the first large-scale EOR project began in Texas in the 1970s. The 1980s saw growth in research and pilot projects, leading to the first commercial-scale CCS project, Sleipner, in the Norwegian North Sea in 1996. The 2000s brought greater focus and investment, with the Intergovernmental Panel on Climate Change highlighting CCS as a key climate strategy, and the EU launching supportive initiatives. In the 2010s, significant power generation projects like Canada's Boundary Dam and the US Petra Nova project demonstrated the viability of CCS for coal-fired power generation. In 2017, the government announced its ambition for the UK to become a global technology leader for CCUS in the Clean Growth Strategy. By the 2020s, increased investments and supportive policies aimed to scale up CCS infrastructure globally and enable integration with low carbon hydrogen production. The UK's Net Zero Teeside project aims to be the world's first gas-fired power plant with CCS, with start-up in 2028.

What is CCS

IEA 2021



Carbon Capture, Usage and Storage development in the UK 2007 to 2024, National Audit Office, 2024



Overview of CCS in the UK

In 2012, the Department of Energy and Climate Change released the UK's first Carbon Capture and Storage (CCS) Roadmap, outlining the government's plan to establish a leading CCS industry by the 2020s. This roadmap included the CCS Commercialisation Programme, a competition designed to reduce costs by funding practical experience in the design, construction, and operation of commercial-scale CCS projects. The programme offered £1bn in capital funding and additional support through low carbon Contracts for Difference, subject to affordability. However, in 2015 the CCS Competition closed, when the £1bn capital budget for the CCS Competition was confirmed as no longer available in the November 2015 Autumn budget.

White Rose CCS: Proposed in 2012 by Capture Power Limited and located at the Drax power station site in North Yorkshire, it would have been the first coal-fired power plant to demonstrate CCS. In 2016, the Secretary of State refused development consent as the project would need funding support from the [closed] Government`s CCS Commercialisation Programme.

Peterhead CCS (up to 2015): The Peterhead (North-East Scotland) CCS project was poised to become the world's first commercial-scale demonstration of post-combustion CO_2 capture, transport, and offshore geological storage from a gas-fired power station. It aimed to capture around one million tonnes of CO_2 per annum over up to 15 years from an existing 400 MW combined cycle gas turbine (CCGT) at SSE's Peterhead Power Station in Scotland. Although the project completed Front-End Engineering Design (FEED) in 2015, it was cancelled the same year due to the UK Government's withdrawal of funding for the UK CCS Commercialisation Competition.

Peterhead CCS (2021): SSE Thermal and Equinor unveiled plans to jointly develop a new low-carbon power station at Peterhead. Peterhead CCS Power Station is planned to be a new 900MW gas-fired power station fitted with carbon capture technology to remove carbon dioxide from its emissions.

SSE Thermal and Equinor project would be Scotland's first power station with carbon capture and storage

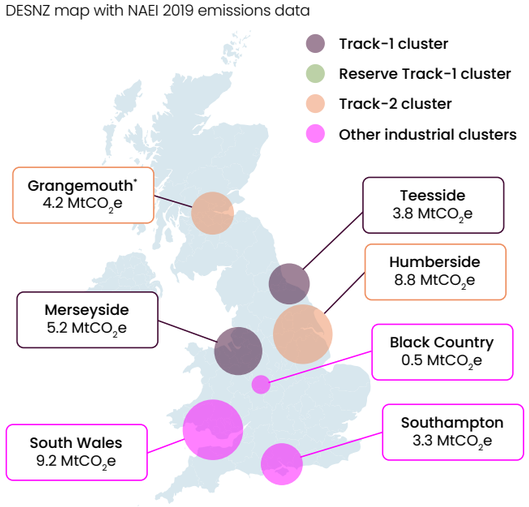
Equinor, 2022

Cluster Sequencing Approach for CCS

As part of the 2020 Ten Point Plan for a Green Industrial Revolution, the previous government set an ambition to deploy CCS in two industrial clusters by the mid-2020s, and an additional two clusters by 2030, with the goal of capturing 20-30 $MtCO_2$ per annum by 2030. The cluster sequencing process aims to map a logical path for CCS deployment in the UK, with industrial CCS clusters as the starting point for a new carbon capture industry with a sizeable export potential.

Major UK industrial cluster emissions

DESNZ map with NAEI 2019 emissions data



* The Scottish cluster links the Acorn project in North-East Scotland to the Central Belt in Southern Scotland.

The Track-1 Cluster Sequencing Process launched in 2021 with the East Coast Cluster (Teesside) and HyNet Cluster (Merseyside) selected as the first two clusters in the UK. In 2023 DESNZ announced Acorn (North-East Scotland) and Viking (Humberside) as the Track-2 clusters.
The Scottish Cluster brings together Acorn, National Gas Transmission's SCO_2T Connect Project (a pipeline repurposing project which links the Central Belt with North-East Scotland) and a variety of industrial, power, hydrogen, bioenergy and waste-to-energy businesses.

Track-1 Project Negotiation List - DESNZ

In October 2024 the current UK government confirmed up to £21.7bn funding available over 25 years to be allocated between the two Track 1 clusters. The Track 1 clusters include five projects (two T&S network projects, and three emitter projects).

HyNet Cluster:

- Eni's Liverpool Bay CO_2 transport and storage system.
- EET Hydrogen's 350-MW HPP1 CCS-enabled hydrogen plant.
- Protos' CCS-enabled energy from waste facility.

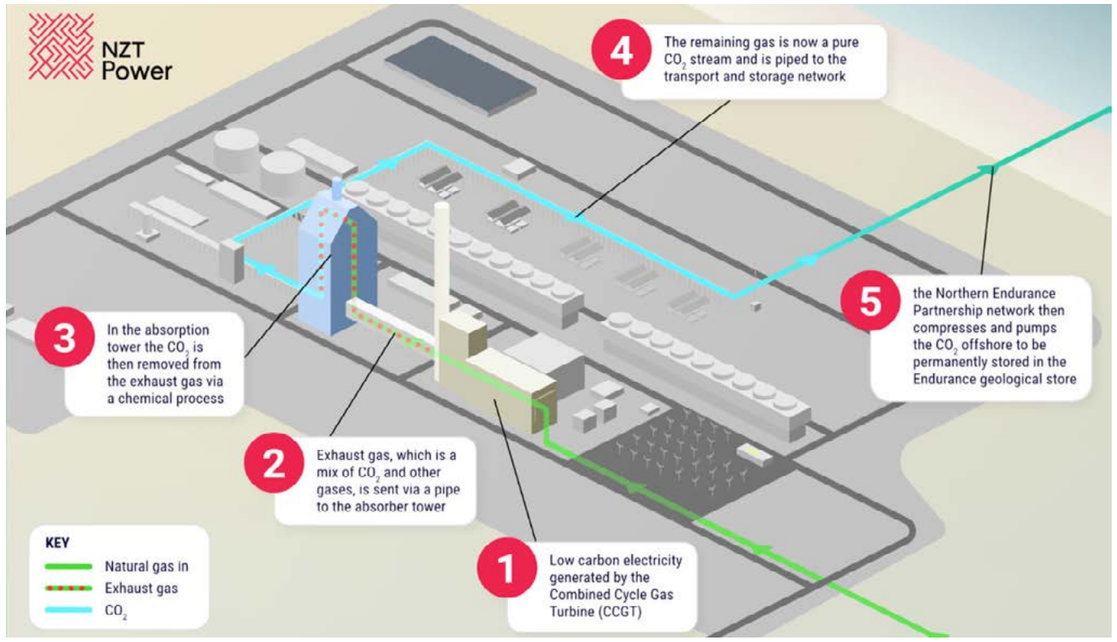
In April 2025, Eni announced that it had reached financial close with DESNZ for the Liverpool Bay CCS project, allowing it to move into the construction phase.

East Coast Cluster:

- The Northern Endurance Partnership CO_2 transport and storage system.
- The Net Zero Teesside Power CCS plant, being developed by BP and Equinor.
  - In December 2024, NZT Power achieved financial close. Construction is expected to commence in mid-2025, with first operation expected in 2028.
  - NZT aims to be the first gas-fired power station with CCS, and the hub of a decarbonised group of industries on Teesside who will share the CO_2 transportation and storage infrastructure being developed by the Northern Endurance Partnership (NEP) to serve the East Coast Cluster. NZT Power, a joint venture between BP and Equinor, could produce up to 742 MW of flexible, dispatchable low-carbon power. Up to 2 million tonnes of CO_2 per year would be captured at the plant and then transported and securely stored by the NEP in subsea storage sites beneath the North Sea.

Net-Zero Teeside proposed CCS-Power plant

NZT Power 2025



Following the current government's announcement in October 2024 of funding for the initial Track 1 clusters, further decisions for continued CCS deployment, including for Track 2 clusters, will be taken in due course.

Government national stated production targets by technology

The previous government's CCS sector vision included:

- Establishment of 2 industrial clusters by mid-2020s.
- Establishment of 4 industrial clusters by 2030.
- Capture 20-30 $MtCO_2$ per annum by 2030, including 6 $MtCO_2$ from industrial CCS.
- Deploy at least 5 $MtCO_2$ per annum of engineered removals by 2030, scaling to 23 $MtCO_2$/year by 2035 and 75-81 $MtCO_2$/year by 2050.

The current government revised its ambitions for CCS in 2024, with a target of storing 20 to 30 million tonnes per year of CO_2 by 2030 now seen as no longer achievable. Revised targets have not yet been announced.

However, the government's Clean Power Action Plan published in December 2024 includes that Power CCUS and hydrogen to power plants in Great Britain present a great opportunity for low carbon long-duration flexibility. The Action Plan includes 'NESO have suggested that we could need to deploy up to 2.7GW of power CCUS and H2P by 2030.'

Government regional stated production targets by technology

No regional CCS production targets exist, but regional considerations are reflected in the Carbon Capture, Usage and Storage Cluster Sequencing Process.

Level of competition in regulated market

Regulated level of competition & unbundling for activities such as transmission, distribution, interconnections, terminals, permanent storage (sequestration), system operations

Transmission network and system operation

Level of competition and jurisdiction boundary

At least initially, CO_2 networks, including the associated onshore and offshore infrastructure, will likely be operated as natural regional monopoly activities. For example, the Track-1 Carbon Capture, Usage and Storage Cluster Sequencing Process launched in 2021 with the East Coast Cluster (Teesside) and HyNet Cluster (Merseyside) selected as the first two clusters in the UK.

The government expects that each Transport and Storage Company (T&SCo) will have responsibility for the system operation of its own network.

Remuneration model

The Energy Act 2023 includes provision of licensing and commercial arrangements for carbon capture and storage and transportation.

Transport & Storage Regulatory Investment (TRI) Business Model:

- Economic Regulatory Regime (ERR): An ERR is needed to create a framework for users of the transportation and storage network to pay fees to T&SCo, which will be regulated by the regulator, Ofgem. It will also establish the revenue that T&SCo is allowed to make and the minimum service standards that T&SCo must provide to its users. The ERR for the first regulatory period will be decided by UK Government, and the Regulator will have a smaller role in future regulatory periods.
  - The Allowed Revenue is the annual amount that the Licensee is entitled to recover, calculated and verified on an annual basis and calibrated periodically.
  - The framework includes an availability incentive, to minimise network outages and promote reliability. The T&SCo will be assigned a target availability, set at 95% to account for planned maintenance outages and unplanned outages. Allowed revenues will be adjusted based on actual performance.
- Government Support Package (GSP): The T&SCo will benefit from a Government Support Package to cover significant but unlikely risks that are beyond what can be managed by the ERR and RSA. These are risks that investor and the supply chain, including insurers, cannot take or price at an efficient level that is good value for money for UK taxpayers, consumers, or users.
- Revenue Support Agreement (RSA): The government has identified that there might be times when T&SCo's actual revenue is less than what they are allowed to earn under the ERR. To address these demand related revenue risks, the ERR has several mitigation measures. If these measures are not enough, T&SCo will have access to the RSA to recover their allowed revenue.

Access rights

Users can obtain commercial rights to deliver CO_2 onto the T&S network by applying for allocation of network capacity at particular Delivery Points and for particular Delivery periods.

If a User has Registered Capacity, they are able (but not required) to deliver carbon dioxide at a Delivery Point in a Delivery Period.

"Network Capacity" refers to the amount of CO_2 that can be delivered at one or more Delivery Points, measured in tons of CO_2 per hour.

Network Capacity is allocated for individual Delivery Periods, where a "Delivery Period" is 30 minutes. The first Delivery Period of any Day ends at 00:30 hours of that Day, and the next Delivery Period of that Day ends at 01:00 hours of that Day, and so on.

The Network Capacity that the T&SCo must make available to Users is set out in the T&SCO's License.

Users must not deliver any carbon dioxide at a Delivery Point, in any Delivery Period, unless they have been allocated and registered as holding Network Capacity at that Delivery Point and for that Delivery Period.

Connections

As set out in the CCS Network Code, in accordance with the Track-1 Cluster Sequencing Process, Initial Users will have been selected to connect to a T&S Network. Each of the Initial Users will accede to the Code Agreement and will enter into a Construction Agreement and a Connection Agreement.

Beyond Initial Users, connections to networked CO_2 will be awarded on a first come first served basis pending evaluation on a project-by-project basis.

Distribution network and system operation

There is no distinction between transportation and distribution for CO_2.

Interconnectors

There are no interconnectors for CO_2. Offshore pipelines are considered part of the T&SCo.

For the purpose of the CCS Network Code, offshore pipeline infrastructure relates to the part of the T&S Network including the pipelines and related infrastructure that are offshore, including the pig traps (specialised pipeline fittings used to launch or receive inspection and cleaning tools known as "pigs") at the terminals and leading to the pig traps or manifold entry flanges at the storage site.

Terminal

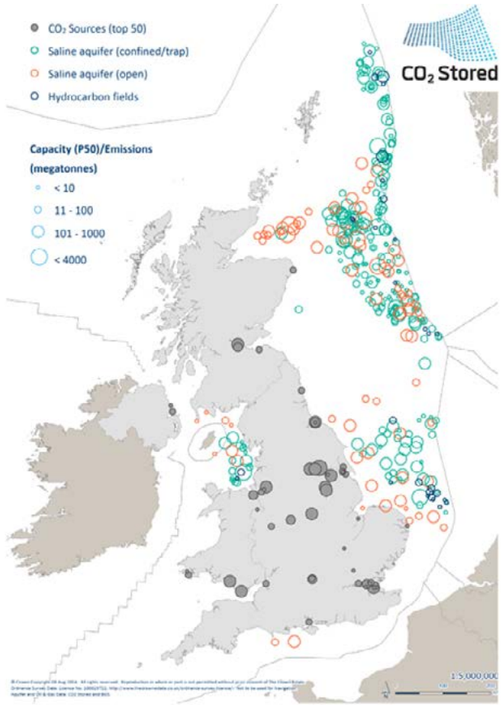
Terminals are currently expected to be integrated as part of the T&SCo infrastructure, with the same regulations as mentioned in the transmission section.

In the CCS Network Code, the Terminal relates to an onshore terminal facility and its related parts that connect the end of the onshore pipeline to the offshore pipeline and related infrastructure. This facility (the terminal) is deemed to be part of the offshore system, not the onshore system.

Permanent storage (sequestration)

Offshore sequestration (i.e. permanent storage of CO_2) is expected to be integrated as part of the T&SCo, with the same regulations as mentioned in the transmission section

There are currently twenty-seven carbon dioxide (CO_2) appraisal and storage licences on the UK Continental Shelf.



CO_2 storage capacity estimation

British Geological Society

An estimated 78 billion tonnes of theoretical CO_2 storage capacity is within the UK continental shelf, one of the largest potential CO_2 storage capacities in Europe.

Governance and industry codes

Decision makers involved in the energy sector & their respective powers, and code governance of the different vectors

Prime Minister and Secretary of State

The Prime Minister and Secretary of State set strategic direction and drive major initiatives such as net-zero targets. In addition, they have a key role during crisis management. Finally, they formulate key energy policy, including:

- Defining the remit of government departments.
- Generating roles and select delivery bodies to fulfil functions.
- Driving inclusion of Net Zero into law.

DESNZ

The Department for Energy Security and Net Zero or DESNZ (formerly known as BEIS: Business, Energy and Industrial Strategy) was established to ensure the UK's energy security and to support the transition to a net zero economy. It is mandated to shape energy policy, regulation, and implementation. It plays a crucial role in creating policy frameworks, strategic direction and targets by formulating primary and secondary legislation:

- Primary legislation: DESNZ has significant powers under the primary legislation related to networked carbon, such as:
  - The Energy Act 2008: Provides for a licensing regime to govern the offshore storage of CO_2.
  - The Energy Act 2023: Sets out a framework of economic regulation for transporting and storing carbon dioxide, as well as the duties, powers and functions given to Ofgem as the economic regulator. The Act also establishes mechanisms for supporting CCS business models. The Energy Act 2023 also gives the Secretary of State the power to designate a Strategy and Policy Statement that they and Ofgem must have due regard to when carrying out their CCS related functions. This is consistent with the approach in other economically regulated sectors.
- Secondary legislation: DESNZ uses secondary legislation to implement detailed rules and regulations, such as the CCS business models.
- Subsidy programs: DESNZ administers multiple subsidy programs, including the Industrial Carbon Capture (ICC) contracts.

Ofgem

Under the Energy Act 2023, Ofgem is responsible for regulating the transportation and storage networks of carbon dioxide (CO_2) in the UK; they will protect users and affected consumers of future CO_2 networks and storage and promote efficient and economic development of T&S networks & operations.

NSTA

The NSTA regulates the UK's offshore carbon dioxide transport and storage industry and maintains the carbon storage public register. NSTA are the licensing authority and approve and grant storage permits.

Treasury

The Treasury plays a crucial role in shaping financial policies for the energy sector, ensuring alignment with the government's economic and environmental goals. Key responsibilities include:

- Approval and risk management: Departments must obtain Treasury approval for transactions deemed novel, contentious or repercussive.
- Fiscal oversight: The Treasury oversees public spending on energy infrastructure and initiatives. For example, HMT is responsible for:
  - Providing the funding for the CCS programme and approving key decisions where there are funding implications.
  - Ensuring that public spending represents value for money.
  - Providing oversight and challenge to DESNZ through representation on the CCS Programme Board.

Devolved administration

Devolved administrations do not set overarching policy and regulatory frameworks for networked carbon. This responsibility primarily lies with the UK government. Devolved administrations do have responsibilities related to energy efficiency measures. For example, Scotland, Wales, and Northern Ireland have their own policies and programs to improve energy efficiency. Supporting low carbon innovation is part of the devolved administrations' responsibilities. They have various initiatives and programs to promote low carbon technologies and practices. The devolved administrations have their own climate change laws and policies. They contribute to the UK-wide targets but also set their own specific goals and regulations.

NESO

The remit of the National Energy System Operator (NESO), following the UK Energy Act 2023 includes the following roles:

- A system planner providing strategic direction for electricity, gas and future systems.
- An independent advisor providing analysis and information to the Government and Ofgem.
- The system operator for electricity.

In November 2024 NESO provided the UK government with advice on pathways to a clean power system for Great Britain by 2030. In particular, the document highlighted that dispatchable plant which use CCS could add significant value to the system, where 2.7GW of low carbon dispatchable power delivered by gas CCS generation and Hydrogen to Power, is included in the clean power pathways.

Code governance and aggregation

The CCS Network Code has established the commercial and technical rules and arrangements governing the interactions between Transport and Storage Companies (T&SCos) and Users, as well as the relationships among individual T&SCos. The code covers several key areas:

- User Connections to the T&S Network: The requirements and procedures for Users to connect to a transport and storage network (T&S Network), or specific parts of a T&S Network.
- Delivery of CO_2 into the T&S Network: The protocols for Users to deliver carbon dioxide into the T&S Network at designated delivery points, including the specifications and compliance standards for CO_2 quality and delivery methods.
- Transportation and Storage of CO_2: The protocols for the transportation and storage processes of CO_2 delivered by Users, ensuring safe, reliable, and efficient handling from delivery points to storage locations.
- Operation and Maintenance of T&S Networks: The operational and maintenance standards for T&S Networks, ensuring consistent and reliable performance. This includes guidelines for routine maintenance, emergency response, and system upgrades.
- Interface between T&SCos: The protocols for interactions between different T&SCos, especially where multiple T&S Networks or parts of a T&S Network are involved.

Energy security standards

Mandatory security standard metrics for network resilience and energy adequacy, and their statistical approach

Network

Currently, no universal security standards exist for CO_2 network resilience or adequacy.

Energy adequacy

There are no policy mechanisms with the principal policy objective of remunerating contribution toadequacy (i.e., to satisfy needs for CO_2 sequestration requirements).

Regulation of retail market

Specific retail market interventions, including elements such as price caps, mandated or incentivised usage-based and/or time-of use pricing, and mechanisms for guaranteed supply continuity under retailer failure.

While there is currently no retail market for networked carbon — the transport and and storage of CO_2 via a CCS network — a commercial market does exist for the purchase of CO_2 for other industrial processes.

B. Investment policy: Market interventions employed to achieve specific policy objectives

Supply:

Mechanisms to incentivize supply side investments

Note: In this section, supply refers to the removal of captured carbon via transportation and permanent storage.

Production

Mechanisms incentivising or disincentivising investment with production as the key policy objective, via support mechanisms or windfall taxes

All supply-side support mechanisms for the removal of captured carbon via transportation and permanent storage" are described in the below section on decarbonisation policies.

Decarbonisation

Mechanisms incentivising investment with decarbonisation as the key policy objective, either through support mechanisms or emission penalties.

Support mechanism for decarbonisation

In the March 2023 Budget, HM Treasury announced up to £20 billion to support the early development of the CCS programme. This included a combination of direct government funding and consumer levies. In the previous government's publication, 'Carbon Capture, Usage and Storage: A Vision to Establish a Competitive Market', it was noted that for CCUS to realise its full potential there is a need for significant private sector investment, in addition to government support. To enable private sector investment, the government has developed CCUS business models and created an economic regulatory regime through the Energy Act 2023. DESNZ ultimately wants CCS to run without public subsidy and its CCS Vision publication set out at a high level how this might work in practice from the 2030s.

In October 2024 the current UK government confirmed up to £21.7bn funding available over 25 years to be allocated between the two Track 1 clusters.

Please note, to provide an overarching summary of investment policy allocation for CCS, the industrial clusters are where support could be made available, 'tracks' define when support could be allocated (i.e. the selection of clusters), and business models set out how support could be made available (depending on project 'type', i.e., transport and storage systems or emitters).

	Market creation phase: until 2030	Market transition phase: 2030 – 2035	Self-sustaining market phase: 2035 onwards
Government Support	High levels of government support and leadership, government selects clusters with funding allocated through bilateral negotiations, competitive allocation of capture contracts commence at the end of this phase.	Reduced government support and diminishing need for government support packages and government allocates capture sector contracts competitively.	Low levels of government support as market developments significantly reduce the need for government funding and capture projects negotiate contracts with stores without government involvement.

There are three primary support mechanisms for CO_2 networks and storage, which can be categorised into the development phase, construction phase, and operational phase:

- **Development phase:**
  - Industrial Decarbonisation Challenge fund: Challenge provided £210 million, matched by £261 million from industry, which has been invested into developing technologies including carbon capture and storage. The Industrial Decarbonisation Challenge was designed to support the UK's drive for clean growth by enabling key industrial clusters (including clusters located in Humber, Teesside, Northwest, Scotland, South Wales and Black Country) to decarbonise at scale. The challenge included the design of infrastructure required for CCS, industrial cluster plans and dedicated research to support technology development for the transition to net zero.
- **Construction phase**
  - Carbon Capture and Storage Infrastructure Fund (CIF): The CIF has a total potential fund of £1bn. Announced in 2020 by the previous government, the fund was established primarily to support the capital costs of establishing transport and storage infrastructure [and early industrial capture projects].
- **Operational phase - Transport & Storage Regulatory Investment (TRI) Business Model:**
  - The Energy Act 2023 includes provision of licensing and commercial arrangements for carbon capture and storage and transportation.
  - Economic Regulatory Regime [ERR]: An ERR is needed to create a framework for users of the transportation and storage network to pay fees to T&SCo, which will be regulated by the Regulator. It will also establish the revenue that T&SCo is allowed to make and the minimum service standards that T&SCo must provide to its users. The ERR for the first regulatory period will be decided by UK Government, and the Regulator will have a smaller role in future regulatory periods.
    - The Allowed Revenue is the annual amount that the Licensee is entitled to recover, calculated and verified on an annual basis and calibrated periodically.
    - The framework includes an availability incentive, to minimise network outages and promote reliability. The T&SCo will be assigned a target availability, set at 95% to account for planned maintenance outages and unplanned outages. Allowed revenues will be adjusted based on actual performance.
    - Government Support Package (GSP): The T&SCo will benefit from a Government Support Package to cover significant but unlikely risks that are beyond what can be managed by the ERR and RSA. These are risks that investors and the supply chain, including insurers, cannot take or price at an efficient level that is good value for money for UK taxpayers, consumers, or users.
    - Revenue Support Agreement (RSA): The government has identified that there might be times when T&SCo's actual revenue is less than what they are allowed to earn under the ERR. To address these demand related revenue risks, the ERR has several mitigation measures. If these measures are not enough, T&SCo will have access to the RSA to recover their allowed revenue.

Energy adequacy & flexibility

Mechanisms incentivising investment with energy adequacy and/or flexibility as the key policy objective, through support mechanisms.

There are currently no policy mechanisms designed to specifically remunerate the contribution of supply-side assets to the adequacy of carbon removal via transportation and permanent storage. All supply-side support mechanisms for the removal of captured carbon via transportation and permanent storage are described in the above section on decarbonisation policies.

Demand:

Mechanisms to incentivise demand side investments

Note: In this section, demand refers to the demand for removal i.e. transport and permanent sequestration of carbon emissions e.g. from power generators and Industry.

Consumption

Mechanisms incentivising investment with consumption as the key policy objective, through support mechanisms for consumption.

As current policy interventions supporting the removal of carbon emissions via transportation and permanent storage are driven by a decarbonisation objective, all such demand-side mechanisms are described in the next section

Decarbonisation

Mechanisms incentivising investment with decarbonisation as the key policy objective, either through support mechanisms or emission penalties

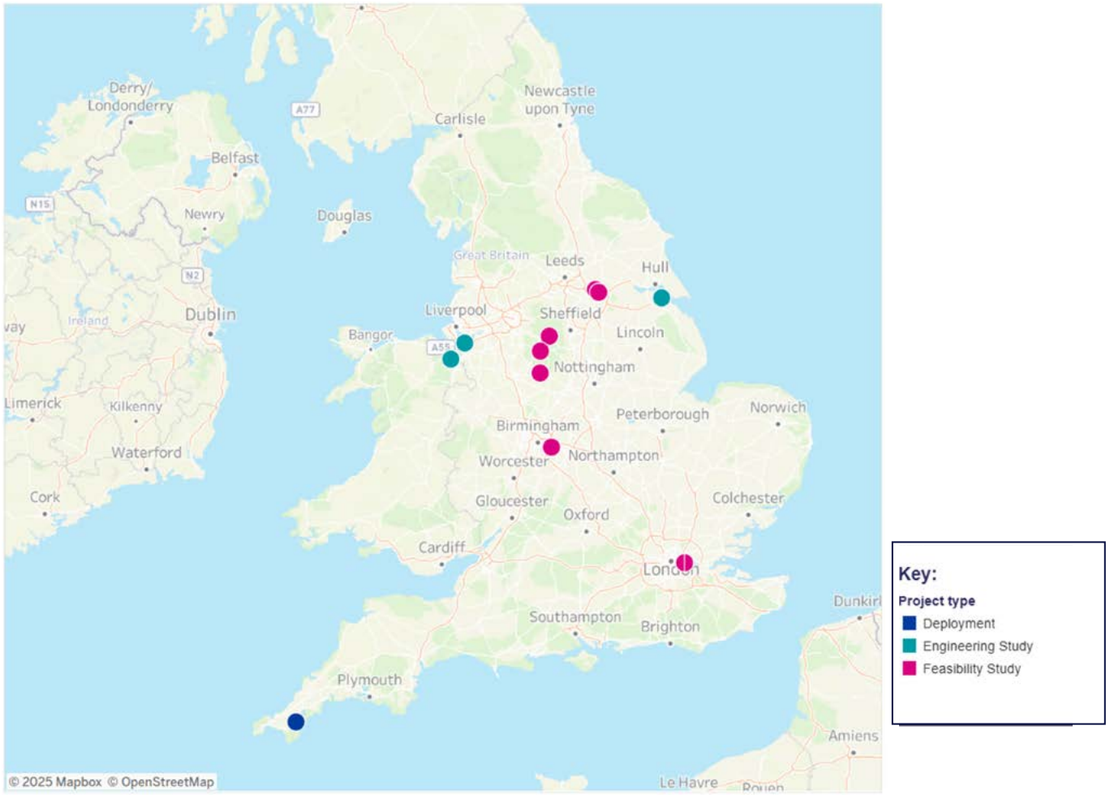
Support mechanism for decarbonisation

In October 2024 the current UK government confirmed up to £21.7bn funding available over 25 years to be allocated between the two Track 1 clusters.

Please note, to provide an overarching summary of investment policy cost allocation for CCS, the industrial clusters are where support could be made available, tracks define when support could be allocated (i.e. the selection of clusters), and business models set out how support could be made available (depending on project 'type', i.e., transport and storage systems or emitters).

CCS uptake by consumers is aimed to be supported through various support mechanisms [please note, we specify the investment policy mechanisms currently in development]:

- CCS Infrastructure Fund (CIF): The CIF has a total potential fund of £1bn. Announced in 2020 by the previous government, the fund was established primarily to support the capital costs of establishing transport and storage infrastructure as well as early industrial capture projects. As a First Of A Kind [FOAK] application in the UK, Industrial Carbon Capture (ICC) will initially have higher capital costs and a risk premium may be attached to it which creates further risks and uncertainties for potential investors. To help overcome this, the CIF may be used to provide capital co-funding, most likely in the form of grants, for the capture components of the industrial application of carbon capture and storage.
- The Industrial Energy Transformation Fund (IETF): is designed to help businesses with high energy use to cut their energy bills and carbon emissions through investing in energy efficiency and low carbon technologies. The IETF launched in 2020, and is in 3 phases with £500 million of funding available up until 2028. To date 12 CCUS projects have been supported through the IETF.



Industrial Energy Transformation Fund Competition winners, CCUS Technology selected

DESNZ 2025

Dispatchable Power Agreement (DPA):

- The Dispatchable Power Agreement (DPA) is a private law contract, based on the renewables contract for difference (CfD), of between 10 and 15 years between a power plant developer and a DPA contract counterparty. The DPA business model has been designed to support Power CCUS by incentivising natural gas fired power facilities to install and operate equipment to capture the carbon dioxide (CO_2) produced when generating electricity, for transport to a permanent storage site. The DPA will incentivise power projects to produce low-carbon, mid-merit electricity, meaning plants are only incentivised to turn on when zero carbon sources of generation, such as renewables and nuclear power, are not meeting the needs of the country. Power CCUS can provide non-weather dependent, dispatchable low carbon generation.
- The DPA will consist of two payments: (i); an Availability Payment for low carbon electricity generation capacity; and (ii) a Variable Payment to adjust the position of the Facility in the merit order relative to unabated Plants when demand cannot be met by low marginal cost technologies such as renewables or nuclear.
- The LCCC (Low Carbon Contracts Company) is the contractual private law counterparty, and settlement body to DPAs.
- The first DPA contract was signed for the East Coast Cluster in Teesside in November 2024. Net Zero Teesside Power aims to be the first gas-fired power station with carbon capture and storage.

Hydrogen Production Business Model (HPBM):

- As part of the Carbon Capture, Usage and Storage Cluster Sequencing Process, revenue support to CCUS-enabled new hydrogen production facilities will be allocated through the Hydrogen Production Business Model.
- Government support for selected Producers of low carbon hydrogen, such as CCS enabled hydrogen production facilities, includes the payment of a premium calculated as the difference between a Strike Price (reflective of the Producer's unit cost of production and negotiated on a project-by-project basis) and a Reference Price (based on the price at which the Producer sells their hydrogen, with a floor at the natural gas price i.e., the most relevant fossil fuel alternative). The HPBM also includes a reward mechanism that incentivises Producers to achieve higher sales prices, which will reduce the size of the support payment under the Low Carbon Hydrogen Agreement. For more information on this business model, please see the NESO hydrogen market guidebook.

Industrial Carbon Capture and Waste Business Models (ICC):

- These business models have been designed to incentivise the deployment of carbon capture technology by industrial users who often have no viable alternative to achieve deep decarbonisation. They comprise revenue support funded by the Industrial Decarbonisation and Hydrogen Revenue Support (IDHRS) scheme and, potentially, capital co-funding [including the above CIF and IETF].
- The Energy Act 2023 provides the primary powers necessary to deliver the ICC business models. Please note, the ICC business model are the government's current proposals, are indicative only and do not constitute an offer by government and do not create a basis for any form of expectation or reliance.

Power Bioenergy with Carbon Capture and Storage (Power BECCS) Business Model:

- The previous government sought views on the government's minded-to position for a business model to incentivise deployment of power bioenergy with carbon capture (BECCS) within the UK. Please note, the power BECCS business model proposals and indicative Heads of Terms are indicative only and do not constitute an offer by government and do not create a basis for any form of expectation or reliance.
- The government response to this consultation on the proposed business model for power BECCS confirmed the positions of Dual CfD as the preferred model, as it offers a clear distribution of costs and risk allocation. The Dual CfD mechanism would consist of a Contract for Difference for electricity (CfDe) and a Contract for Difference for carbon (CfDc):
  - CfDe: A CfD for electricity generation (in £/MWh) where the generator is paid the difference between a contractually agreed strike price and a market reference price for electricity.
  - CfDc: A CfD for carbon (in £/tCO_2) under which a subsidy is paid above the prevailing carbon price for negative emissions (such as the UK ETS, a voluntary carbon market or bilateral negative emissions sale) up to an agreed strike price.

Greenhouse Gas Removals (GGR) Business Model:

- Engineered GGRs cover a wide range of technologies, some of which require access to a CO_2 transport network to permanently store the removed CO_2 - these are 'CCS-enabled' GGRs.
- The purpose of the GGR Business Model is to attract private investment in a variety of GGR technologies and accelerate commercial deployment by providing revenue support for negative emissions.
- The GGR business model proposals and indicative Heads of Terms are indicative only and do not constitute an offer by government and do not create a basis for any form of expectation or reliance.
- The contract structure for the GGR Business Model will follow precedents established in the low-carbon electricity Contract for Difference scheme and other CCUS business models. The GGR Agreement will comprise (i) the Front-End Agreement, and (ii) the Standard Terms and Conditions.
- In addition, the previous government in 2020 launched a Direct Air Capture and Greenhouse Gas Removal Innovation Programme competition, to provide funding of up to £100 million for developing technologies that enable the removal of greenhouse gases from the atmosphere in the UK.

Penalty for emissions

The UK ETS applies to regulated activities, including relating to CCUS, which result in greenhouse gas emissions, including combustion of fuels on a site where combustion units with a total rated thermal input exceeding 20MW are operated. As referenced within the 2023 Carbon Capture, Usage and Storage update on the business model for Transport and Storage: The Licensee shall comply with all obligations arising under the UK ETS in relation to all carbon dioxide that is delivered by Users into the Onshore Transportation System.

The previous government consulted on integrating engineered greenhouse gas removal (GGR) in the UK ETS. Engineered GGRs cover a wide range of technologies, some of which require access to a CO_2 transport network to permanently store the removed CO_2 - these are 'CCS-enabled' GGRs. The UK ETS Authority confirmed it believed the UK ETS was an appropriate long-term market for GGRs, and the inclusion of engineered GGRs in the UK ETS will incentivise investment in and provide a source of demand for GGRs from polluting sectors and futureproof the UK ETS so it continues to play a key role in delivering net zero.

Energy adequacy & Flexibility

Mechanisms incentivising investment with energy adequacy and/or flexibility as the key policy objective, through support mechanisms.

There are currently no policy mechanisms designed to specifically remunerate the contribution of demand-side assets to the adequacy of carbon removal via transportation and permanent storage. All demand-side support mechanisms for the removal of captured carbon via transportation and permanent storage are described in the above section on decarbonisation policies.

C. Operational market design: Market design elements that match supply and demand and enable stable and reliable day-to-day operations

Wholesale market

Operational market design related to facilitating the matching of supply and demand

Presence of national wholesale market

Please note, this market design guidebook focuses on networked carbon and not the UK Emissions Trading Scheme, i.e., the market for carbon emission credits.

There is no national wholesale market for CO_2 being transported as networked carbon.

The CCS Network Code sets out the commercial and technical arrangements between the networked carbon Transport and Storage Company's (T&SCos) and Users, and between individual T&SCos, in relation to:

A. the connection by Users to a T&S Network, or part of a T&S Network;

B. the delivery of carbon dioxide by Users into the T&S Network at a Delivery Point;

C. the transportation and storage of carbon dioxide delivered by Users at Delivery Points;

D. the operation and maintenance of each T&S Network; and

E. the interface between the T&SCos in relation to different T&S Networks or parts of a T&S Network.

The Licensee [legally bound by the provisions of the CCS Network Code by signing or acceding to the Code Agreement] must develop, maintain and operate the T&S Network in an economic, efficient, effective and coordinated manner.

Balancing and settlement

Processes and mechanisms to manage and reconcile discrepancies between supply and demand and ensure operability of the system

System balancing services

Mechanisms and contractual arrangements employed by system operator to facilitate real-time system operation, including sub-settlement period energy balancing (to resolve short-term discrepancies between supply and demand), and ancillary services to maintain system stability and security

No system balancing services have been identified for networked CO_2.

Energy balancing – normal

Routine processes and mechanisms to ensure balance of supply and demand under typical operating conditions, further specified through the primary balancer, residual balancer, dispatch mechanism and gate closure where applicable

The Licensee [legally bound by the provisions of the CCS Network Code by signing or acceding to the Code Agreement] must develop, maintain and operate the T&S Network in an economic, efficient, effective and coordinated manner. As set out in the CCS Network Code:

Dispatch

- The provisions for dispatch of networked carbon are set out in the CCS Network Code.
- Users must nominate quantities of carbon dioxide (expressed in tCO_2) for delivery at a Delivery Point, for each Delivery Period of each Day.
- The T&SCo use nominations from Users to:
  - optimise the use of the T&S Network; and
  - operate the T&S Network in a safe and efficient manner.

Gate closure

As applied to Users:

- The provisions for gate closure of networked carbon are set out in the CCS Network Code.
- For each Day in relation to which a User holds Registered Capacity, the User must provide a Daily Nomination for each Delivery Period in that Day by the Nomination Close Time. The "Nomination Close Time" is 13:00 hours on the Day before the Day to which the Daily Nomination relates. A Daily Nomination may be submitted no earlier than seventy-two hours before the Day to which the Daily Nomination relates.
- At any time before the Nomination Close Time (but not after), a User may change an earlier Daily Nomination already submitted, and where a User does this then: (a) the last Daily Nomination that it submitted before the Nomination Close Time shall be treated as the User's Daily Nomination; and (b) any earlier Daily Nomination for that Day shall be superseded by that later Daily Nomination.
- Each User may request that the T&SCo provide the Enhanced Response Service, i.e., for the User to be able to Renominate by submitting a Renomination up to thirty minutes before the start of a Delivery Period.
- If in respect of any Delivery Point and each Delivery Period of a Day a User has not submitted a Daily Nomination, the Nominated Quantity for that Delivery Period (or Delivery Periods) of that Day shall be deemed to be zero.

As applied to the T&SCo:

- The T&SCo must confirm to the User by no later than the Confirmation Close Time [15:00 hours on the Day before the Day to which the Daily Nomination relates] whether the User's Daily Nomination for each Delivery Period has been accepted or rejected.

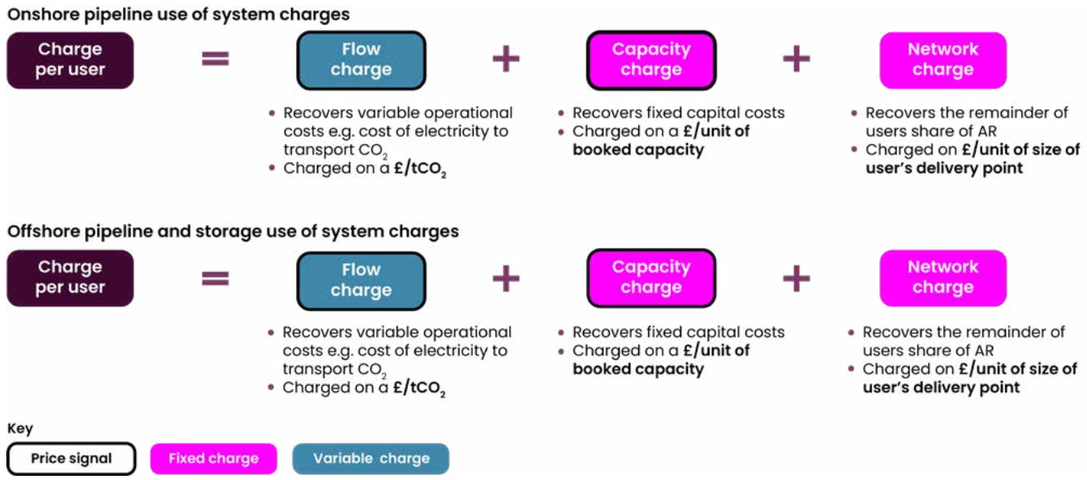
- The T&SCo may reject a User's Daily Nomination for any Delivery Period only where: (a) as at Nomination Close Time, the Daily Nomination does not comply with requirements set out in the CCS network code; or (b) after Nomination Close Time, a Capacity Constraint affects the ability of the T&SCo to accept the whole or part of any Nominated Quantity for that Delivery Period; or (c) after Nomination Close Time, a Minimum Flow Deficit affects the ability of the T&SCo to accept any Nominated Quantity for that Delivery Period.
- The T&SCo must use reasonable endeavours to accept requests from Users to vary the quantity of carbon dioxide to be delivered (expressed in tCO_2) in a Delivery Period to which the request relates "Flow Tolerance Requests."

Contractual and information imbalance settlement

- The provisions for imbalance settlement of networked carbon are set out in the CCS Network Code.
- A User's Daily Nomination (or Renomination) for each Delivery Period must be the User's best estimate, made in good faith, of the quantity of carbon dioxide (expressed in tCO_2) that the User intends to deliver at the Delivery Point for each Delivery Period to which the Daily Nomination (or Renomination) relates.
- The flow of carbon dioxide being delivered by a User during a Delivery Period must not exceed the User's Available Registered Capacity for that Delivery Period.
- Where the T&SCo has rejected (or partially rejected) a User's Daily Nomination, the T&SCo must keep the User updated about the extent to which the Nominated Quantities of the User or other Users would be required to increase to meet the Minimum Flow Rate in any Delivery Period affected by a Minimum Flow Deficit, to enable the User to respond to the Minimum Flow Deficit by increasing its Nominated Quantity or Nominated Quantities through a Renomination.
  - Where a Minimum Flow Deficit occurs and the T&SCo is required to take the action, the T&SCo must: (a) notify all Users of the occurrence of the Minimum Flow Deficit as soon as the T&SCo becomes aware of it, together with details of when and for how long the Minimum Flow Deficit is likely to continue; and (b) use reasonable endeavours to: (i) mitigate the impact on Users, by declaring a Minimum Flow Deficit only where necessary; and (ii) notify Users as soon as it becomes apparent that a Minimum Flow Deficit is no longer impacting a Delivery Period.
- Flow charges: A User must pay to deliver carbon dioxide to the T&S Network, at the User's Delivery Point. A User's "Daily Quantity" is the quantity of carbon dioxide that the User delivers each Day at the User's Delivery Point expressed in tCO_2.
- Capacity charges: A User must pay for its Registered Capacity, irrespective of whether the User utilises its Registered Capacity by delivering carbon dioxide at its Delivery Point.

T&S Charging Structure

DESNZ, 2022



Energy balancing – emergency

Procedures and mechanisms implemented to address severe imbalances between supply and demand that threaten stability and reliability of energy system, further specified through the central balancing function, wholesale market closure, balancing notice and load shedding merit order.

As included within the CCS Network Code, Emergency is defined as a situation where T&SCo in its judgment considers that action must be taken without delay to: (a) avert or reduce danger to life or property; or (b) secure the safety of the T&S Network or a part of the T&S Network or the safe transportation of carbon dioxide by it or reducing the risk to it.

Emergency procedures and terms of reference are to be determined for the CCS Network Code.

D. Cost allocation: Allocation mechanisms of various costs

Policy costs
Costs incurred from providing policy support to achieve specific government objectives, generally for investments

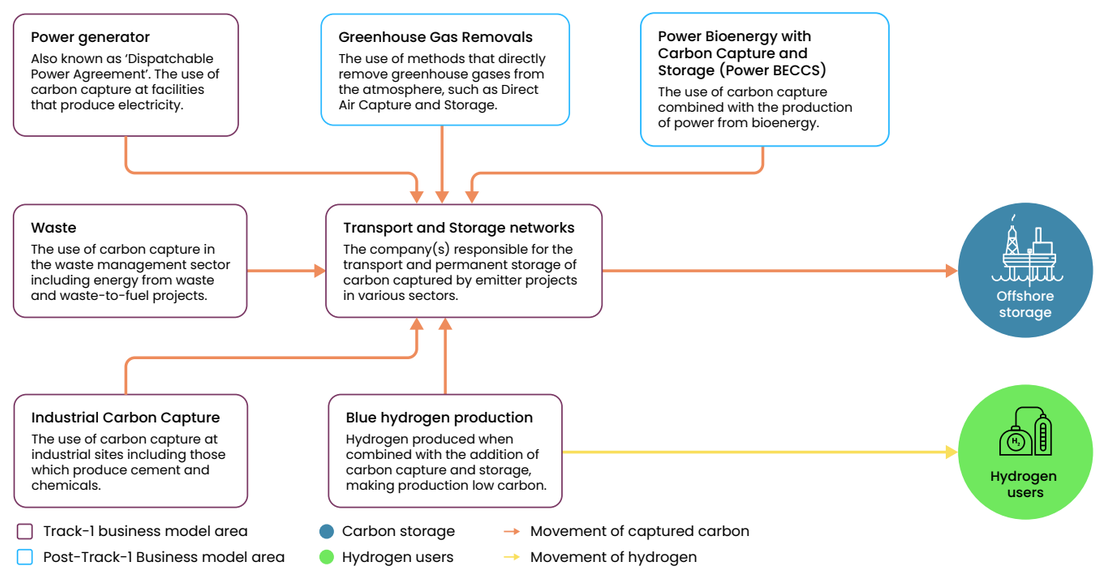
Allocation on taxpayer and market participants

Please note, to provide an overarching summary of policy allocation for CCUS, the industrial clusters are where support could be made available, tracks define when support could be allocated (i.e. the selection of clusters), and business models set out how support could be made available (depending on project 'type', i.e., transport and storage systems or emitters).

In addition, please note, we specify the policy cost mechanisms currently in development.

- Industrial Decarbonisation Challenge fund: Allocated to taxpayers, the Industrial Decarbonisation Challenge fund provided grants up to a total of £210 million to be invested into developing technologies including carbon capture and storage.
- CCS Infrastructure Fund (CIF): DESNZ is considering the different forms of funding the allocated £1bn CIF could utilise. Grants are currently the leading option; however, the government has not ruled out alternative funding arrangements in this area, including loans, equity, or loan guarantees. In every case this is subject to government satis-faction that CIF funding represents value for money for the consumer and the taxpayer in the context of other government support mechanisms.
- Industrial Energy Transformation Fund (IETF): Allocated to taxpayers, the IETF provides grant funding, up to £500mn, to help businesses with high energy use to cut their energy bills and carbon emissions through investing in energy efficiency and low carbon technologies.

Overview of CCUS Business models, National Audit Office, 2024



Dispatchable Power Agreement (DPA):

- The DPA provides the contractual framework for power CCUS, it is based on the Contracts for Difference (CfD) for Allocation Round 4 (CfD AR4) standard terms and conditions but adapted to enable natural gas fired power CCUS facilities ("Project") to play a mid-merit role in meeting electricity demand, displacing unabated thermal generation plants. The DPA will utilise an Availability Payment, linked to facility performance, to incentivise the availa-bility of low carbon, non-weather dependant dispatchable generation capacity. The Avail-ability Payment will be calculated and paid regardless of whether a facility is dispatching and so will not incentivise facilities to displace lower cost and lower carbon sources of generation such as renewables and nuclear. Payments will be allocated to market partic-ipants, where the levy will be calculated and managed by the CfD counterparty (the LCCC) and collected from electricity suppliers.

Hydrogen Production Business Model [HPBM]:

- As part of the Carbon Capture, Usage and Storage Cluster Sequencing Process, revenue support to CCUS-enabled new hydrogen production facilities will be allocated through the Hydrogen Production Business Model.
- The Energy Act 2023 enables two options for funding the Hydrogen Production Business Model (HPBM): a levy on gas shippers (the Gas Shipper Obligation (GSO)) and government funding.

ICC and Waste ICC business models

These have been designed to incentivise the deployment of carbon capture technology by industrial users who often have no viable alternative to achieve deep decarbonisation. They comprise revenue support funded by the Industrial Decarbonisation and Hydrogen Revenue Support (IDHRS) scheme and, potentially, capital co-funding [i.e., through the CIF]. Please note, the ICC business models, are indicative only and do not constitute an offer by government and do not create a basis for any form of expectation or reliance.

Greenhouse Gas Removals:

- Proposed commercial framework for the greenhouse gas removals (GGR) business model includes a 'dual CfD' consisting of a Contract for Difference for electricity (CfDe) and a Contract for Difference for carbon (CfDc). Please note, the proposals are indicative only and do not constitute an offer by government and do not create a basis for any form of expectation or reliance.

Power Bioenergy with Carbon Capture and Storage (Power BECCS) Business model:

- The government's minded to position includes a dual CfD mechanism to consist of a Contract for Difference for electricity (CfDe) and a Contract for Difference for carbon (CfDc). Government is considering the source of funding for the power BECCS business model, please note, the proposals are indicative only and do not constitute an offer by government and do not create a basis for any form of expectation or reliance.

Transport & Storage Regulatory Investment (TRI) Business Model:

- The basis of the revenue model is 'User Pays' model. Revenue will be made up of payments from those who use the T&S network to have their captured CO_2 transported and stored. Under this model, T&SCo will collect its allowed revenue set under the economic regulatory regime [ERR] through T&S fees paid by users of the T&S network. HMG will determine the ERR for the First Regulatory Period, with the Regulator having a more limited role than it will in the second and subsequent regulatory periods.

Government Support Package [GSP]:

- T&SCo will benefit from a GSP provided by HMG to cover certain high impact, but low probability, risks beyond those which are manageable by operation of the ERR and the RSA [i.e., allocated to taxpayers].
- Revenue Support Agreement [RSA]: in the development of the revenue model for the T&S Network, HMG has identified that there may be certain demand-related revenue risks to T&SCo, where T&SCo's actual revenues may fall short of T&SCo's Allowed Revenue under the ERR. Such demand-related revenue risks will be addressed through a number of mitigation measures in the ERR and where the ERR is not sufficient, T&SCo will have access to the RSA as a mechanism which will enable the recovery by T&SCo of its Allowed Revenue in the event of a shortfall. [i.e., allocated to taxpayers].

Charges (levies), charging base and basis

It's likely that that levies will be on consumers and its to be determined what the metrics will be.

Transmission network costs

Costs incurred to remunerate network transmission companies to account for investment, operational & maintenance costs for transportation over long distances

Allocation to taxpayer and market participants

Transmission network costs are allocated to market participants (i.e. Users) through the Use of System charges as set out in CCS Network Code.

Balancing costs

Costs incurred by the system operator to ensure real-time balance between supply and demand, including the procurement and deployment of balancing services

Balancing cost recovery will be included as part of the Use of System charges payable by Users to the T&SCo.

Distribution network costs

Costs incurred to remunerate network distribution companies to account for investment, operational & maintenance costs for final stage transportation to end users

Allocation to taxpayer and market participants

There are no carbon distribution networks.

Payment responsibility (charging base)

Allocation of network and balancing costs across market participants, including allocation between supply (producers) and demand (consumers), and any exemptions or discounts for specific groups/technologies

There are no carbon distribution networks.

Charging metric (charging basis)

Metric used to charge market participants for network or policy costs, generally either on an energy or capacity basis, including those designed to allocate costs to usage or capacity at specific times of the day or year.

There are no carbon distribution networks.

Inter-temporal cost allocation

The government developed the Transport and Storage Regulatory Investment (TRI) model with an expectation that T&S infrastructure will support a thriving CCUS market, with a diverse user base, well beyond 2050. Given this, as the market develops, the government expects allocation of risk to change over time, as higher utilisation of T&S infrastructure should be supported by an increasing CO_2 price/taxes (both domestically and internationally), and the technology and its use becoming established at scale and better understood. This will lead to the market becoming sufficiently developed to mitigate T&SCo's exposure to financial risk, including the potential for market-based products (e.g. insurance).

However, for initial networked carbon systems, risks to revenue recovery include:

- Utilisation build-up during the early operational phase – users will join the network in phases and the T&S network will not be fully utilised for some time resulting in T&SCo collecting less than its allowed revenue, assuming users pay T&S fees that reflect their use of the network;
- Timing mismatch of when planned capture projects connect – T&SCo will only start receiving user revenue when the first user joins the T&S network and so if the first user joins later than expected T&SCo will not be able to collect any revenue;
- Underutilisation of the network – once the first user has connected to the T&S network.
- T&SCo may collect less than its allowed revenue, for example, if further users don't connect on time, there are fewer users than expected, or if there is less CO_2 injected into the network than expected; and
- Bad debt of users – once the first user has connected to the T&S network, T&SCo will collect less than its allowed revenue if there are unforeseen delays in payment of T&S fees or non-payment by users (e.g. insolvency of a user).

In order to mitigate against these risks, Risk Mitigations Mechanism (RMMs) have been developed, including mutualisation to address the impact of utilisation build-up. Mutualisation involves increasing T&S fees in order to enable T&SCo to collect more of its allowed revenue than it would be able to if T&S fees were only charged in proportion to users' expected utilisation of the network and booked capacity. Users' exposure to increasing T&S fees would be limited to a cap, set by the UK ETS price.

- As included within the CCS Network Code: The Use of System Charges are intended, subject to the Mutualisation Cap, to recover the Allowed Revenue of the T&SCo, as determined by the Regulator in accordance with the conditions of the T&SCo's Licence.

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- **UK Government** – CCUS Net Zero Investment Roadmap – Link
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- **DESNZ** - Cluster sequencing for carbon capture, usage and storage (CCUS) deployment: Phase-1 - Link
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- **DESNZ** – Hydrogen Strategy Update to the Market: December 2024 – Link
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- **DECC** – Decision Letter on White Rose Carbon Capture and Storage Project - Link
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- **NSTA** – Carbon Storage – Link
- **NAO** – Carbon Capture, Usage and Storage Programme – Link
- **NESO** - Clean Power 2030 - Link
- **The CCS association** – CCS Network Codes – Link

Security of supply standards

- **DESNZ** - CCUS Non-Pipeline Transport and Cross-Border CO_2 Networks - Link

B. Investment policy

Supply

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- **DESNZ** – CCUS Dispatchable Power Agreement business model summary and consultation - Link
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System Operator