

The case for a 'market maker' and a business model for CO₂ storage

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CCS technology is proven and able to deliver huge emission cuts, so why is deployment so slow?

Effective market mechanisms have to be in place for deployment

ZEP advisory committee noted that attention had focused on the emitting part of the CCS chain (CO₂ capture), but large-scale CCS also requires CO₂ transport and storage infrastructure – ***at the right time, in the right place, at the right capacity***; and in the current policy environment, there is no indication this will happen.

AC mandate – form a cross industry team to prepare a report which:

1. Identified key enablers (and barriers) for any potential operator to offer their services in storing captured CO₂ from 3rd parties on a commercial basis
2. Presented feasible business models for CO₂ storage covering the demonstration, pre-commercial and commercial stages, based on these enablers

Team observed that for a viable business, income & cost must balance over the whole cycle



Pre-investment and investment

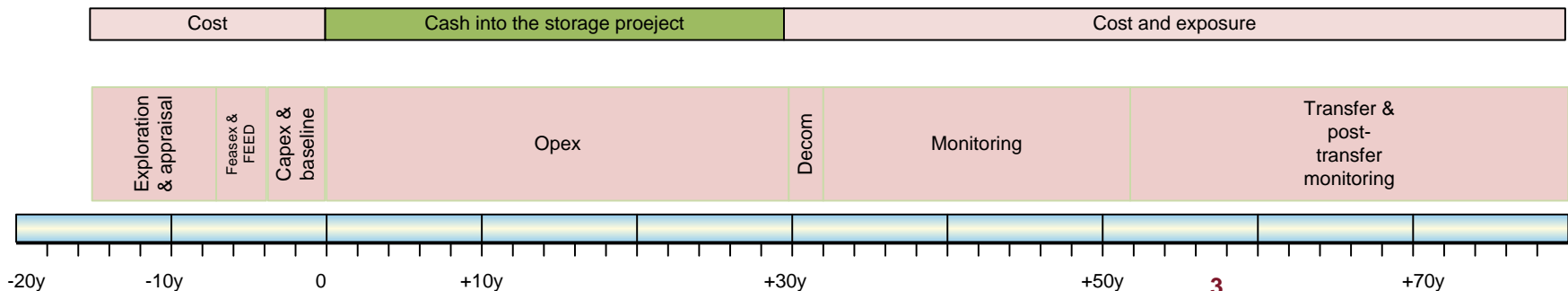
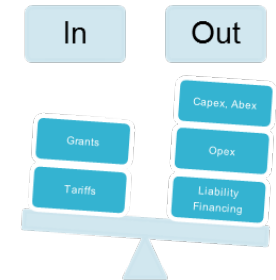
- Exploration & Appraisal
 - Creating storage atlases
 - Acquiring seismic and environmental surveys
 - Drilling and coring wells
- Feasibility and design
 - Study, modelling, containment risk assessment
 - Front end engineering design
 - Permitting
 - Setting up finance
- Construction
 - Detailed design
 - Construction
 - Monitoring baseline

Operating income phase

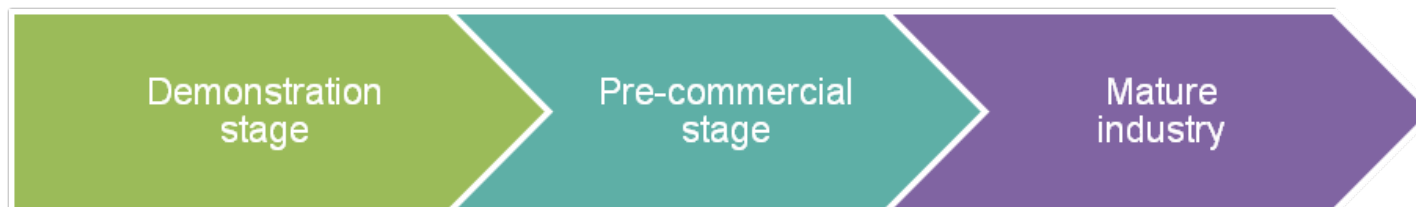
- Operating cost & monitoring
- Performance contingency costs
- Finance costs
- Liability and insurance provisions

Closure costs

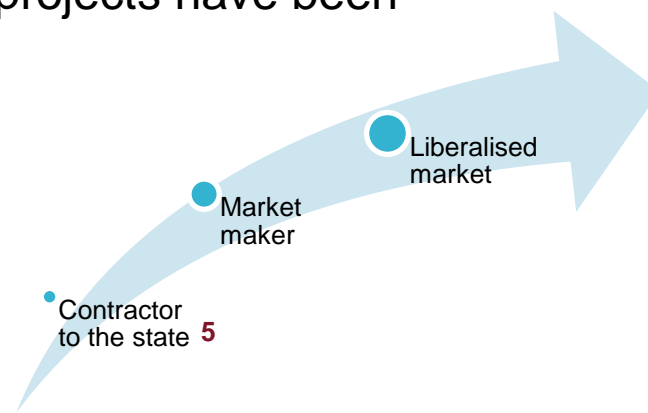
- MMV and modelling in support of handover
- Decommissioning
- Handover costs



Three phases in CCS deployment identified



- Characteristics of each phase have been examined
 - Division depends on policy uncertainty, geological appraisal, and the presence of networks of emitters and stores
- It has been found that some business models are more suited to various phases than others
- It was also recognised that the demonstration phase has not yet been finished. No commercial scale demonstration projects have been constructed in Europe to date.

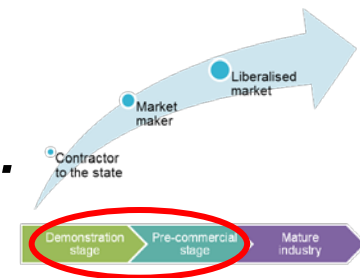


Three business model “types” have been identified:

1. Contractor to the State

A ‘**Contractor to the State**’ model is suitable before an established policy incentive mechanism exists and when market failure requires tailored State intervention. In this model, the State decides on each investment on its individual merits. This means that state funding is divided into relatively smaller project-size pieces, with the flexibility to adapt policy in response to events.

This model is key to incentivising early movers.



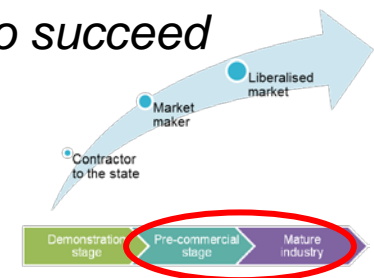
2. Enabled Market

Hybrid business model comprising State intervention in some parts of the market and managed competition in others.

The Enabled Market employs a regulated entity (the **Market Maker**) with two key roles:

- To manage the development of primary infrastructure for CCS on behalf of the State (trunk pipeline plus back-up hub store). This allows the State to ensure optimal design, construction and operation of primary infrastructure in order to achieve system efficiencies, including economies of scale.
- To have a duty to receive all captured CO₂ and ensure that corresponding storage is available. It will also be mandated to supply CO₂ to low-cost storage sites such as EOR storage.
- Takes title and liability for the CO₂ from the emitter

*This model is perfectly suited to **grow storage volumes**: but to succeed the **market trajectory for CO₂ capture must be planned, programmed and predictable.***

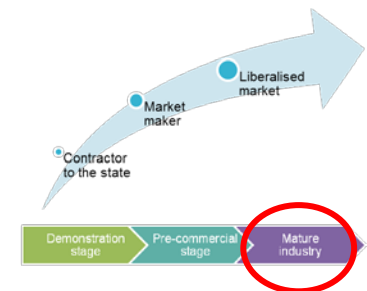


3. Liberalised Market

The '**Liberalised Market**' business model describes a market in which private companies involved in the CCS chain develop and manage pipelines, hubs and storage sites without specific government direction.

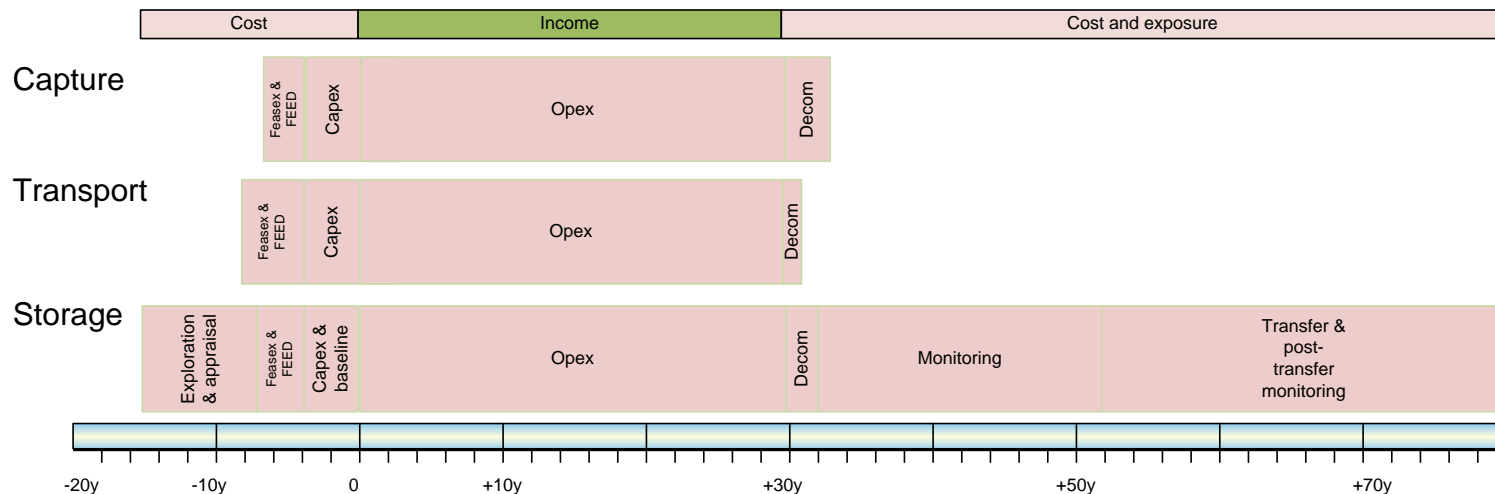
The government's role is limited to creating the mechanism that enables CCS to be a viable business opportunity (whether via a high, robust carbon price, a premium power price for low-carbon power, or an emissions performance standard) and providing an appropriate set of regulations to ensure safe and secure CO₂ storage.

The CCS market is not yet sufficiently mature to move to a liberalised market.



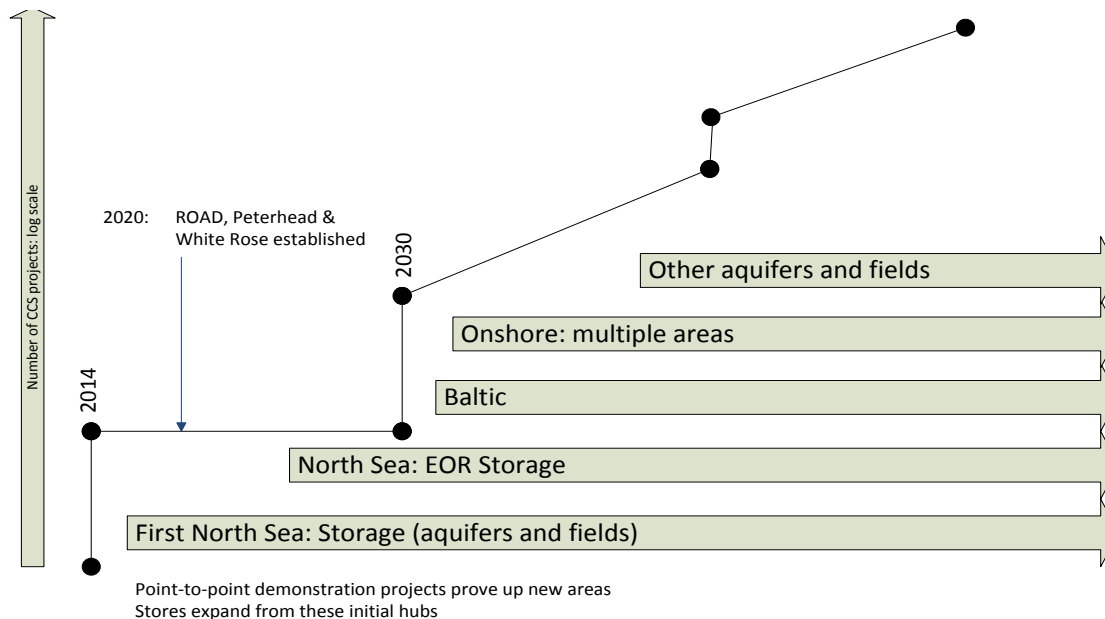
Full chains are challenging to deliver owing to counter party & financing risk

- One key element was found to dominate the storage business and, to a lesser extent, transport: **counterparty risk**.
- Storage operators are exposed to uncertainty for a much longer time than capture operators.
- Policy instruments must facilitate capital provision and enable business models that support pre-investment and many decades of post-closure exposure.
- Storage cash flows will have to be underwritten in a similar manner to the temporary measures being seen for capture (point-to-point projects).
- A key recommendation is therefore to reduce counterparty risk by separating capture (from power and industrial sources) from transport and storage businesses



Hubs are key to cost-effective CCS and require a clear policy framework to develop

- Economies of scale in T&S are potentially enormous.
- CCS will ideally develop as a staged roll-out of key hubs and connecting infrastructure, initially focused on North Sea.
- A policy framework for CO₂ transport and storage is critical to create market certainty and long-term secured cash flows needed for private sector capital and industry investment. ***Without it, a network will simply not materialise in time to deliver EU climate targets.***



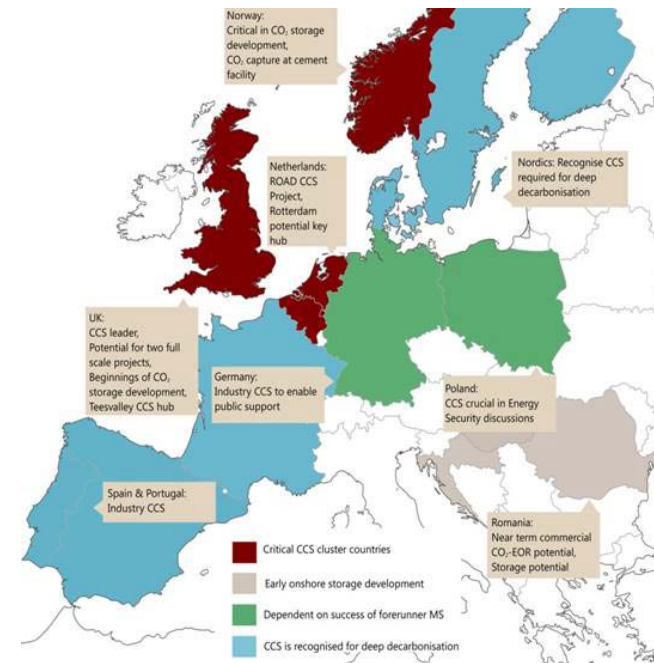
The team also explored the conditions needed to facilitate rapid decarbonisation

Key Critical Success Factors in order to deliver potential hubs and clusters are:

- Ambition to decarbonise industry and energy
- The presence of emissions sources and storage formations
- A politically supportive industrial region and member state
- The potential for EU regional funding
- The potential for economic value creation and retention through the development of CO₂ advantaged manufacturing of products or CO₂ utilisation opportunities.

Recommendations of the taskforce

- **Break the CCS chain. Separate T&S from capture**
- **Establish Market Makers** to accelerate the development of key hubs and deliver economies of scale.
- **Create a flexible funding mechanism** to develop storage and transport infrastructure.
- **Establish a liability management mechanism** to remove the heavy cost burden from storage operators.
- **Support a well-defined and predictable growth trajectory for CO₂ capture** in national plans (NDCs)



A first step:

- *Effective delivery requires coordination by regional development organisations, each drawn from relevant Member States, working to create national market makers to develop T&S networks linked to industrial and power emission sources.*



Developed a politically achievable recommendation

- *“Effective delivery requires coordination by regional development organisations, each drawn from relevant Member States, working with national market makers and T&S network developers.”*
- RDOs will produce projects ready for innovation funding application in 2020
- We envision these as cross border groups – like the USA regional sequestration partnerships – with established full time staff.
 - Drawn from the MS represented ; strong links back to the relevant ministries
 - Cover capture, power and industry, transport, geological storage, public engagement, economics, energy system modelling, business & finance, R&D, climate science, regulatory and policy.

Characteristics of the 3 phases

Demonstration stage	Demonstration stage	Pre-commercial stage	Mature industry
<p>Current day</p> <ul style="list-style-type: none"> ✓ CCS directive transposed ✓ Limited funding in some MS ✓ Storage demonstrated by Statoil⁵ ✓ Three power/CCS projects are moderately mature; one stalled, one in FEED. Public/private partnerships. ✓ UK: CFD fund & Carbon Price floor⁶ ✗ Current funding so complicated by rules that it cannot be spent ✗ EUA price €8; Energy market in turmoil (billions written off shares) ✗ Not all countries allow CCS ✗ Significant concentrated CO₂ emitted but only in Norway is it stored ✗ Zero commercial power capture or dedicated storage projects ✗ Lack of potential storage providers ✗ No security of demand for storage service (supply from the power) ✗ Power plant has no security that the sink will be there long term ✗ Except in UK only income stream for CCS is avoided cost of EUAs. This comes to power plant. ✗ Storage provider is at the end of the value chain 	<p>Emergent: transition steps <i>To get current three or more demos</i></p> <ul style="list-style-type: none"> ✓ Funding for <u>capex</u>, <u>opex</u> and <u>downside/overspend</u> ✓ Projects do not need to make significant profits, but risks are covered ✓ Assured revenue stream to cover cost of generation (<u>capex</u>, <u>opex</u>) and capture, transport and storage, and cost of <u>capex</u> [temporary measure] 	<p>Emergent market <i>For market to develop</i></p> <ul style="list-style-type: none"> ✓ Signal carbon price rise, in law create "growing market" ✓ Flexible funding source: for storage appraisal; for capture plant; for transport : in large enough chunks ✓ First mover incentives...incentives to O/G operators to unlock storage ✓ Ability to provide CO₂ to EOR storage (EORS) projects under CCS funding mechanisms, while protecting the ability of EOR companies to receive upside. ✓ Funding mechanism created for oversized infrastructure "common infrastructure" ✓ Fund a portfolio - do not try to pick winners ✓ Flexible funding source for <u>opex</u> (and capacity charge) – long term cash flow guarantee ✓ Stable business and political environment and outlook - avoid white elephants. Path to "more and bigger". Political commitment and roadmap. ✓ Concentration on MS that are willing to proceed rather than all, others opt in later. Mature offshore storage. ✓ Develop liability limiting/sharing mechanism ✓ Decoupled CCS chains 	<p>Liberalised market</p> <ul style="list-style-type: none"> ✓ Carbon will be priced/taxes/EPs: 80-90% emission reduction on track ✓ Confidence that the policies work and will be in place for some time ✓ Lots of captured CO₂ looking for a home, multiple sources ✓ Extensive transport network ✓ Storage offshore mature ✓ Onshore storage becoming possible ✓ CO₂ production will swing (excess capacity relative to average rate) ✓ CCS regulation mature and well tested ✓ Liabilities and risks of storage well understood and predictable ✓ Capital providers well used to funding, cost of capital reducing ✓ Storage technology proven, business as usual ✓ North sea ring established, other countries adopting ✓ Widespread public acceptance ✓ Portfolio of projects: risks are spreadable/sharable/insurable ✓ Conditions for competition will exist ✓ Technology will be improving, competition and technology will drive down prices ✓ CCS supply chain will be mature ✗ Construction needed to start in 2020-2030 ✗ Subsurface risk still exists, a leak might have taken place somewhere but this will have been fixed

⁵Part of gas project, driven by Norway carbon tax

⁶Political indications that this might not last

(4) 'Characteristic' business models identified – each suited to different development stages

Contractor to the State is effective before an established incentive mechanism exists and when market failure requires state support. *This model has already proved successful for the North Sea region and will be key to incentivising early movers in other regions.*

Enabled Market comprises state support in some parts of the market, managed competition in others. Consists of a regulated entity, 'Market Maker', which removes counterparty risk by :

- a) Managing the development of primary infrastructure on behalf of the state
- b) Having a duty to take all captured CO₂ and ensure corresponding storage is available

This model is ideal for growing storage volumes during pre-commercial phase.

Liberalised Market: private companies develop and manage pipelines, hubs and storage sites without specific state direction. *The CCS market is not yet sufficiently mature to move to this model.*



Four key conclusions



1. A policy framework for CO₂ transport and storage is critical to deliver EU climate targets
2. Transport and storage operators need market certainty + manageable risk – the more sources to a sink the better
3. A risk-reward mechanism is vital to realise storage potential – in the timeframe needed
4. Different business models are effective for different phases of CCS development

ZEP's recommendations



- **Establish a Market Maker** to accelerate the development of key hubs and deliver economies of scale.
- **Create a flexible funding mechanism** to develop storage and transport infrastructure.
- **Establish a liability management mechanism** to remove the heavy cost burden from storage operators.
- **Support a well-defined and predictable growth trajectory for CO₂ capture** in national plans.

Findings: Challenges (1)

Causality:

- Capture operators need to have guaranteed CO₂ storage solution, at a known price, before they can gain finance.
- Storage operators need guarantee of income before they can invest in [costly] exploration, appraisal, and feasibility work.
- Transport operators need confidence of income in order to perform feasibility and routing studies including public engagement.
- Both capture & storage need to know that transport is technically, politically and commercially feasible before investing.

Longevity:

- All parties need confidence that other parties (or substitutes) will be present for the duration of the projects (at least 30 years).
- Confidence in policy stability to underpin business models.

Findings: Challenges (2)



Exposure:

- Storage businesses don't only have [significant] exposure at the feasibility stage, but also have an overhang of around 20 years for the closure and post-closure monitoring periods. During these periods they are exposed to risk and uncertainty, without recourse to any balancing income stream.

Value for money:

- The TTFS works from the principle that CCS should be efficient and should strive toward a low cost. Taking input from the UK CCS cost reduction taskforce this implies employing economies of scale in transport and storage.
- Economies of scale imply a level of pre-investment, especially in infrastructure, but the question is **how can this be financed?**