DEEPER DOWN

As the pressure to maintain progress in tackling climate change grows, The Crown Estate's Dr Ward Goldthorpe discusses the key to unlocking the full potential of Carbon Capture and Storage

Carbon Capture and Storage (CCS) has a unique role to play in decarbonising industrial processes and power generation throughout the world. There is increasing focus on the necessity to deliver this solution for reducing carbon dioxide emissions as the world continues to use fossil fuels, but moves closer to using up the carbon budget that will restrict global warming to 2°C.

The EU and its member states have recognised that CCS will be one of a number of different technologies required to deliver decarbonisation targets, particularly for industrial emissions, however efforts to date to move full scale CCS demonstration forward have been less than successful.

In order for CCS to fulfil its potential and necessary role in Europe, large scale infrastructure for transport and permanent storage of CO_2 will need to be deployed. However, for this to take place a number of separate investment and co-ordination issues, and risks that are quite different from those in construction and operation of power stations or industrial installations, will have to be overcome.

The North Sea Basin has some of the best geological formations for storage capacity in Europe; in the vicinity of the offshore oil and gas fields. Exploiting this resource will be the key to Europe meeting its decarbonisation targets by mid-century, and upstream oil and gas operators have the expertise to undertake this task. The oil and gas industry has decades of experience of safely transporting and injecting CO_2 underground in North America, Norway and elsewhere.

What is Carbon Capture and Storage?

When fossil fuels are burnt or used in some industrial processes carbon dioxide is produced. Because CO_2 is considered a major contributor to global warming and part of the solution to climate change is preventing that CO_2 from entering the atmosphere. Carbon Capture and Storage is one way to do this – CO_2 can be removed from the exhaust gases of power stations and industrial plants (such as steelworks, natural gas processing, cement and fertiliser plants), transported to a storage site, and pumped more than a kilometre underground into stable geological formations that will keep it there permanently like the oil and natural gas accumulations of the North Sea and elsewhere in Europe. The International Energy Agency (IEA) has stated that 'the deployment of Carbon Capture and Storage is critical to global efforts to mitigate climate change and keep global warming below 2°C to pre-industrial levels', and that CCS is critical to European and global efforts to mitigate climate change.

> **'The challenge of energy decarbonisation in the UK has placed The Crown Estate at the forefront of the world's biggest clean energy programme including offshore wind, wave and tidal, and CO_2 transport and storage.'**

CCS is often confused as a power generation technology. In fact CCS is really a suite of many different technologies that are combined together through the capture, transport and storage chain in an analogous way to natural gas or LNG production, transport and utilisation – except in reverse! CCS is the only way to dispose of the unwanted CO_2 that we produce, and will continue to produce, in power and industry as we transition to a low carbon energy world. In this way, CCS can be likened to other waste removal activities (such as industrial waste and general household refuse). Industries based on processes for which there is no alternative for decarbonisation will need to begin deploying CCS before 2030 in order for Europe to meet 2050 emissions targets. The CO_2 transport and storage infrastructure required for removing these industrial emissions will be an essential minimum scale that will eventually need to be built across Europe.

Over the coming decades fossil fuel generation capacity will also continue to be utilised in order to meet power demand at affordable prices and balance variability in supply from renewable sources. A proportion of this will have to be fitted with CCS to abate emissions. To achieve the IEA 2°C scenario for emissions abatement, 310 million tonnes of CO_2 will need to be stored per year in Europe by 2030. To put this in context, this is less than 10% of total EU annual CO_2 emissions in 2011. Is there enough storage? The UK Energy Technologies Institute has estimated that there is a 50% probability of 78,000 million tonnes of storage capacity beneath the UK continental shelf alone.

The Crown Estate

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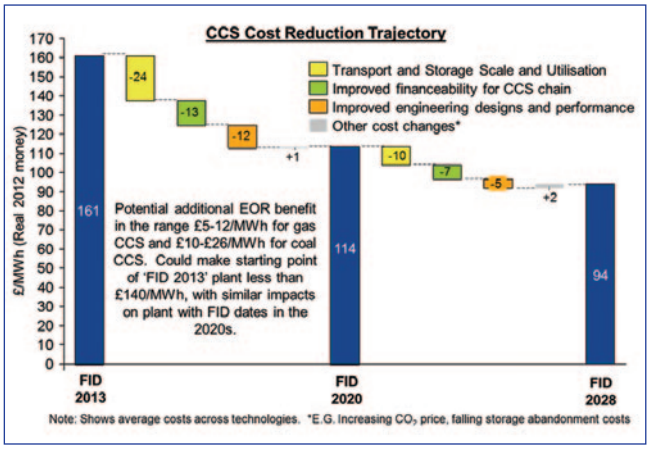

continental shelf and subsurface storage rights includes spatial planning and providing leases for all these activities.

The Crown Estate manages a highly diverse property business valued at £8.6bn (~€10.4bn) for the benefit of the nation. It pays the surplus revenue, profit, to the UK Treasury: in 2012/13 this was £252.6m. Over the past ten years The Crown Estate has paid over £2bn to the Treasury.

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Our energy and infrastructure portfolio includes almost all the entire seabed out to the 12 nautical mile territorial limit and the rights to explore and utilise the natural resources of the UK continental shelf (excluding the hydrocarbons).

The UK Government is currently taking steps, through its competitive CCS commercialisation programme, to help CCS equipped power generation become a viable option in the UK's energy mix by the 2020s. As part of this process, we have signed the UK's first two Agreements for Lease for the permanent geological storage of CO_2 with the developers of two projects that have been named as preferred bidders to receive financial support for engineering design studies.

However, in order for CCS to fulfil its potential and necessary role, not only within the UK but also for continental Europe, we recognise that transport and permanent storage of CO_2 face a number of separate investment and deployment issues, and risks that are quite different from those in the construction and operation of power stations or industrial installations.

The UK Cost Reduction Taskforce

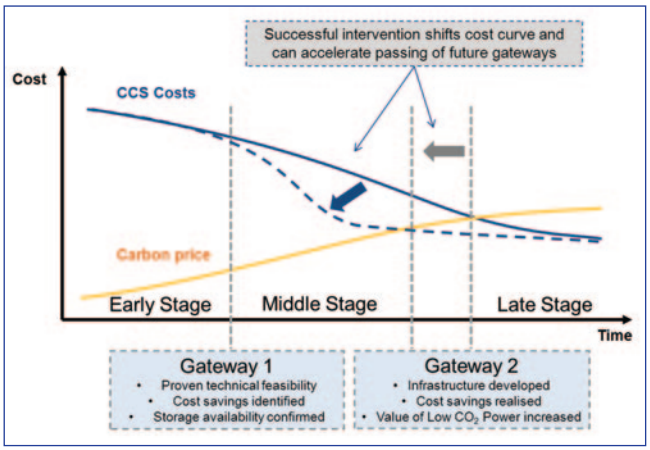
The Crown Estate has been working with the CCS industry on project specific cases, (including power station developers, potential industrial users and potential storage providers) as well as through the UK CCS Cost Reduction Task Force during 2012/13. This task force had the objective of identifying ways of helping to reduce the cost of deploying CCS infrastructure.

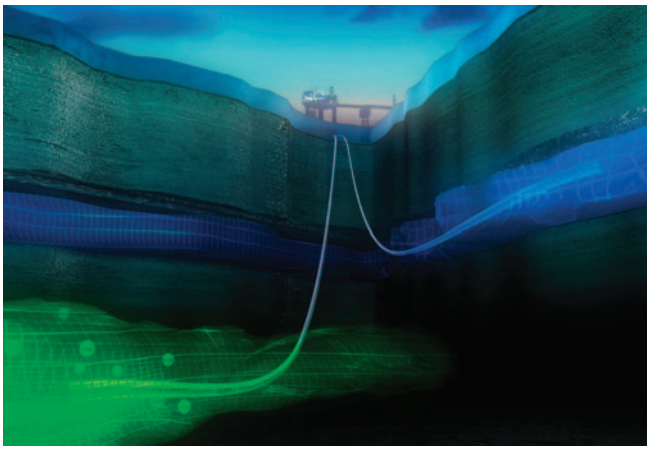
The task force signalled the importance of storage to the cost and deployment of CCS (see CCS Cost Reduction Trajectory graph) and highlighted aspects such as storage site availability and store viability as being critical to its delivery. The Crown Estate is now leading an industry transport and storage development group to take forward recommendations of the task force and assist delivery of proven storage sites and transport infrastructure in the UK with the aim of making recommendations on measures that can unlock cost reductions, maximise benefits of scale and decrease technical, commercial and financial risk in storage. The group will also aim to ensure UK CO_2 transport and storage network configurations are optimised in order to minimise long-run costs and create storage hubs with large scale use.

Assessing storage resource potential

Many countries have produced, or are intending to produce, storage atlases that provide location and potential capacity assessed at country, state or basin scale. While these atlases are useful for initial screening of the feasibility of CCS at a generic level, they are not sufficient to give power generators the degree of certainty required to take forward new stations with capture plants to a final investment decision (FID), or for financial institutions to commit funding. To turn conceptual power or industrial capture projects into reality, storage sites have to be 'characterised' and ready to be developed – in other words financeable or 'bankable'.

The process of characterisation of storage sites has been well defined by oil and gas industry experts and a number of standards have been prepared. Further standards work is currently being undertaken by the International Organisation for Standardisation (ISO) working groups. The length of time and cost to characterise a storage site depends on the type of site and whether data has already been collected from oil and gas exploration or production. The important thing to recognise is that storage characterisation and development is an entirely different activity to power generation or industrial processing. Ensuring we characterise enough storage over the next 10-15 years will be one of the most important foundations for industrial decarbonisation at lowest cost in the future.





CO_2 Stored

The Energy Technologies Institute in the UK led a storage appraisal project at the basin scale level for the UK continental shelf and created an interactive web-enabled database for site screening purposes. The Crown Estate and the British Geological Survey have formed a partnership to further develop and host this database, now known as CO_2Stored. A million pounds of development over five years will enhance the data and functionality to provide more robust screening capability and move the knowledge of individual sites closer to the level at which characterisation can commence.

Storage development pathway

De-risking the delivery of Europe's aspirations for energy security, decarbonisation and retention of its industries in a low carbon world means that complementary national and pan-European policies should support a clear development pathway for CO_2 transport and storage infrastructure.

The figure above demonstrates the idea that if fit-for-purpose policies and support are provided at the early stage of CCS development, cost can be reduced faster and later stages of deployment can be brought forward in time. A key to the success of CCS will be to avoid unco-ordinated deployment of full chain integrated projects over the next decade that do little to promote a common transport infrastructure or the development of storage hubs that can contribute to economies of scale. Such 'point to point' CCS projects will suffer economically from having expensive transport and storage systems, and will not set up the lower cost options for future use of CCS in industrial applications.

To de-risk CCS as a viable low carbon option, additional government interventions are therefore required that address the structural problem of CO_2 transport and storage infrastructure needing a development pathway in parallel to policies that support low carbon power generation or industrial processes. Furthermore, a distinction needs to be made with renewable power generation projects when formulating policy because, unlike power transmission infrastructure, there is no existing CO_2 pipeline network for carbon capture projects to connect to.

So how can storage sites be characterised and brought to bankability at the lowest cost and risk? One effective way in the early-to-middle phase of CCS development would be to encourage oil and gas operators to characterise stores in and around productive fields or those approaching decommissioning. However, because there is currently no existing economic reason for these companies to do so, investment in storage site characterisation will require a mixture of both member state and pan-European policy mechanisms.

Another factor that must be considered is how to incentivise the development of a 'network' of CO_2 transport and storage infrastructure, rather than simply a series of point to point connections. As demonstrated in the UK CCS Cost Reduction Taskforce report, a 'clustering' approach to infrastructure development could be a major contributor to CCS cost reduction. While individual countries around the North Sea Basin such as the UK, Netherlands and Norway could create the early to middle stage CO_2 transport and storage infrastructure for their own use, it is highly likely that at least some of the CO_2 emissions from the major industrial regions of Europe will eventually need to be transported to safe storage sites in the North Sea.

Future costs will be minimised if pan-European policies support an emergent smart design that can leverage scale and the legacy pathway for deployment followed over the next 10-15 years.

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