Non-Pipeline Transport and the Journey to Merchant Carbon Sequestration

Written by Progressive Energy Ltd on behalf of Oserra Connect Ltd

The UK's Carbon Capture and Storage (CCS) vision has long identified non-pipeline transport as a critical component. To date, the UK has focused on large scale pipeline connected projects connecting directly into Transport and Storage (T&S) networks such as the HyNet and the East Coast Cluster (ECC) schemes. However, for the UK to transition from Government supported to fully merchant CCS by 2035 and decarbonize industries located outside of the existing clusters, there is a need to rapidly accelerate non-pipeline transport deployment.

Non-pipeline transport (NPT) refers to the movement of carbon dioxide by road, rail or ship from customer capture sites to aggregation hubs where the carbon dioxide can be injected into a T&S network. Road transport of carbon dioxide is an established business, with 600,000 tonnes of CO_2 moved annually for the utilisation sector. Transport of other cryogenic liquids such as liquefied natural gas are also mature industries.

The UK government recognises the role that non-pipeline transport can play in enabling the CCS industry, as evidenced by its consultation on NPT earlier this year. However, concerns are often raised about the commercial challenge of managing the cross-chain risk between capture projects, NPT service providers and T&S networks, as well as the ability to monitor the source and quality of NPT carbon dioxide.

Progressive Energy has created an NPT service business, Oserra Connect, that is working with several customers to capture, transport and aggregate carbon dioxide for injection into the East Coast Cluster in Teesside. This business is demonstrating that cross-chain risk and quality assurance can be managed with minimal Government intervention.

There are established insurance products from the transport sector which are adequate for managing loss or contamination of carbon dioxide or service unavailability. These products, such

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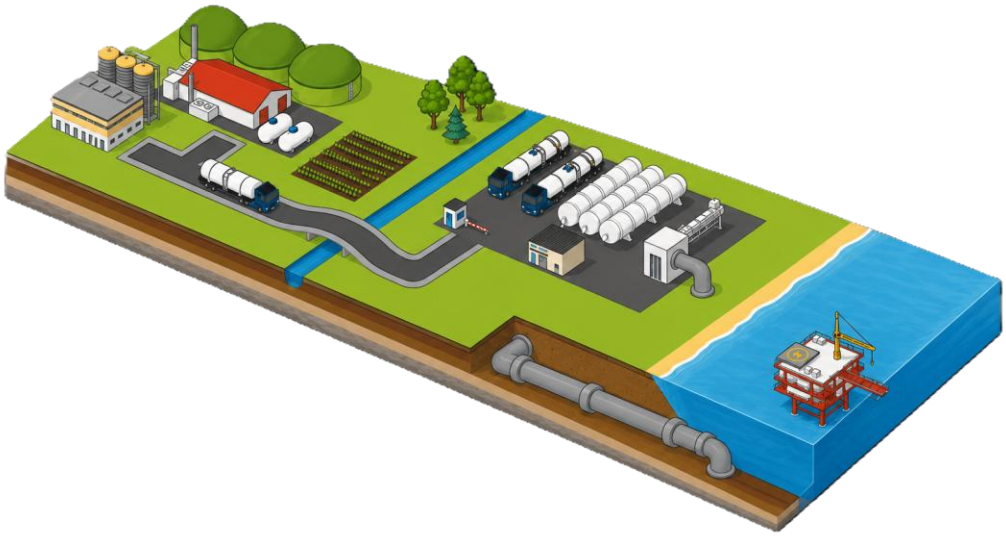
as business interruption and stock in transit insurance, show a clear pathway to the CCS industry moving from Government to insurance backed management of project risk.
Quality control of NPT carbon dioxide can use the approach that has been successfully used in the food industry for decades. Carbon dioxide is tested before it is loaded into transport and only accepted if it meets the agreed quality standard.



Full chain showing capture of CO_2 at customer sites and collection, transport and aggregation by Oserra Connect prior to injection into long term geological storage.

The concern around CO_2 tracking has led the Government to mandate a capture led business model, which allows the Government to perform due diligence on the source and supply chain of the carbon dioxide from capture to store. However, this capture led approach, which requires each customer's individual stream of CO_2 to be injected separately into the T&S network, restricts the capacity of the market to aggregate CO_2, limiting economies of scale and increasing costs.

The biomethane industry provides a useful example of how there are established practices for monitoring the flow of molecules in and out of an aggregated system. Currently companies can inject biomethane molecules into one point of a network but use a mass balance approach to track biomethane and credit offtakers with biomethane volumes, even where offtakers are not directly connected to producers.

Carbon Dioxide aggregators can record carbon dioxide volumes from customers and ensure compliance with carbon dioxide feedstock requirements, such as biomass sustainability rules. Volumes can be tracked through the transport system and any losses recorded and attributed

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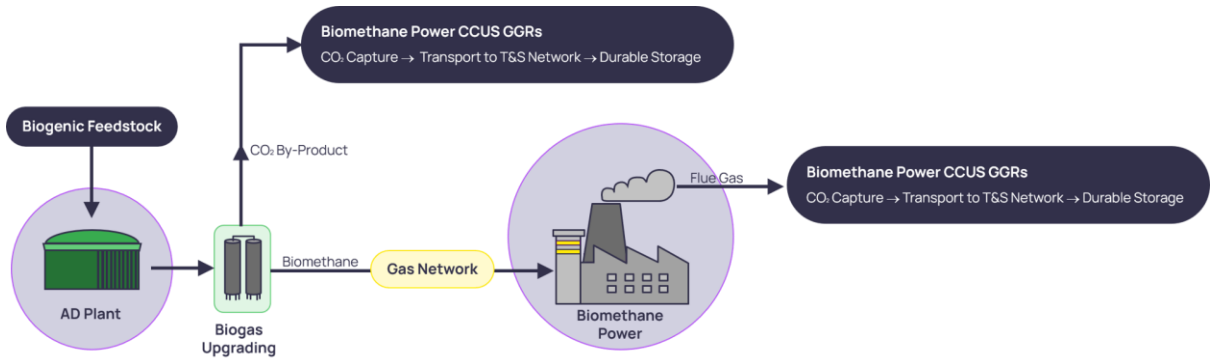
through the full value chain either on a direct or proportional basis. This approach would provide robust assurance of removal volumes whilst lowering the cost of capture through aggregation.
The deployment of non-pipeline transport will enable universal access to carbon storage, with operators who are currently too far or too small able to access T&S networks via NPT. Critically this will include the lowest cost sources of carbon capture, such as the anerobic digestion industry.

Anaerobic Digestion involves the processing of biogenic waste into biogas, a combination of biomethane and carbon dioxide. The process is essential for managing UK waste feedstocks such as sewage sludge, food and agriculture waste. The industry already produces 7TWh of biomethane to grid with nearly 1Mt of carbon dioxide co-product currently vented to atmosphere, with a fraction of this captured and utilised in the industrial gases sector. This carbon dioxide can be liquefied at low cost and transported by Oserra Connect, delivering carbon removals and supporting the growth of the biomethane industry, which is forecast to grow to 35TWh biomethane and 5Mt carbon dioxide by 2035.



Overview of the Anaerobic Digestion and bio-CO_2 CCS process

Carbon capture from the biomethane industry and other sectors is commercially proven and much lower technical risk than alternative technologies. It will also involve capturing carbon dioxide from many small individual sites which helps to improve business resilience by ensuring that any individual capture project failures only have a small impact on the total captured volume. In contrast, large projects such as 2nd and 3rd generation SAF often involve much greater development timelines and technology and financing risks, where single project failure would have a huge impact on the overall volumes forecast.

There is a high demand for biomethane in the UK as a cost-effective solution to decarbonise businesses that are reliant on natural gas. When combined with carbon capture, they can offer a complete solution to businesses to reach net zero, through a combination of green gas and removals.

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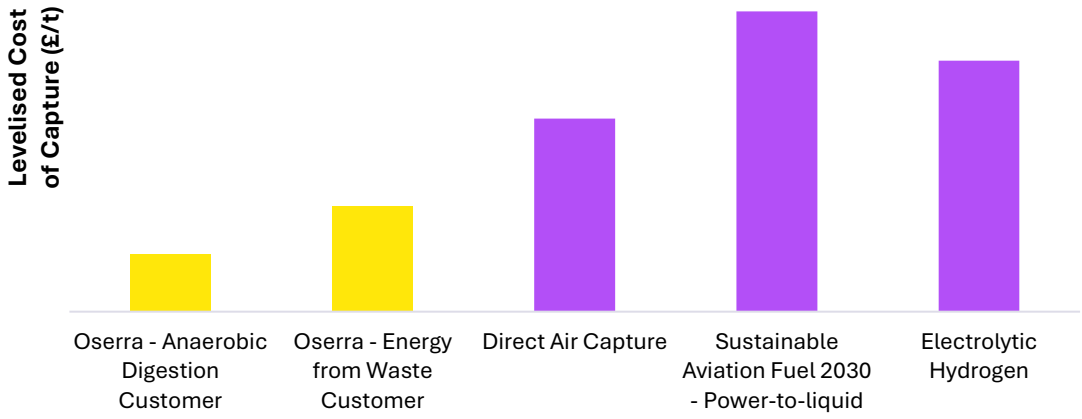
Companies are already willing to pay a premium for these removals, with the voluntary carbon market achieving an average purchase price of $250/t, higher than carbon taxes in various jurisdictions, such as the EU and UK Emission Trading Schemes. Comparatively these costs are far lower on a levelised cost of abatement basis than some alternatives, such as electrolytic hydrogen and sustainable aviation fuel.

Comparison of different Technologies on a costs of CO_2 abatement basis



The Independent Review of Greenhouse Gas Removals (GGRs) Net Zero Aviation Mandate recommendation suggested that airlines should have the choice to procure SAF or GGRs. A GGR is the equivalent of a carbon credit or carbon removal, more commonly called Carbon Dioxide Removal (CDR) globally. The Net Zero Aviation Mandate proposal would likely increase both the demand and value of GGRs, with non-HEFA SAF prices expected to be more than £1,000/tCO2[1], with the SAF buyout currently around £1,909/tCO2.

Allowing companies to meet compliance obligations through GGRs would allow companies to choose whether to pay a premium for carbon avoidance (e.g SAF) or pay a lower price for carbon removals. Noting that carbon avoidance may have other associated co-benefits.

If airlines were to be able to meet SAF mandate compliance obligations through GGRs it is likely that carbon removals would be able to operate on a fully merchant basis. With the cost of capture, transport and sequestration all funded through the GGR revenues, with prices to airlines expected to be £400 – 500/t for high-quality BECCS removals.

[1] Sustainable aviation fuel mandate: final stage cost benefit analysis

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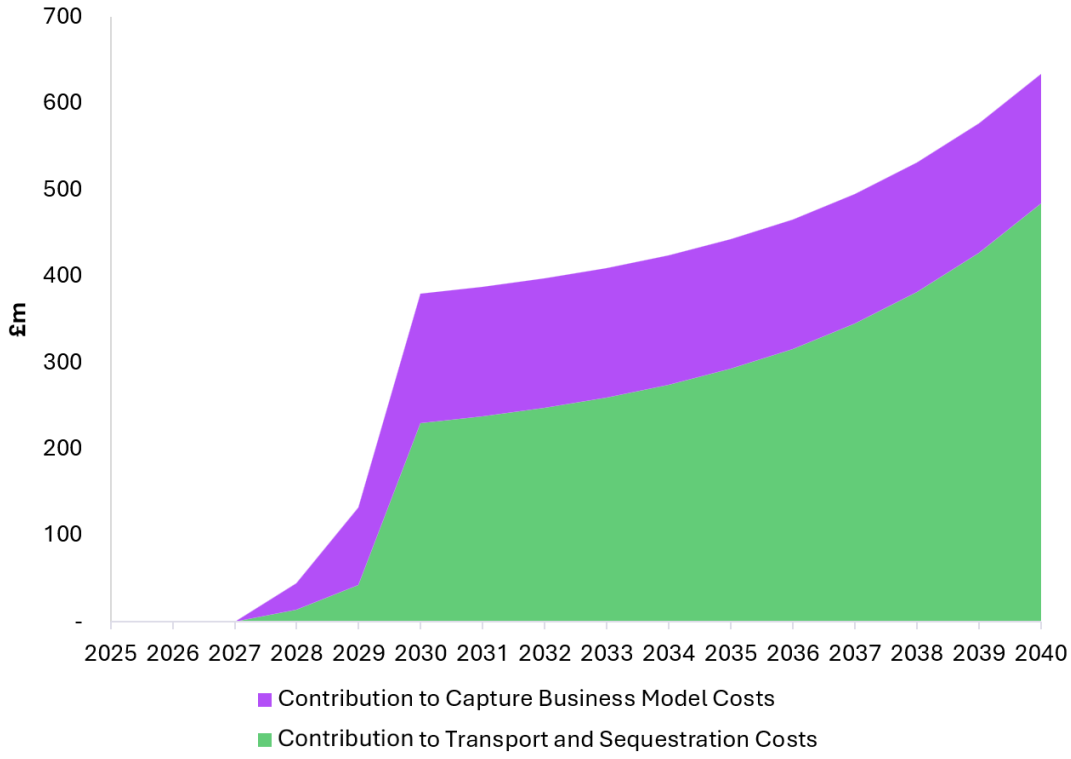
It is not just airlines that should procure carbon removals. Many other sectors would benefit with a growing understanding that decarbonising the last 10% is best done via removals, rather than high-cost alternatives. This is true of the power sector, technology (e.g. AI) and finance sectors. Crucially this follows the "Polluter Pays" principle with industries that can't decarbonise cost effectively able to meet their compliance requirements through procurement and funding of high-quality carbon removals.

Progressive Energy's own analysis has shown that allowing GGRs into the SAF mandate could reduce UK exchequer commitments to CCS funding by almost £400m by 2030. Mandating carbon removals from other industries could likely deliver similar benefits, reducing the cost of CCS to the exchequer and supporting the growth of the low carbon economy.

Benefit to UK Government in reduced transport and storage and business model contracts, assuming that GGR incorporation in the SAF mandate occurs prior to HyNet and Teesside operation (pre-2030).



The NPT pathfinder process is the first step on the journey but the route to merchant CCS is increasingly clear and is expected to be dominated by carbon removals.

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