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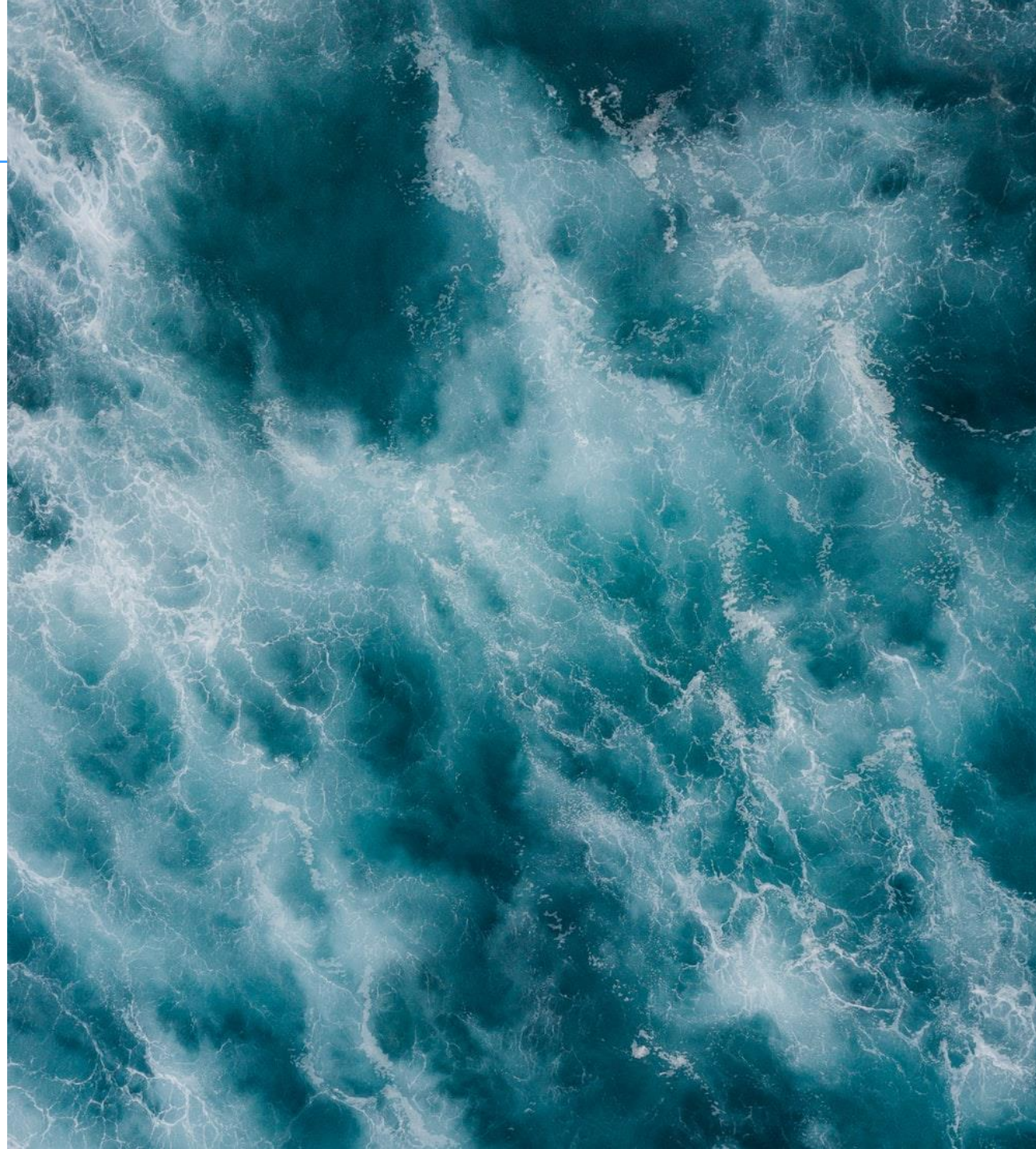
Overcoming Commercial and Regulatory Barriers to CCS - Lessons Learnt from the North Sea

February 2022

OPC UK LTD | 1-2 Apollo Studios, Charlton Kings Rd, London NW5 2SB | +44 (0)207 4281111 | london@opc.co.uk | www.opc.co.uk

Agenda

- OPC Overview & Myself
- Overview of CCS Costs
- The price of CO_2
- Government intervention & support
- Cross chain risk & regulatory challenges
- Hubs and clusters, business models



Oilfield Production Consultants (OPC)

- Established in 1988
- Founder led and managed
- Technical expertise
- Expert, Independent, and Efficient

34 Years	45 Countries
761 Clients	6,289 Projects

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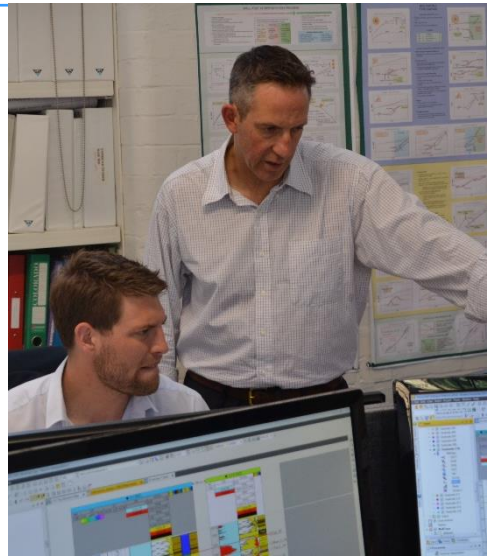
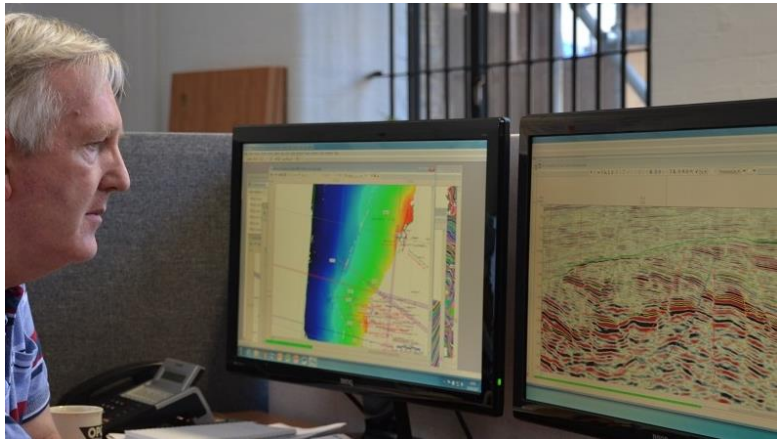
Technical Studies and Projects

- Carbon Capture and Storage multi-disciplinary assessments
- ESG strategy and framework development
- Greenhouse Gas inventorying
- CPR's, asset evaluations and reserves audits
- Seismic-to-simulation field modelling and optimization
- Integrated reservoir modelling and multi-disciplinary field studies
- Reservoir surveillance and management
- Geothermal modelling
- Trouble-shooting problem wells

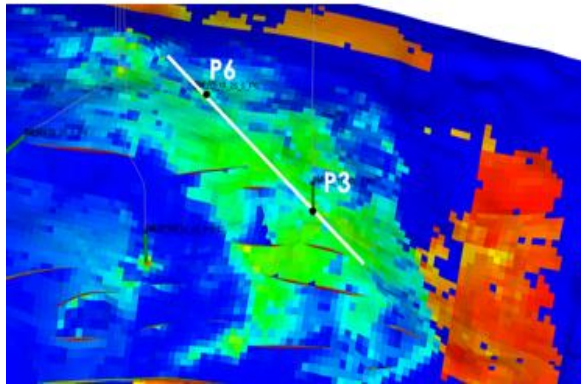




Carbon Capture and Storage Experience

White Rose Carbon Capture Project, National Grid, 2014

OPC provided support in reservoir simulation and modelling for long term carbon injection and storage project. The White Rose Carbon Capture and Storage project would have been the first coal-fired power plant to demonstrate the use of oxy-fuel technology for low-carbon electricity at a competitive cost. The proposed 426 MW plant was expected to send 2 Mt CO2/year to an offshore saline aquifer, achieving 90% capture.

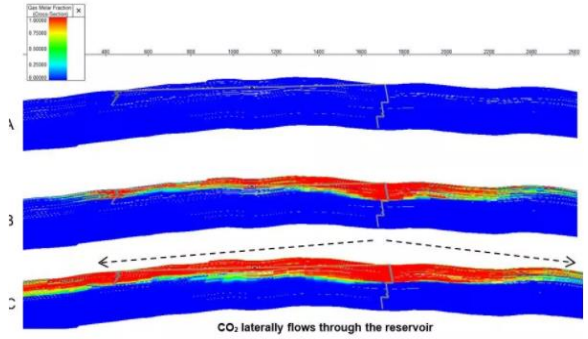


Viking CO_2 Injection Study, Chrysaor, 2020

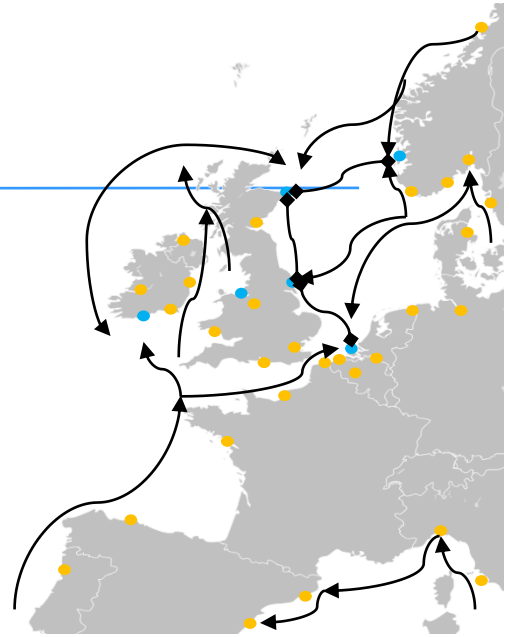
OPC carried out an investigation into CO_2 injection into an abandoned gas field initially from a well injectivity point of view for the well. This was to investigate well injection performance based on CO2 injection gas and any possible impurities in it. Work involved building a PROPSER model to provide a tool to assess injection rates under various conditions.

Phase 1 Feasibility Study, Confidential, 2021

During this high-level review, OPC estimated the theoretical storage capacity of the field, assessed the CO_2 injectivity of the wells for various injection scenarios, and commented on the suitability of the existing pipelines and wells for transporting and injecting CO2. A pipeline specialist was seconded on a project basis performing an assessment of the pipeline including, flow assurance, and pipeline integrity.



A – Pre injection. B – 2.5 years of CO2 injection. C – 8.5 years of CO2 injection.

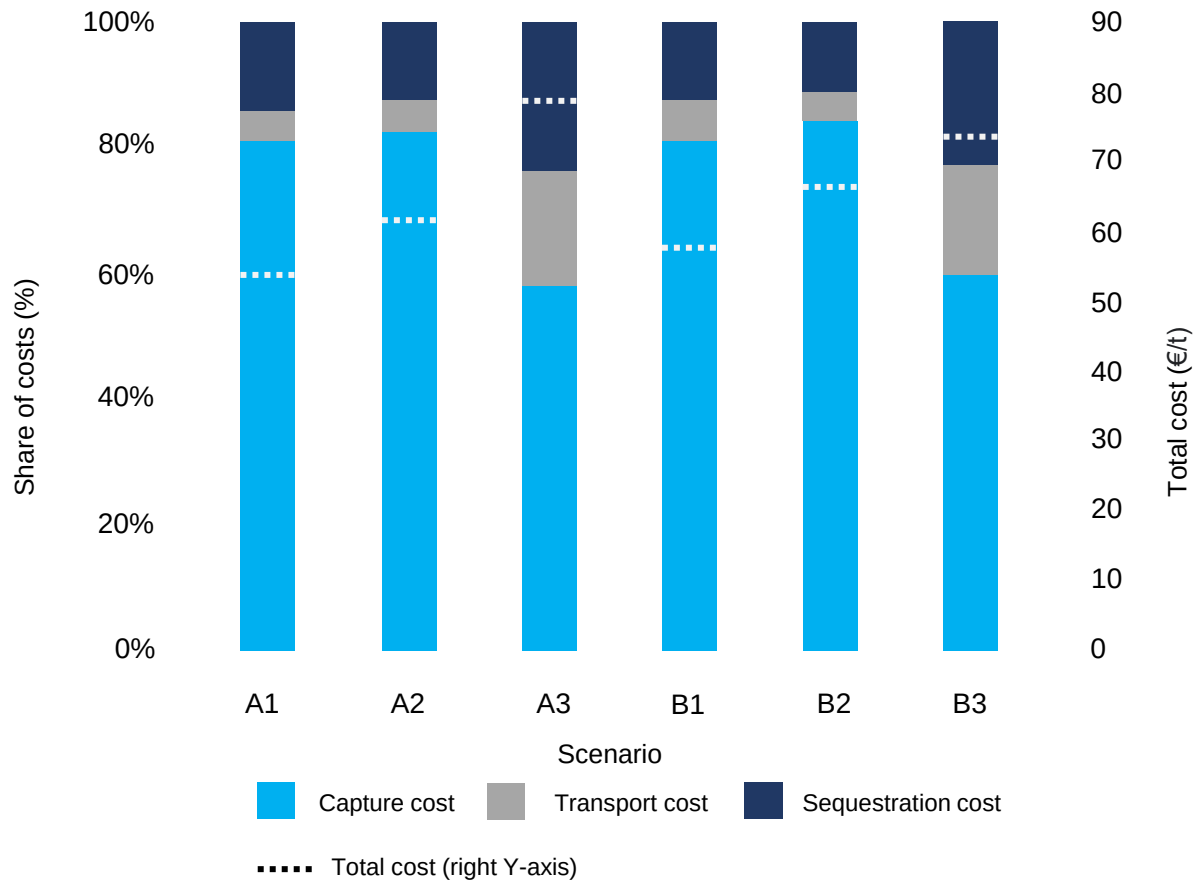


Phase 2 Feasibility Study, Confidential, 2021

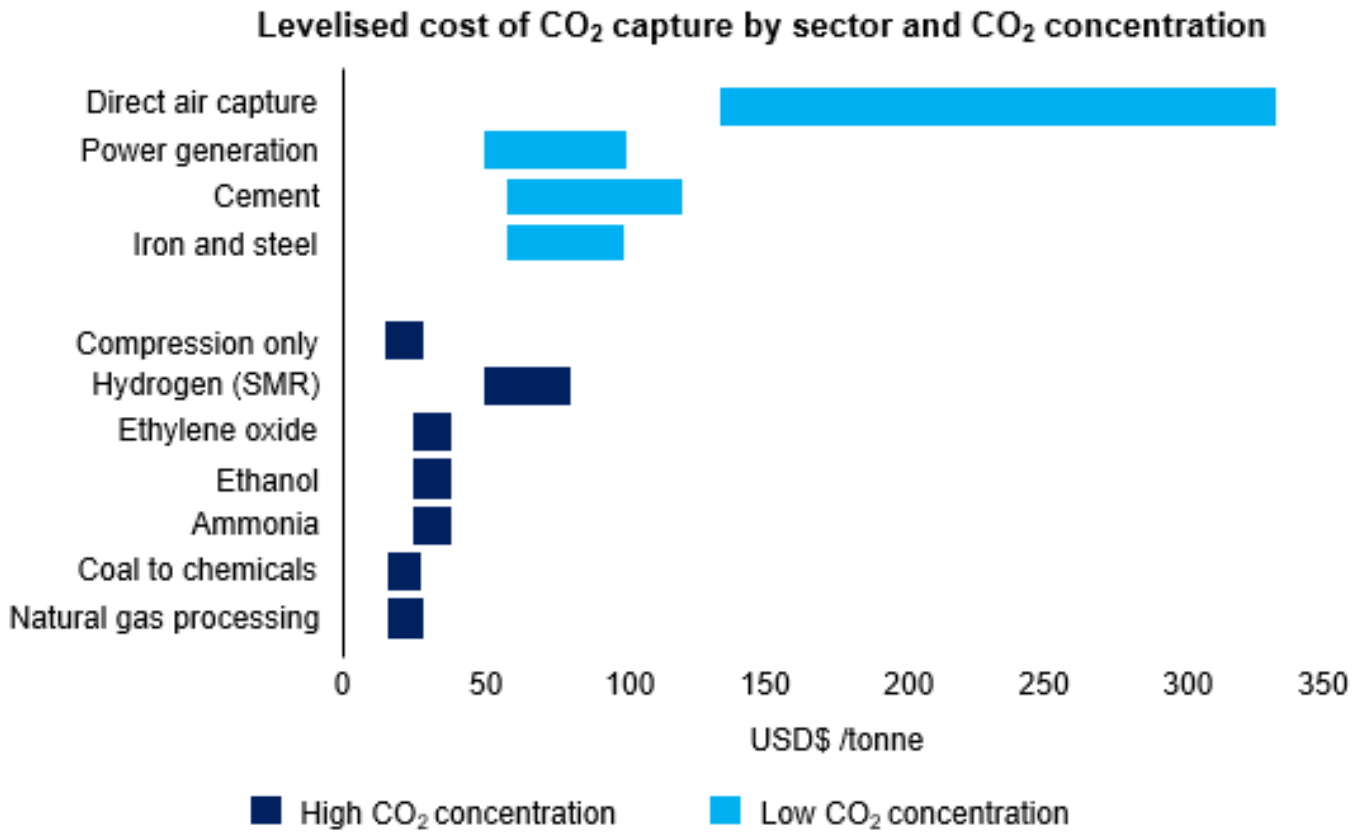
OPC performed modelling of the client's gas reservoir to understand the practical CO_2 storage capacity and appraised the geomechanics of the reservoir. OPC assessed the existing facilities and assessed the economics of injection scenarios including commentary on the commercial and regulatory environment to put costs/returns into context. This included clusters, hubs, and existing policies.

The Cost of CCS

- Majority of associated costs along CCS chain are in capturing the CO_2
- High variation of costs depending on project location and size



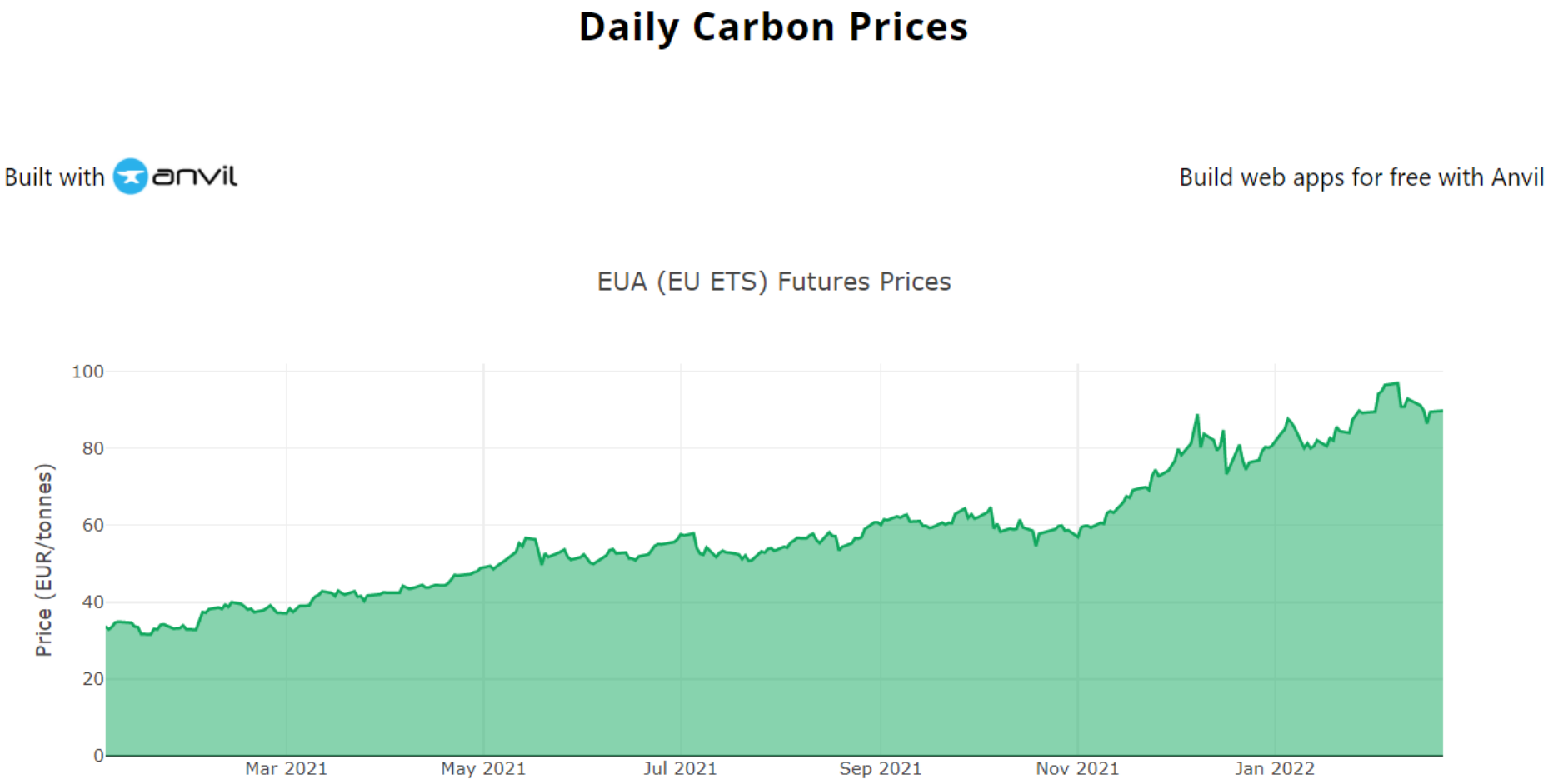
Capture Costs



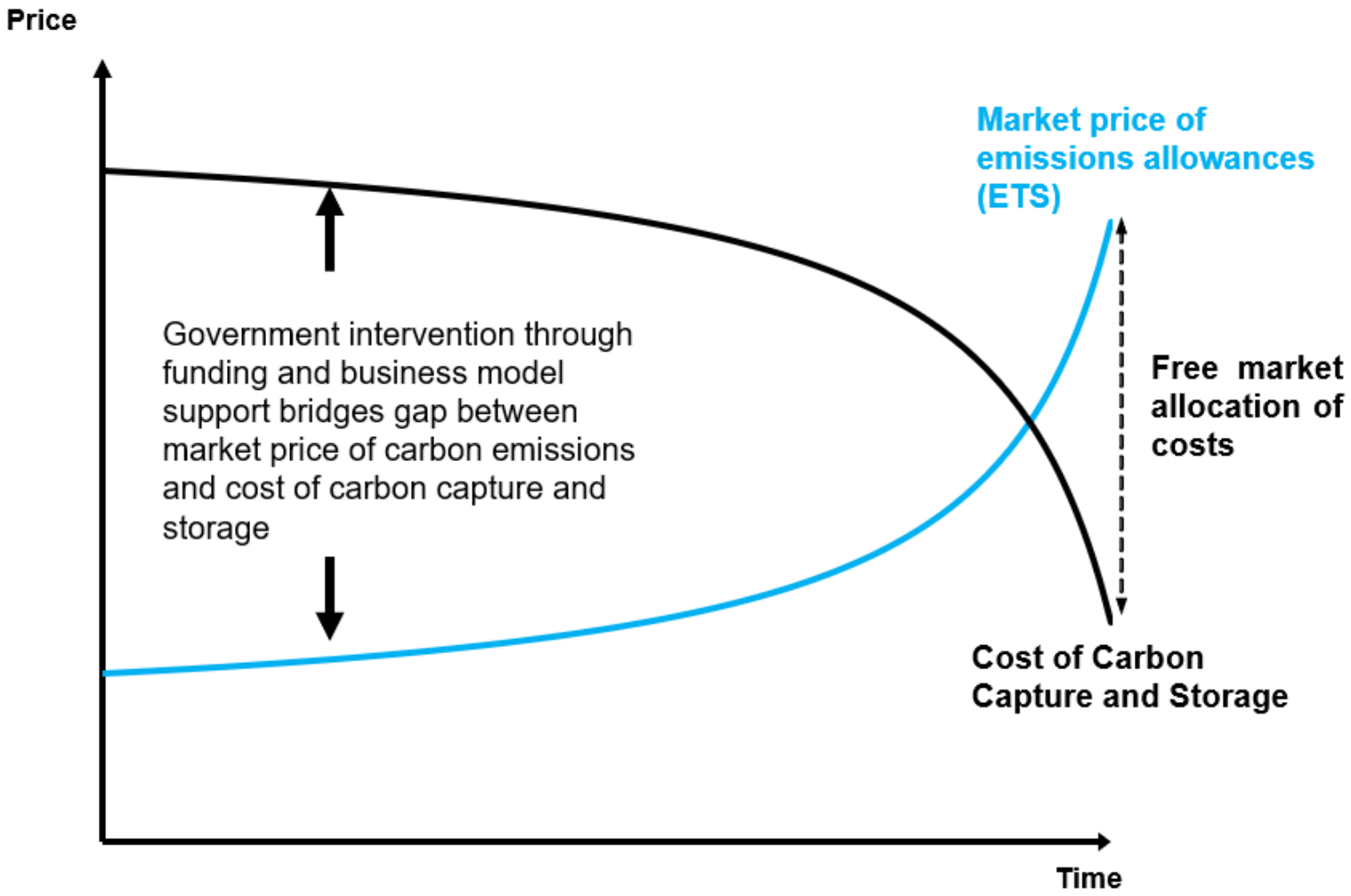
Storage Costs

	Endurance	Hamilton	CaptainX	Forties5
Injection Rate (MTY)	7	5	3	6 then 8
Capacity (MT)	280	125	60	300
Storage Efficiency (%)	19	70	3	6
Unit Cost (EURO / tonne of CO_2)	**6.96**	**8.45**	**16.38**	**12.06**
Total Expenditure (EURO millions)	1961	1063	980	3617
Pipeline length (km)	160	26	86	217
Storage type	Saline Aquifer	Depleted Gas Field	Saline Aquifer	Saline Aquifer

The Cost of CO_2



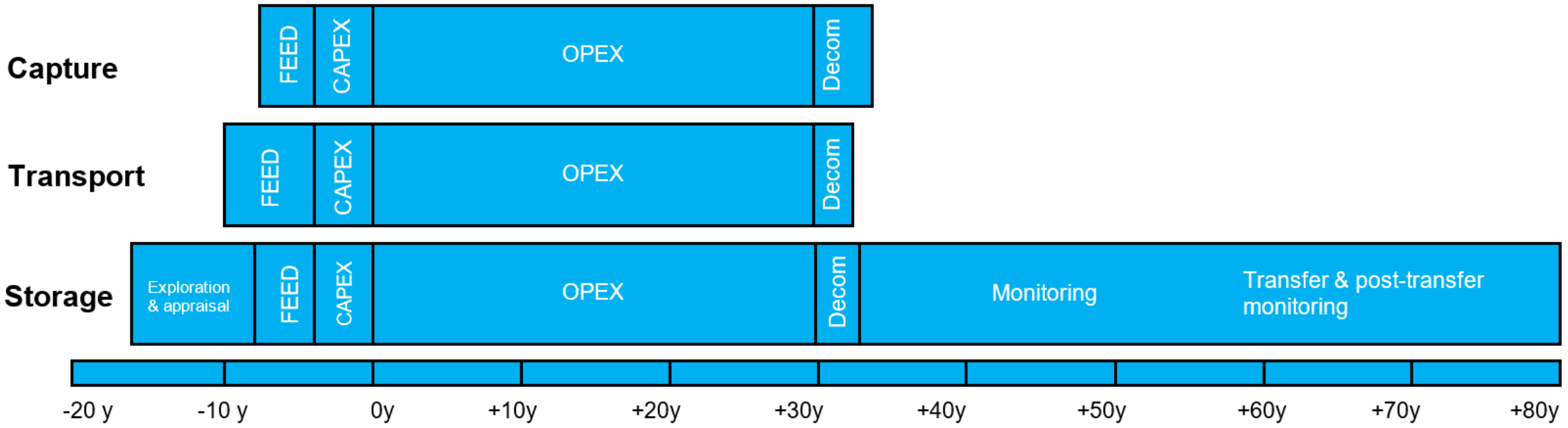
Government Support is Essential



CCS Barriers

- Cross-chain risk
  - CO2 supply security
  - CO2 liability risk transfer
- Economics and market
- Policy

Project Timeframes



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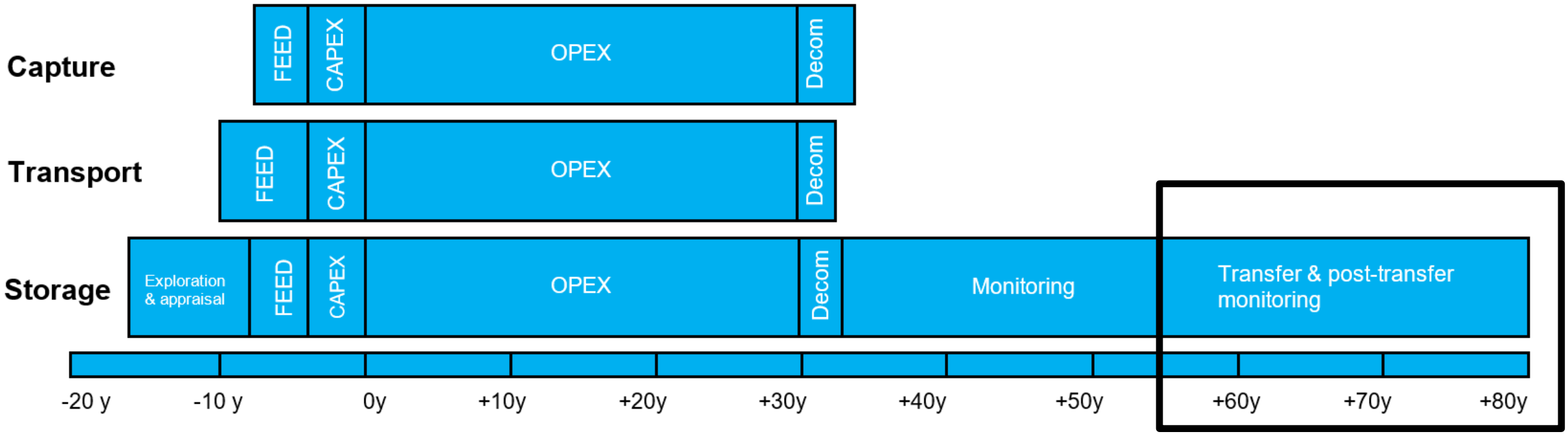
CO_2 Liability Risk Transfer



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Lessons Learned

- Hubs and Clusters

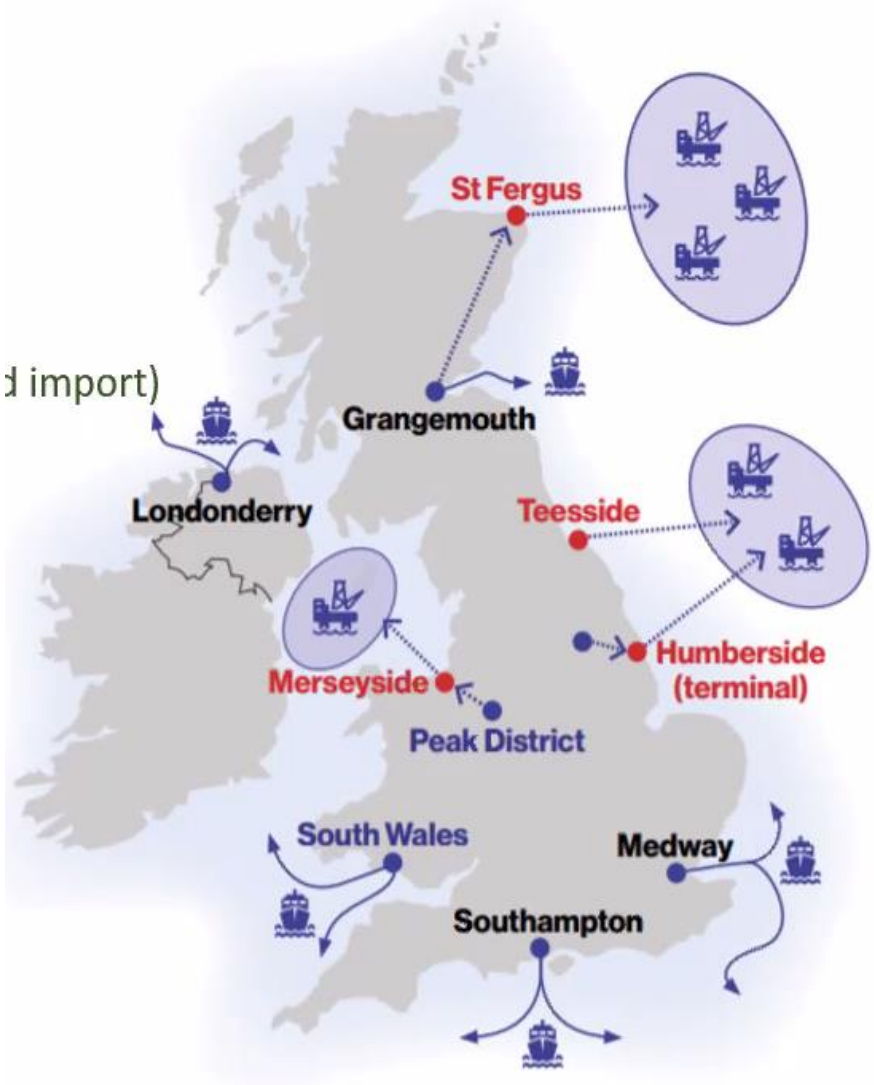
- Transport and Storge Business Models

Lessons Learned

- Hubs and Clusters
  - East Coast Cluster (Teesside & Humberside)
  - HyNet (Liverpool bay)

- Both selected by the UK governments track 1 clusters

- **GBP 1 billion** in government support



Transport and Storage (TS&Co) Business Models

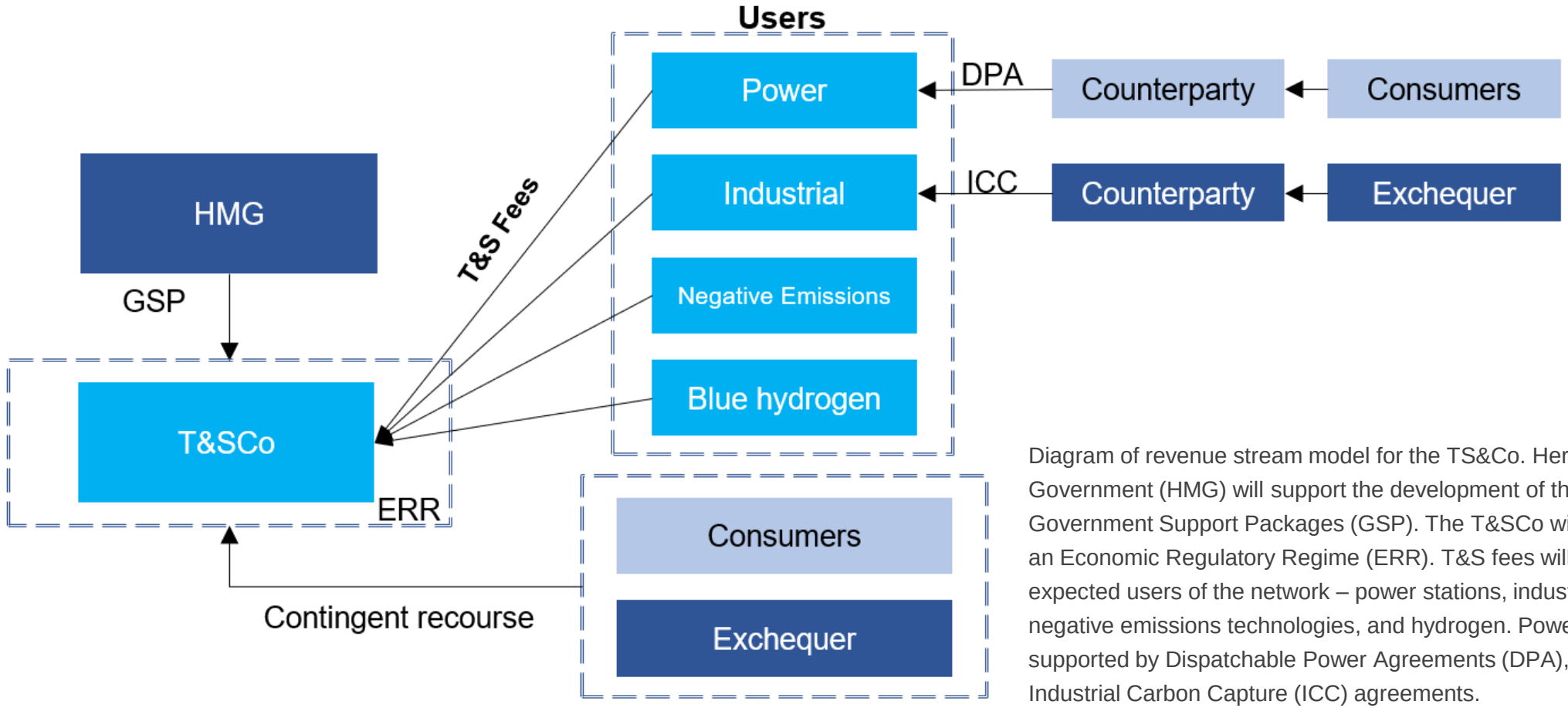
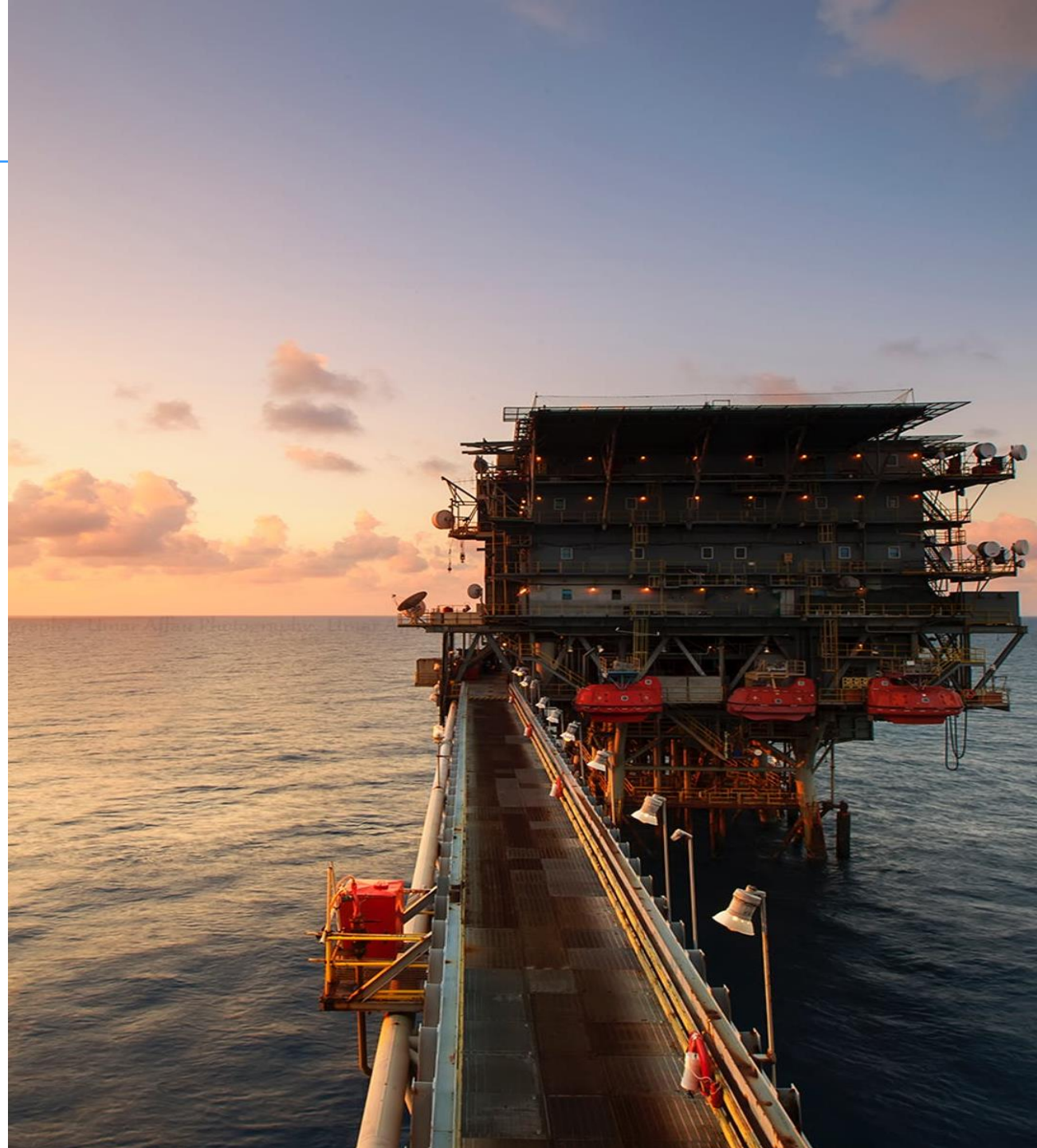


Diagram of revenue stream model for the TS&Co. Her Majesties Government (HMG) will support the development of the T&SCo via Government Support Packages (GSP). The T&SCo will be governed by an Economic Regulatory Regime (ERR). T&S fees will be generated from expected users of the network – power stations, industrial facilities, negative emissions technologies, and hydrogen. Power users will be supported by Dispatchable Power Agreements (DPA), industrial users via Industrial Carbon Capture (ICC) agreements.

Summary

- Deployment of CCS is dependent on sufficiency high price to emit CO_2
- Whilst the technology is immature, government support is essential
- Regulation and policy key to overcoming major technical and commercial risks
- CCS will occur in hubs and clusters for scalability and risk reduction



Thank you!

Questions?