CCUS Overview

Global Developments and Emerging Investment Case for CCUS in Alaska

> Nicholas Fulford, Senior Director Gas & Energy Transition 17th February 2023



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Recap on Market Drivers





Why are governments investing taxpayer funds into CCS?

- Economies reliant on hydrocarbon export:
 - Provides a mechanism for export of a lower carbon fuel
 - Potential to capture low carbon premium
 - Extension of oil/gas production, enhance longer term asset values
 - Attracts "green" or lower cost financing
 - Relevant to many of Alaska's export markets (US West Coast, SE Asia etc.)
- Economies reliant on manufacturing:
 - Provides a mechanism to sell lower carbon products
 - Improves global competitiveness
 - Job creation
- General:
 - Speaks to voter pressure on governments to act on carbon mitigation
 - Growing market for cross border CO2 export / import



Compliance Carbon Market (CCM) Coverage

22% of Global Emissions currently covered by Compliance Carbon Markets



Policy options to incentivise CCUS deployment





Overview of CCS Value Chain



Source - Bui et al. 2018. Carbon capture and storage (CCS): the way forward.

CO₂ concentration

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Compulsory Carbon Markets - 2022 Prices

<4 % of Global Emissions within Carbon Price Corridor sufficient to drive sustainable economics





Improving Economic Case for CCS



CCUS significantly impacts outlook for Hydrocarbons

- Global deployment of CCCUS could substantially alter the energy mix in the 2050 timeframe
- Will slow the decline in global oil production (delay "peak oil")
- Could provide a growth engine for natural gas
 - Hydrogen, Ammonia synthetic fuels
- Helps to remove barriers to debt / finance



Gaffney Cline GaffneyCline analysis using Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5) to assess the potential impact of CCUS on oil and gas demand. The AR5 database has over 1000 scenarios from 31 global energy models.

Buyers, Sellers, Governments striving for carbon neutral LNG

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10/21/2020 07:02 PM EDT Updated: 10/21/2020 08:17 PM EDT

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Chinese giant signs carbon-neutral LNG cargo deals with Shell and Total

Offsetting carbon emission through purchase of such cargoes forms part of CNOOC's plan for low-carbon development

18 January 2021 9:52 GMT UPDATED 20 January 2021 9:36 GMT

Singapore's Pavilion inks first long-term LNG

Singapore's Pavilion Energy announced it inked a deal with Qatar Petroleum's trading unit to buy up

Each cargo delivered to Singapore under this agreement will come with a statement of greenhouse gas emissions from wellhead to discharge port, Pavilion Energy said in a statement.

Pavilion Energy, owned by Singapore state-owned investment company Temasek Holdings, signed the deal with Qatar Petroleum Trading, a subsidiary of Qatar Petroleum.

Qatar, which plans to increase its LNG production to 126 million tons a year by 2027 from 77 million currently, has been trying to secure buyers for the extra volumes.

When issuing a buy tender for LNG earlier this year, Pavilion had asked potential suppliers to outline their carbon mitigation efforts because it aims to eventually make its purchases carbon neutral.

Business Models Evolution



Development Pipeline (CO₂ Hubs and Clusters)



Source: Adapted from Global Carbon Capture and Storage Institute Annual Report, 2019

CCS Value Chain – Value Driver and Risks



Business Models – LNG & CCS similarities



- Take or Pay off-take contract to provide security for both buyers and seller
- Consequences/security for emitters in event of T&S failure

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Business Models – Approaches

	Single Project Model	Aggregator Mode	Open Market Model
Scope	 Single emitter, single storage location 	 Open model to include multiple emitter and storage players. 	 Emitters fee to transact with a range of storage entities
	 Easiest to implement Potential for relatively quick FID Similar to early LNG model 	 Commercially complex Similar to today's sophisticated LNG market 	 Likely medium to long term option for Alaska
Examples	 North slope CO2 capture and / or ammonia plant emissions Local injection as EOR or permanent sequestration Coal plant capture Cook inlet sequestration 	 Network of emitters from Anchorage area Nikiski hydrogen / ammonia Gathering pipeline Sequestration in Cook Inlet 	 Would require a commoditized CO2 gathering system Could be developed on the back of an LNG project as a "foundation" customer







Revenue/Funding Models with CCS Projects - Examples

Desired	0	Financial Support		
Project	Sector	Revenue	Capital grant	
Air Products, USA	Refinery/ petrochemical (15% CO ₂ concentration)	Grant + revenue from CO ₂ sales to trunkline (for EOR)	\$253 million American Recovery and Reinvestment Act (\$384 million total)	
Shell Quest , Canada	Refinery/ petrochemical (15% CO ₂ concentration)	Offset credits under Carbon Competitiveness Incentive Regulation (CCIR)	\$865 million (\$120 million from federal/\$745 million from Alberta) (\$1.31 billion total)	
Illinois Industrial Carbon Capture and Storage, USA	Bioethanol plant (90% CO ₂ concentration)	45Q tax credit	\$141.5 million (US DOE) (\$208 million total)	
Porthos Project, the Netherland	Multiple emitters (petrochemical/industrial gas)	ETS (Dutch carbon tax system)	€102 million for T&S (gov ownership) €2.1 billion for capture(bridge gap between ETS and CCS)	

- Above examples are for refinery, petchem and industrial projects
- CCS is primarily a government-funded project for such emissions



Revenue/Funding Models for CCS Hubs

- Individual developers for CCUS hubs may be eligible for revenue/funding described above
- Major hubs:
 - Teesside (UK): emitters in Teesside, transport and storage by Northern Endurance Partnership led by bp. (27 Mpta, together with Zero Carbon Humber)
 - Porthos (NL) by state-owned enterprises (SOEs) (2.5 Mtpa)
- Key features of these projects :
 - Government grant designed to close the financial gap
 - Government equity investment via SPV or SOE favours T&S infrastructure
 - Segregation of operation and risks: capture and T&S
 - Tariff for T&S: usage charge and capacity charge



Dutch CCS hub – Porthos model and funding









UK CCS Hub - East Coast Cluster model and funding





Cline Source: bp. UK Gov

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Lessons from Global CCUS Experiences

- Significant technical risk remains
 - Sequestration and reservoir suitability becoming better defined
- Financial incentives spurring very significant innovations
 - Particularly in capture technology
- Cost base improving
 - Economies of scale (e.g. aggregator models) are helping
- Regulatory
 - Insurance and bond market responding to demand
 - Key feature typically government backstop on liability
 - Class VI permits currently represent a constraint, states with primacy are developing faster (e.g. North Dakota)
 - Key risk remains funding mechanisms



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