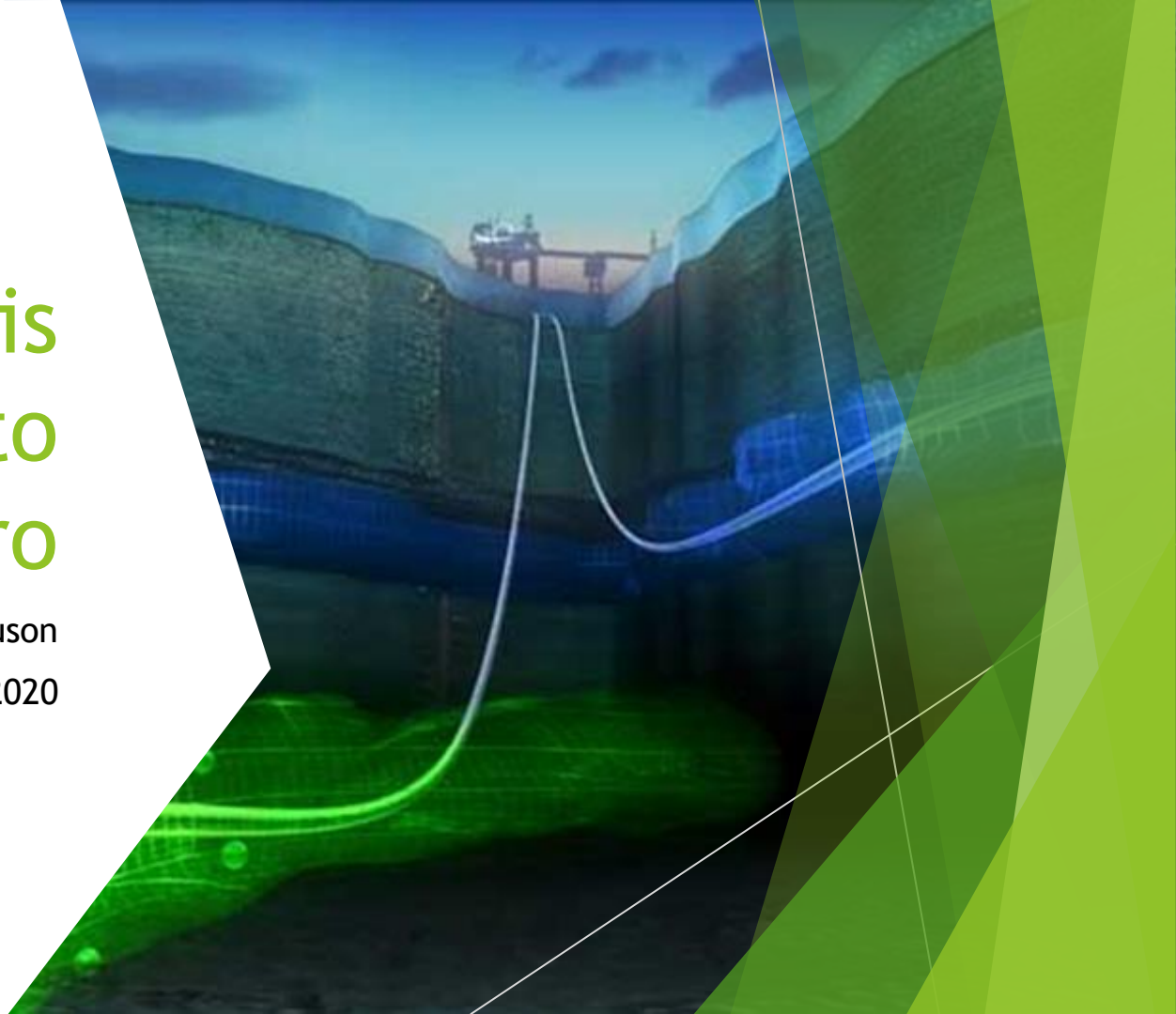
Why CCUS is Essential to Net-Zero

Suzie Ferguson

13th November 2020



Agenda

- Introduction
- CCS Technologies
- Applications of CCS
- Global Greenhouse Gas Emissions Context

Introduction

What is CCS?

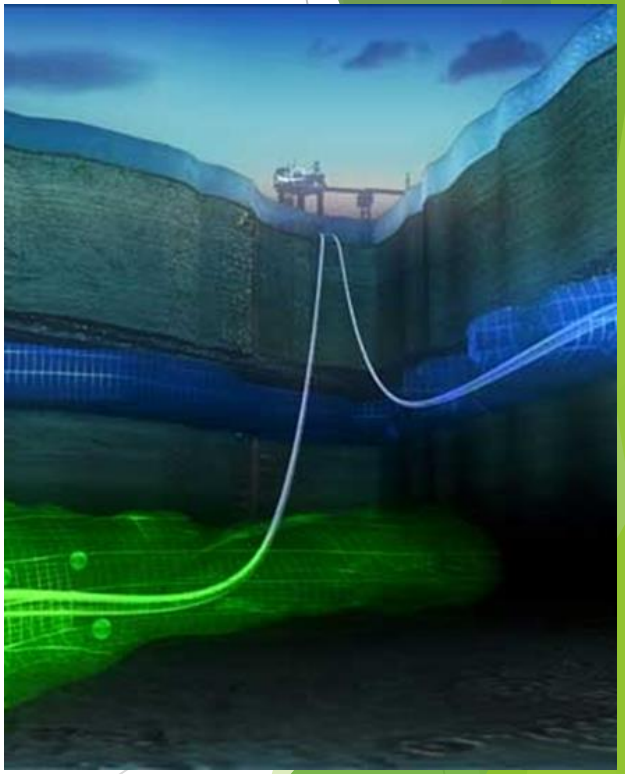
- **Carbon Capture and Storage (CCS) is:**

  The capture of carbon dioxide (CO_2) which would be emitted to the atmosphere and transporting it to a suitable location for permanent storage.

- **Carbon Capture and Utilisation**

  The capture of (CO_2) which would be emitted to the atmosphere and using it to create a saleable product.

- CCS and CCU are often grouped together as “CCUS”.

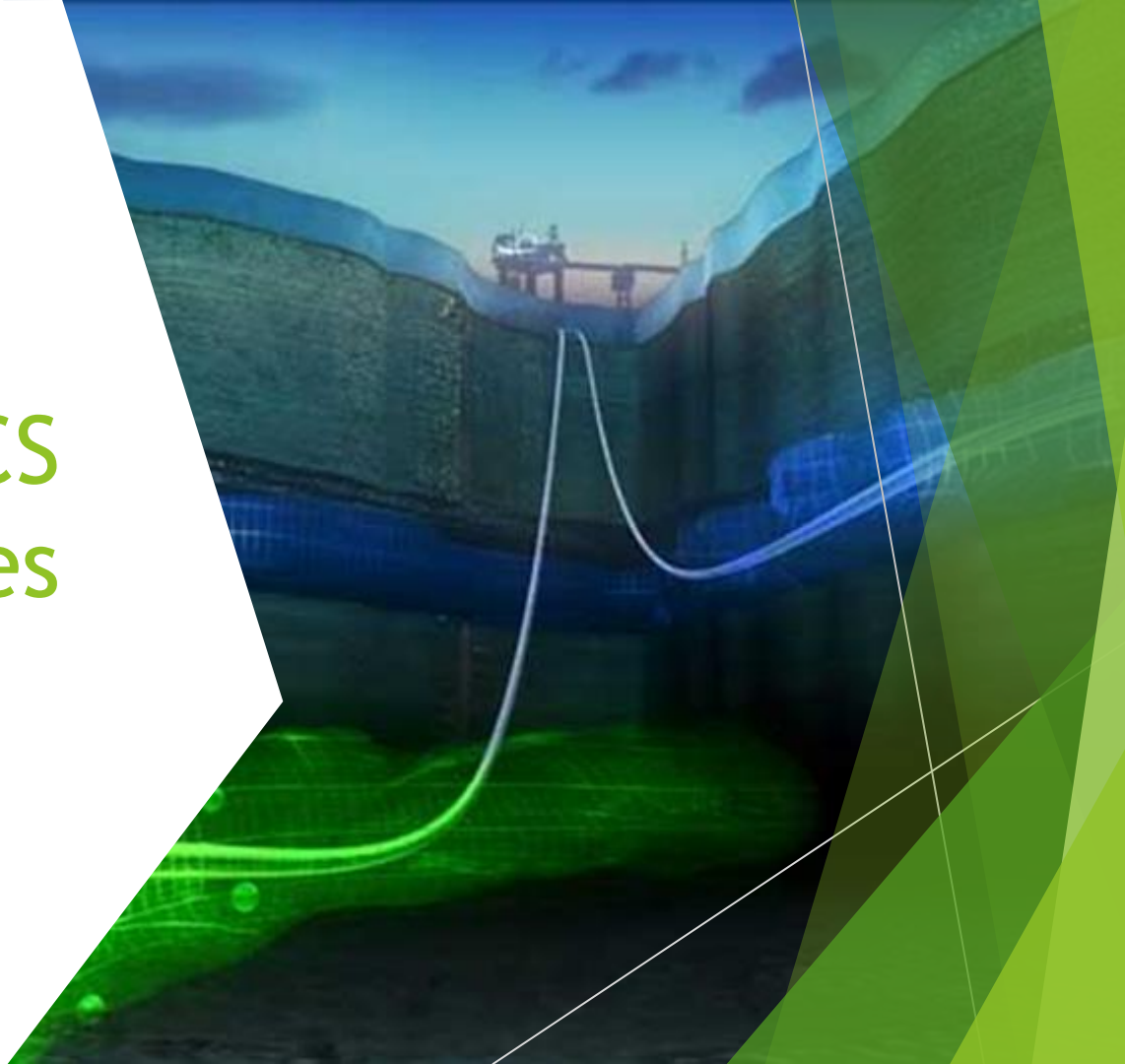


https://www.slideshare.net/globalccs/hagen-13735499

Introduction - Speaker Background

- My generation grew up learning about Rio Accord in school then the Kyoto Protocol as current news
- Studied Chemical Engineering to help design solutions to climate change
- Joined Foster Wheeler from University, now Wood, an Engineering Contracting firm working in the oil & gas / energy industry
- Moved to CCS area in 2006
  - Involved in studies and design of projects in this area for most of the last 13 years

CCS Technologies



CO_2 Capture using a liquid solvent

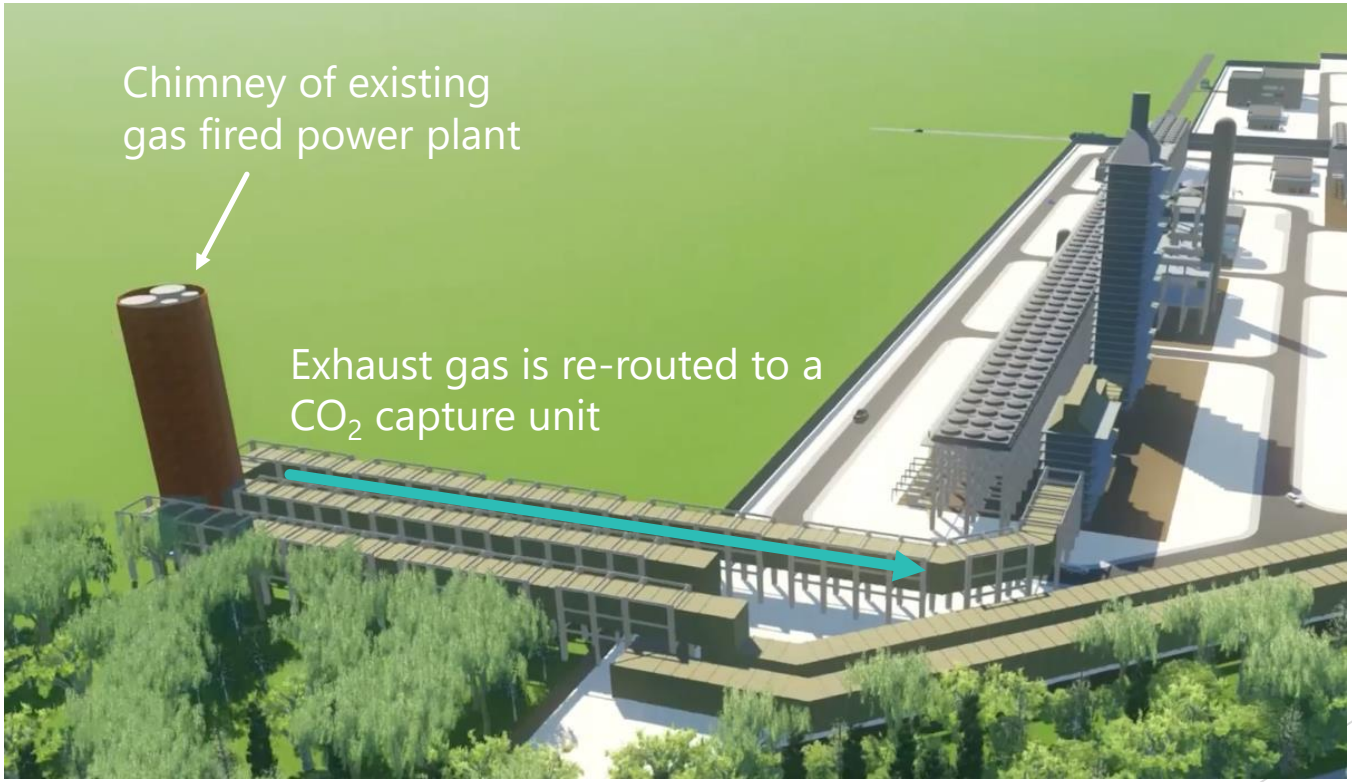


Image from Humber Zero Project

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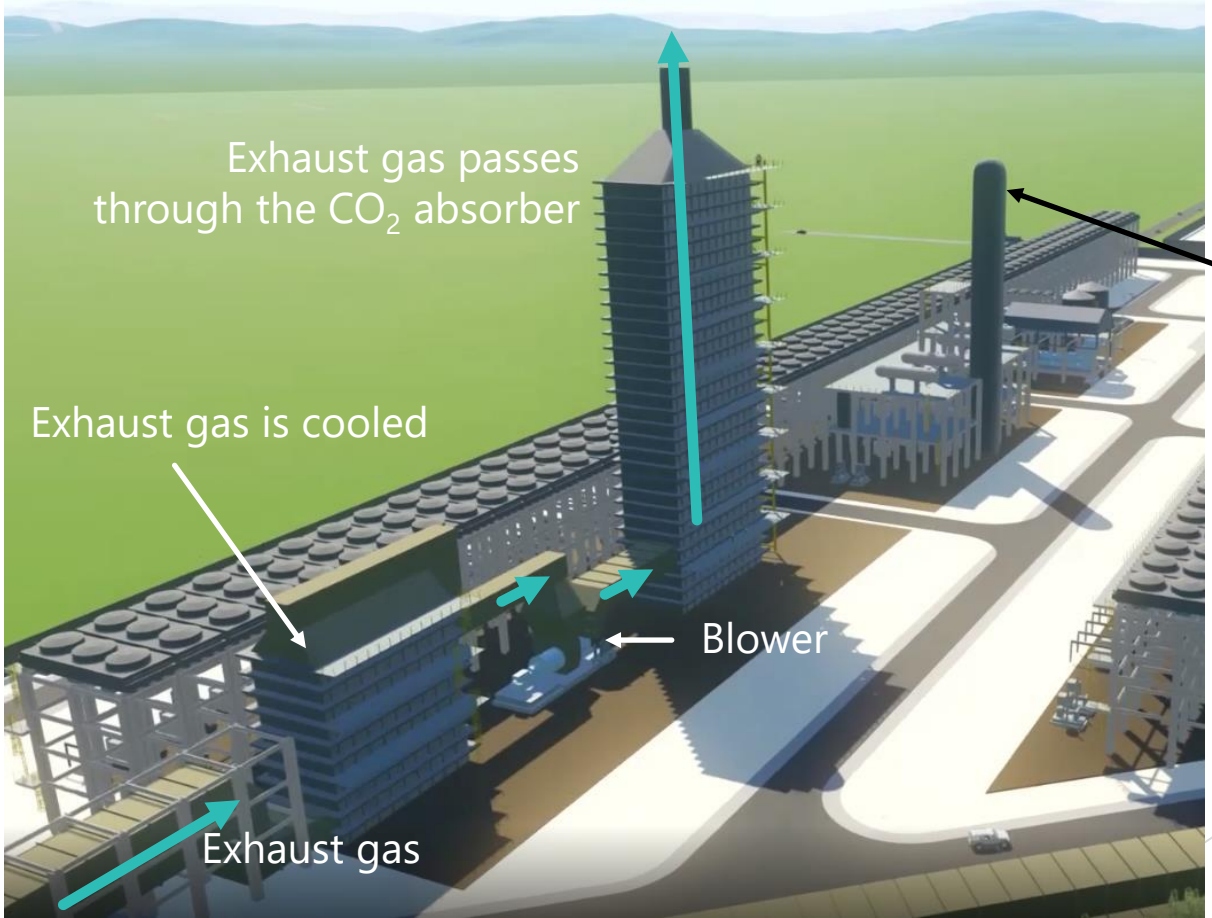


- A water based solvent captures 95% of the CO_2 from the exhaust gas
- The solvent is then heated to release pure CO_2 in the regenerator column
- The solvent is continuously reused
- The pure CO_2 is compressed and sent to a pipeline to be permanently stored

From Humber Zero Project

Post Combustion CO_2 Capture

- Capture of CO_2 after combustion has taken place
- Most proven technologies are solvent based and have been in successful and safe operation for decades.
- Near atmospheric pressure stack gases contain 3.5 to >20 vol% CO_2

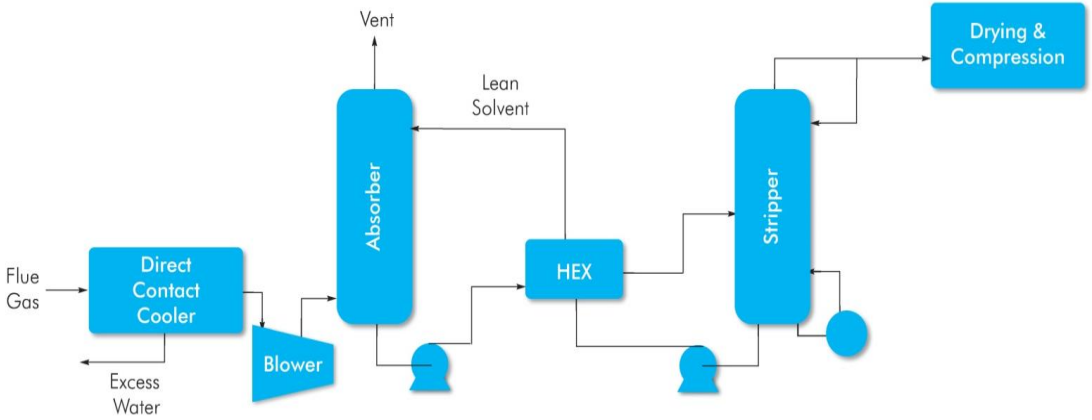
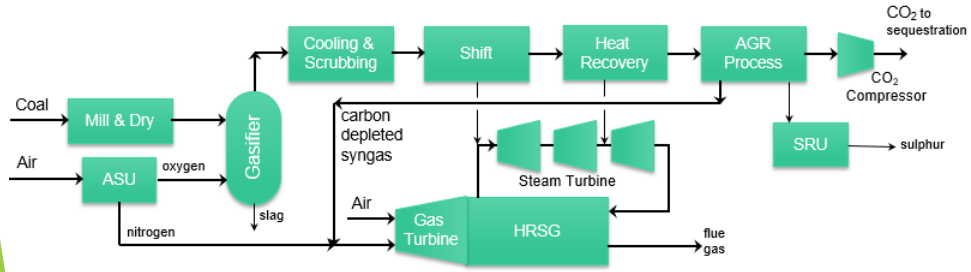
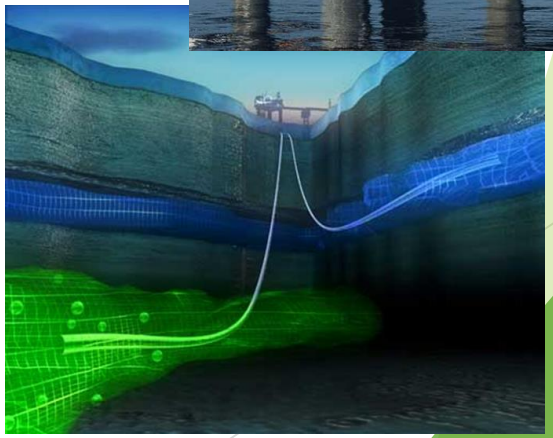


Image of SaskPower's Boundary Dam Power Plant
https://www.saskpower.com/Our-Power-Future/Infrastructure-Projects/Carbon-Capture-and-Storage/Boundary-Dam-Carbon-Capture-Project

Pre-Combustion CO_2 Capture

- Capture of CO_2 before combustion has taken place
- Includes removal of CO_2, sometimes all carbon species, from a potential fuel stream
- High partial pressure streams containing no oxygen
- Most existing CO_2 removal units vent a nearly pure CO_2 stream to atmosphere
- A more complex route to power





Equinor's Sleipner project has been capturing 1 MTPA of CO_2 since 1996

https://www.slideshare.net/globalccs/hagen-13735499

Oxy-Combustion CO_2 Capture

- Combustion with oxygen instead of air
- Exhaust gas comprises mostly CO_2 and water, since nitrogen is removed in an ASU
- Recycle of exhaust gas is required to moderate combustion temperature
- Designs appear competitive and demonstrations in progress
- Promising option for FCC units

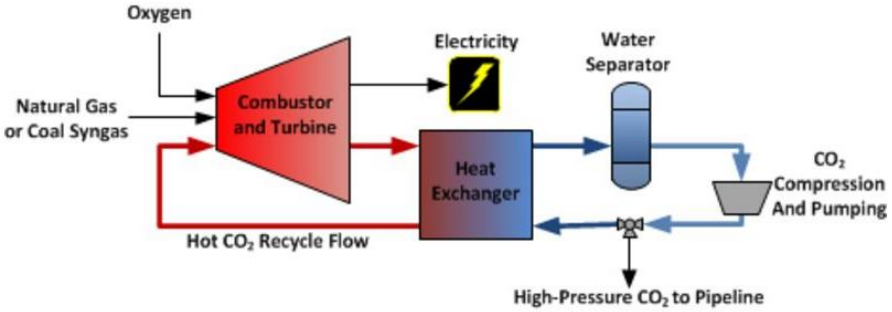


Image of Net Power's Allam Cycle Oxy-Combustion Technology
https://www.bbc.com/news/business-24225901

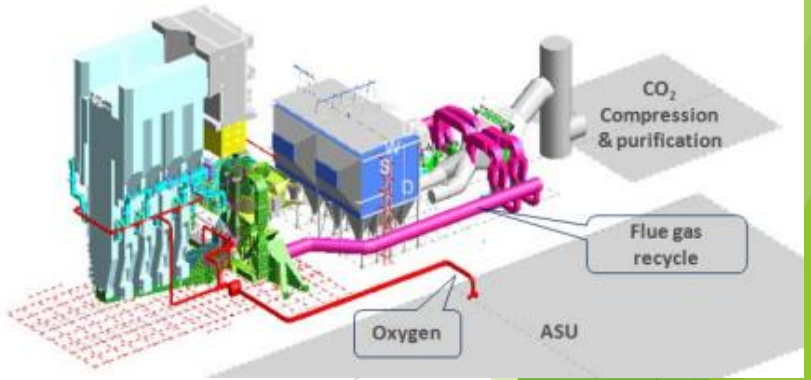
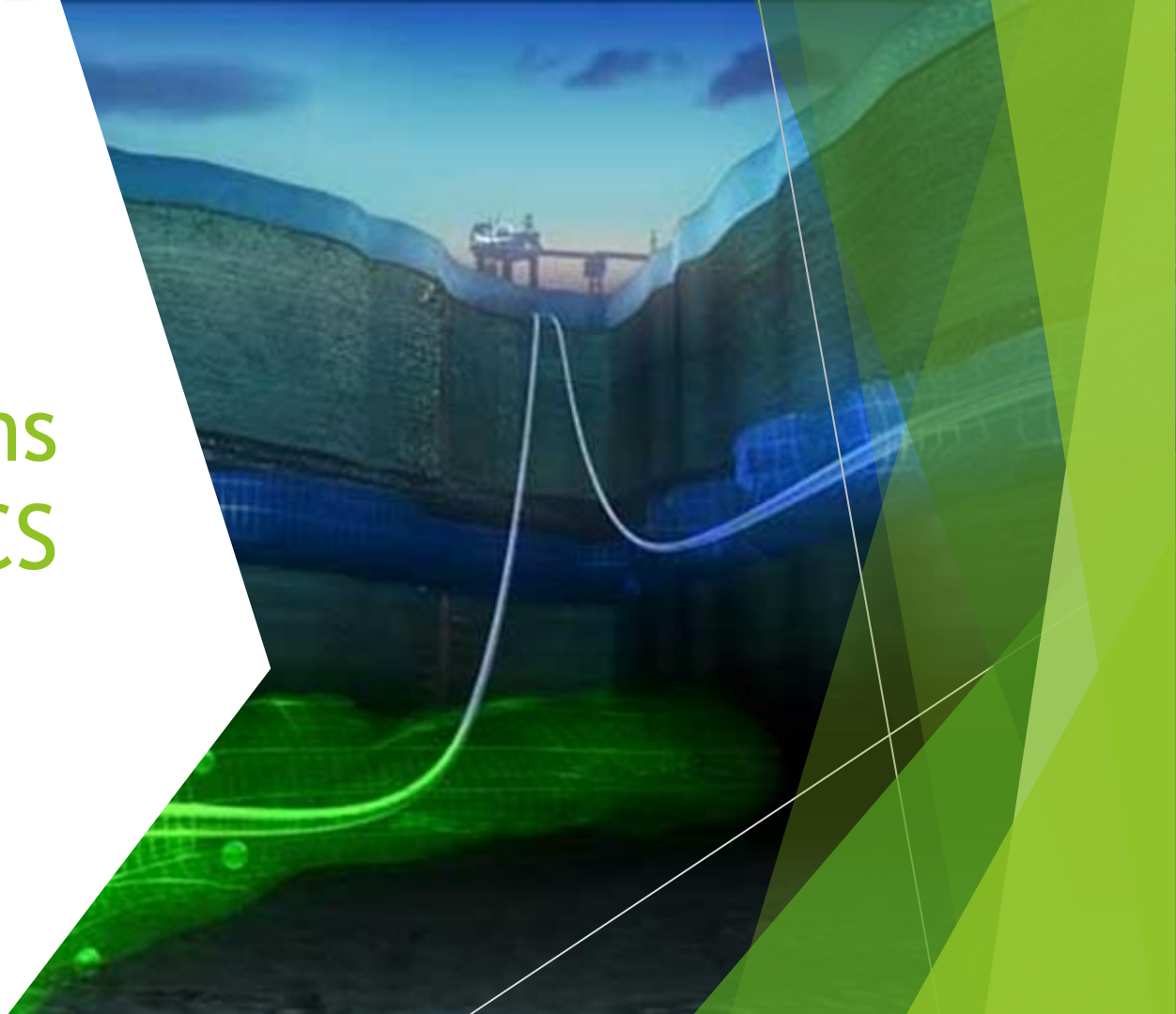


Image of The Compostilla Project Oxy-CFB
https://ieaghg.org/docs/General_Docs/OCC2/Presentations/2_OXYCFB300_Compostilla_OCC2_ML.pdf

Applications of CCS



Pre-Combustion CO_2 Capture

Already applied for CO_2 removal in:

- Gas Treating Plants
- LNG Liquefaction Plants
- Hydrogen Production Units
- Ammonia Production Plants
- Integrated Gasification Combined Cycle power plants

These units only need add CO_2 compression and connection to a CO_2 store often a **lowest cost route to emissions reduction from existing assets**

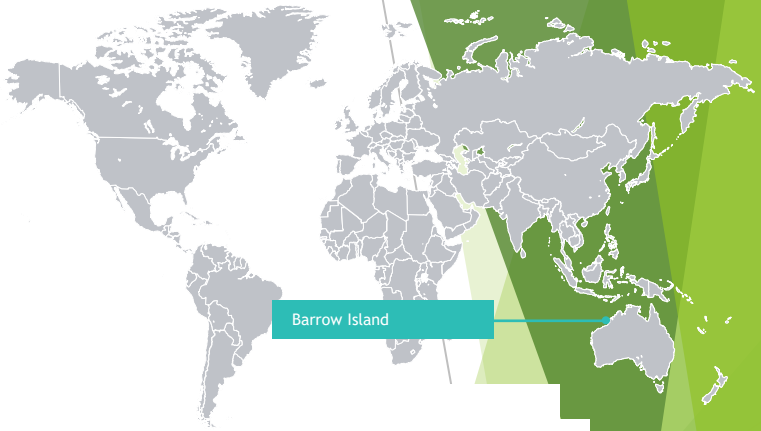
Also provides a route to decarbonisation of fuel gas systems:

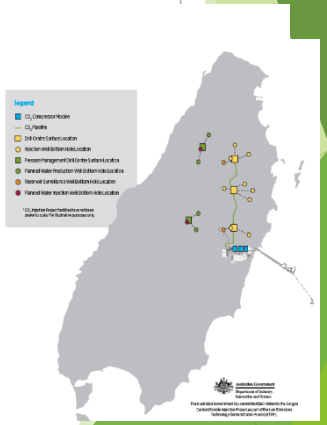
- Oil Refineries
- Steel Plants
- Domestic gas grids

Example - Gorgon CO_2 Injection Project (Chevron)

Gorgon Carbon Dioxide (CO_2) Injection Project:

- world's largest CO_2 injection plant
- A storage capacity of 4 MTPA, accounts for 40% of the Gorgon total projected emissions.
- The CO_2 injection system can handle 250 MMSCFD of high purity CO_2.
- Key concern is ensuring control of the corrosion rates during operations.





Virtuoso Wood's Flow Management Tool (FMT): being deployed to provide online monitoring and offline simulation functionalities to help in the operations management.

Post-Combustion CO_2 Capture

Already applied as a CO_2 source in:

- Coal Power Plants
- Fertiliser Plants

Bolt-on-the-back solution that can be highly effective >95% CO_2 capture and applied to **any exhaust gas**:

- Baseload & grid responsive thermal power plants (fossil fuel / biomass / energy from waste)
- Combined heat and power units
- Industrial fired heaters
- Refinery FCC units
- Hydrogen production plant flue gases
- Cement and lime production flue gases
- Glass production line flue gases

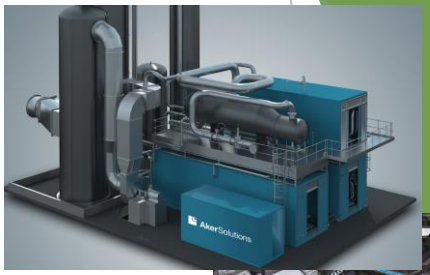
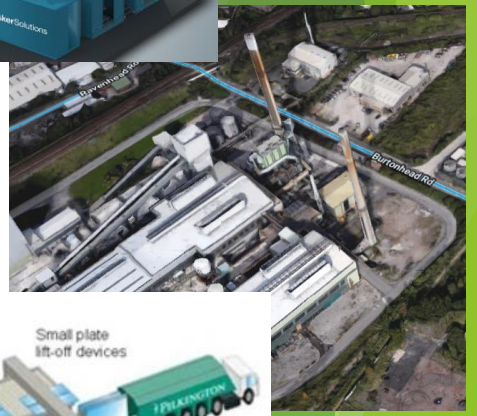
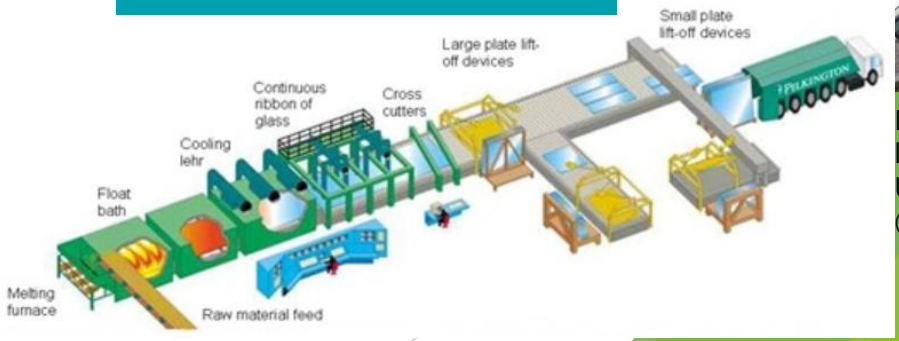


Image of Aker's Just Catch technology
https://www.akercarboncapture.com/technology/products-and-solutions/



NSG's Float glass lines in St Helen's UK
(google earth)

The chemistry of glass manufacture results in unavoidable CO_2 emissions as well as fuel consumption



NSG's Float glass process
https://www.slideshare.net/rjmitson/flat-glass-products-float-manufacture2007

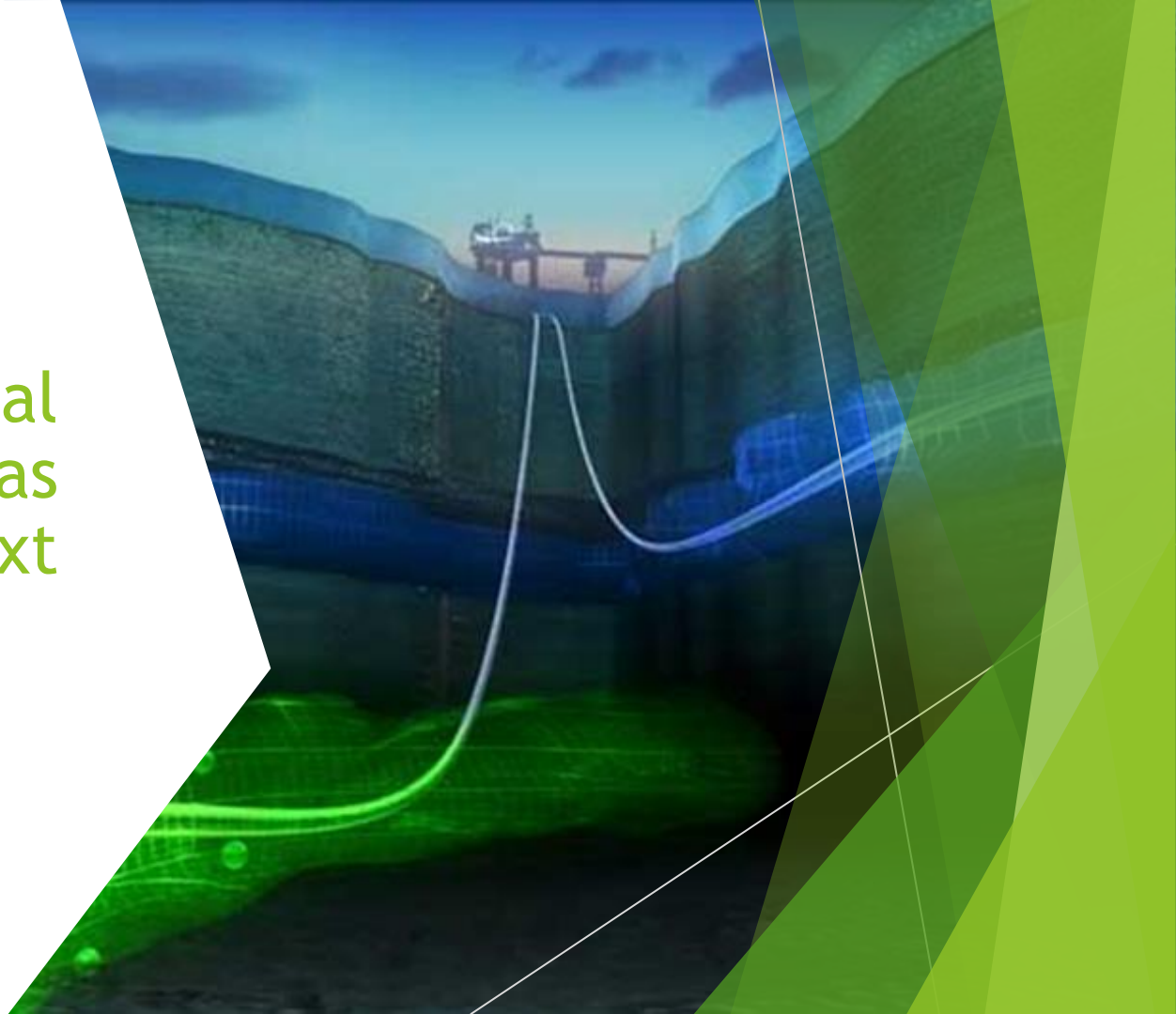
CCS based GHG Removal Technologies

CO_2 capture applied to any bio-derived CO_2 stream has the potential to result in net-negative CO_2 emissions:

- Direct Air Capture (DACCS)
- Bioenergy with CCS (BECCS)
- CO_2 capture from biomass fed hydrogen production (gasification or reformation)
- CO_2 capture from biofuels production
- CO_2 capture from Energy from Waste of Waste to synfuels processes
- CO_2 Capture on other biogenic CO_2 streams currently vented
  - Brewing and other fermentation based processes
  - Bio-ethanol production
  - Biogas production

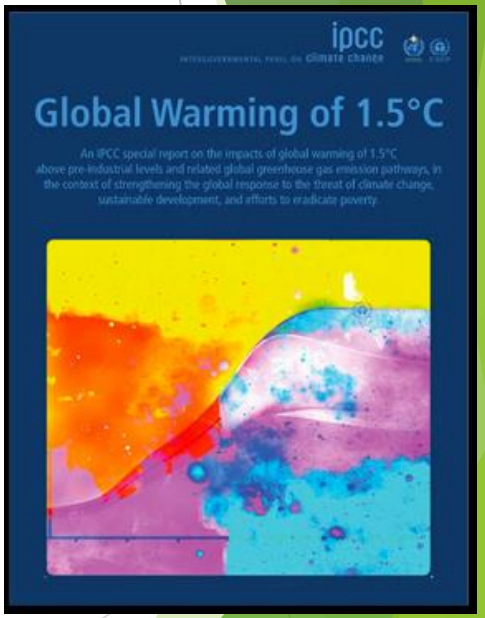
BECCS Animation by Drax
https://www.drax.com/press_release/world-first-co2-beccs-ccus/

Global Greenhouse Gas Emissions Context

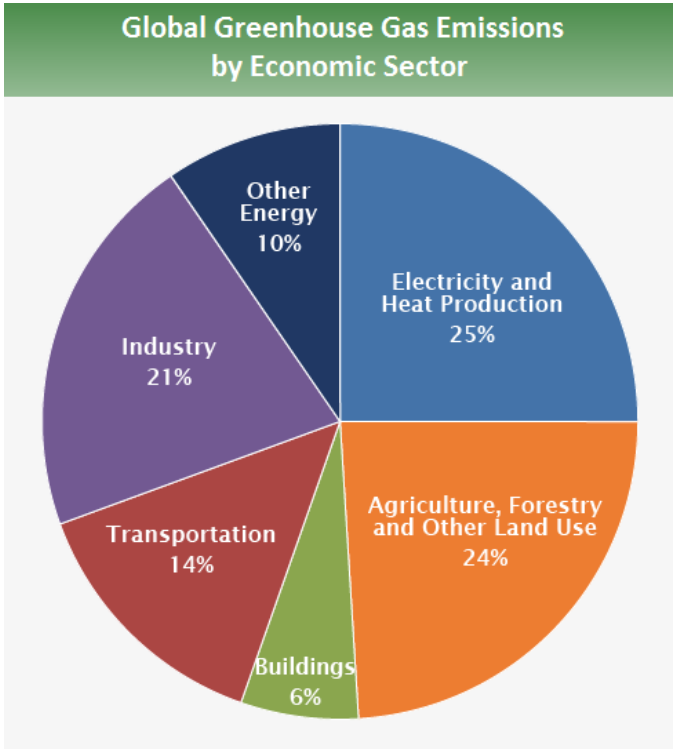


Global Context

- IPCC 1.5ºC Report published in 2018:
  - Limiting global warming to 1.5ºC is possible
  - Requires deep emissions reductions
  - Rapid, far reaching and unprecedented changes in all aspects of society
- We must decrease net emissions by 45% by 2030
- We must reach net-Zero by 2050



Global Context



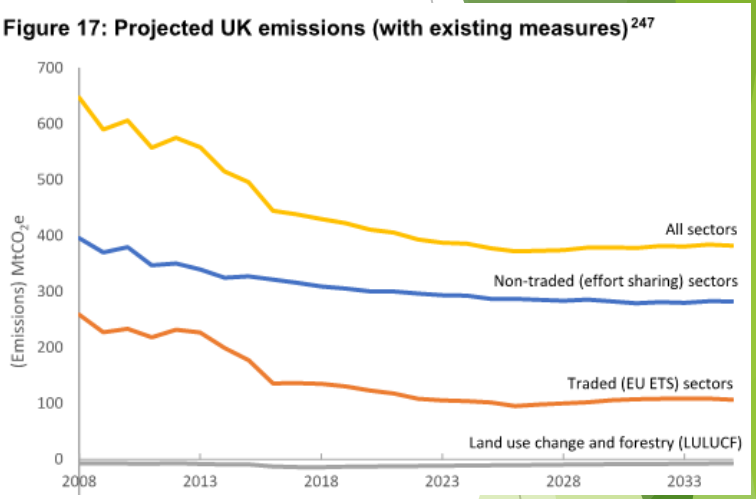
Source: IPCC 2014

- **Electricity and heat**: burning coal, oil and gas for heat and power
- **Industry**: burning fossil fuels for energy AND emissions via process chemistry
- **Agriculture** and deforestation does not include the CO_2 removed by ecosystems
- **Transportation**: road, rail, air and marine
- **Buildings:** space heating, water heating and cooking

UK Emissions by Sector

2018 Total UK emissions were 458 tCO2e

Department for Business, Energy & Industrial Strategy



Source: National Energy and Climate Plan

Electrification using renewable or nuclear energy - with energy storage - can decarbonise many **but not all** emissions sources

Minimum CCS requirements for Net-Zero

- Some production processes cannot be decarbonised any other way:

Steel, cement, lime, glass → Geologically store the unavoidably produced CO_2

- There is no currently available way to achieve zero emissions from agriculture

Ruminants & rice paddies naturally emit methane → Geologically store CO_2 captured from the biosphere

Other very handy uses of CCS

- CCS can reduce CO_2 emissions from (existing or new) **demand responsive** fossil fuel power stations by >90%.
- CCS applied to natural gas for **large scale hydrogen** production can decarbonise domestic heating and vehicles at greater scale and lower cost **sooner** than via renewably powered electrolysis.
- CCS processes can capture CO_2 directly from the air, using energy to directly reduce CO_2 concentration in the atmosphere.
- CCS applied to biomass (or biogenic waste) combustion power generation can produce **carbon negative electricity**.

CCS gives us many more routes and options to decarbonise and the ability to achieve Net-Zero

Questions & Answers