MAKING GAS CCS A REALITY

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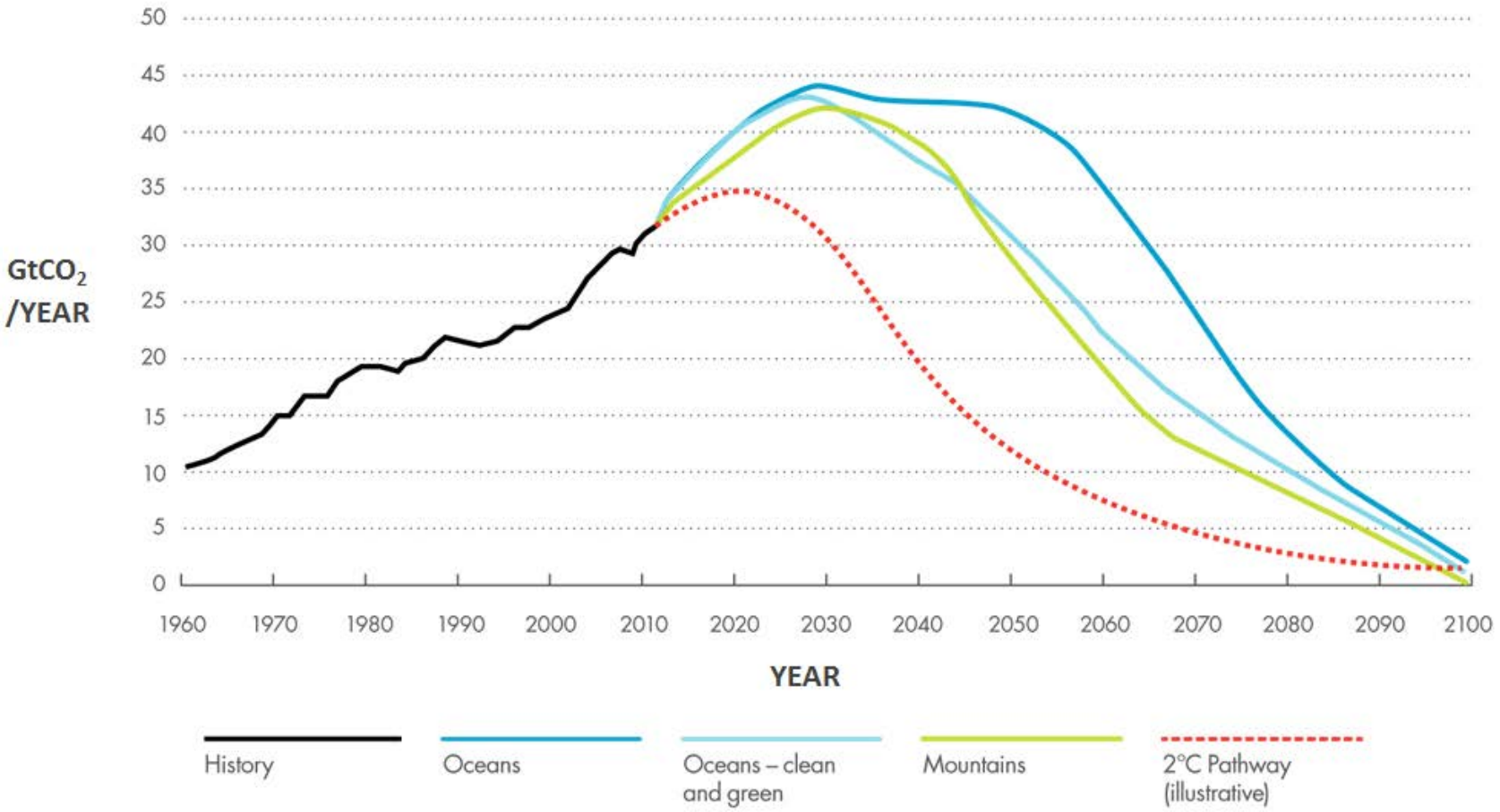
THE DOOR TO THE 2 DEGREES SCENARIO IS CLOSING...



SHELL'S RESPONSE TO THE CO_2 CHALLENGE

NATURAL GAS

BIOFUELS

EFFICIENCY

CARBON CAPTURE & STORAGE

CCS – KEY TO A LOW CARBON FUTURE

17%

CCS has the potential to deliver 17% of the required mitigation by 2050

(International Energy Agency)

40%

Without CCS the cost of tackling climate change could be 40% higher

(International Energy Agency)

138%

Without CCS, the cost of limiting global CO_2 emissions to 450 ppm could increase by 138%

IPPC Fifth Assessment Report

£32 billion per annum

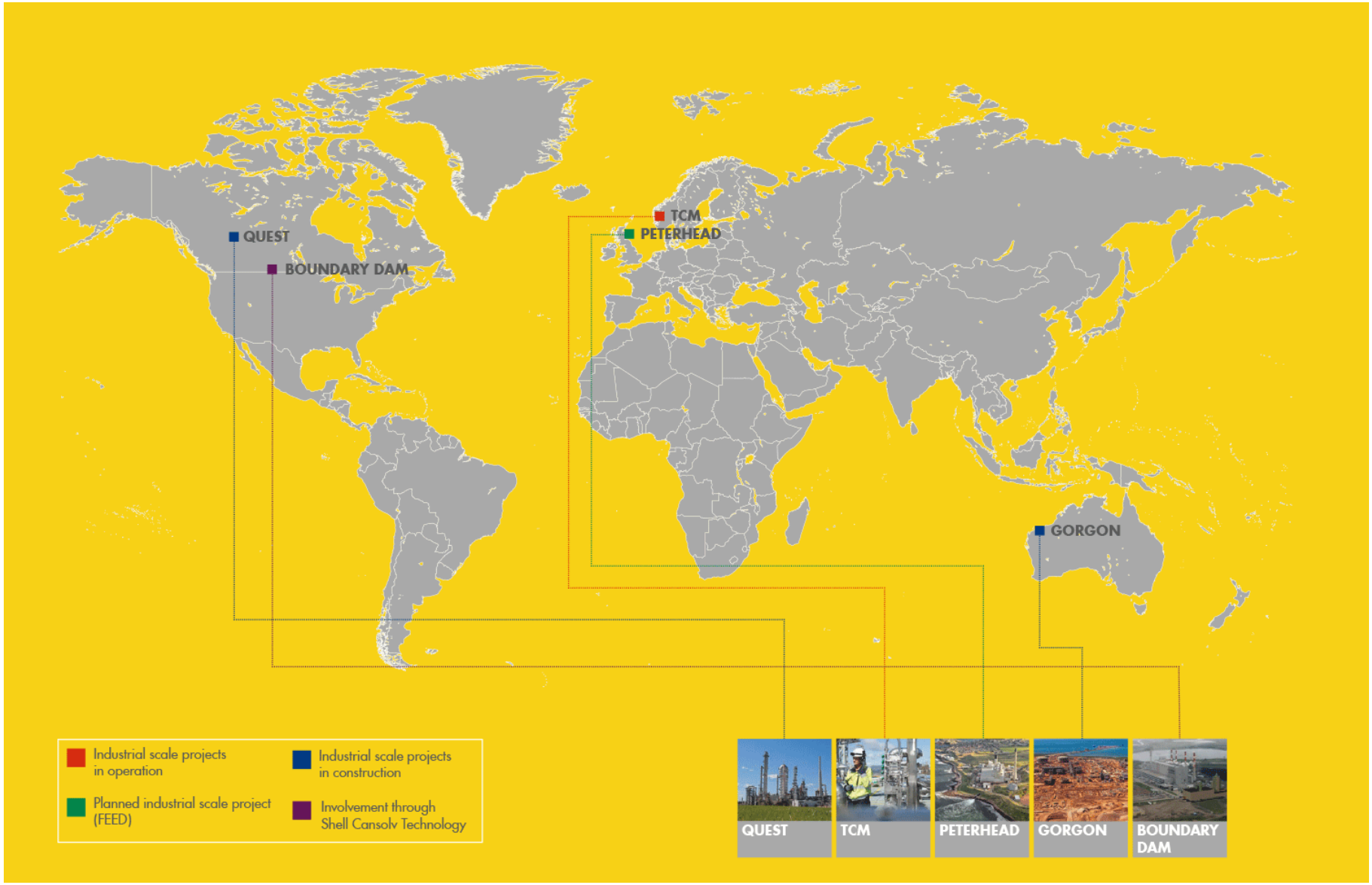
Without CCS, the additional costs to run a decarbonised UK economy in 2050 will be £32 billion.

UK Energies Technology Institute

FIRST OF A KIND CCS 4 GAS

- A step toward commercially available Gas CCS by the mid-2020's
- Tackle the first-of-a-kind technical and non-technical challenges
- Provide confidence to key decision makers

SHELL CCS PROJECT INVOLVEMENT



SHELL'S COMPETENCE BASED PROGRAM & INDUSTRIAL CCS

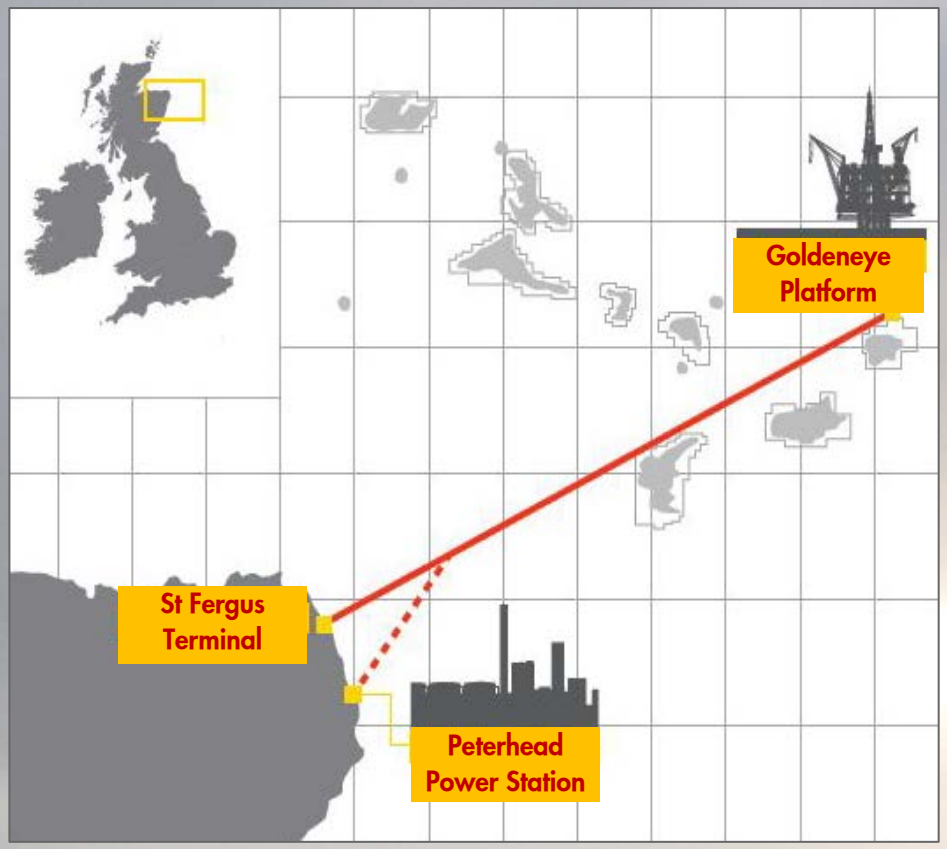




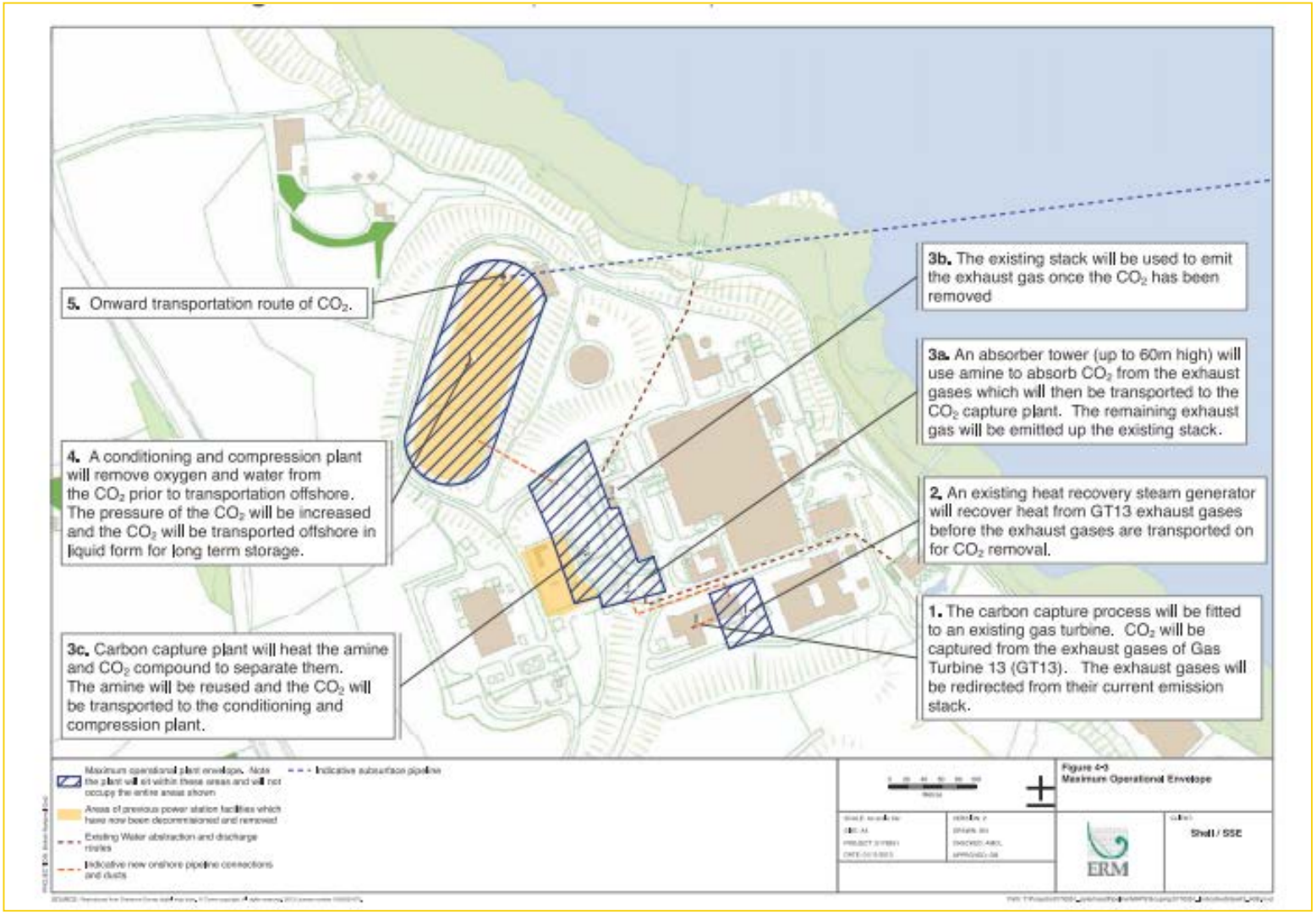
	Quest	Peterhead	Gorgon	Boundary Dam	TCM
•Onshore storage	X		X	X	
•Offshore storage		X			
•Saline aquifer storage	X		X		
•Depleted reservoir storage		X			
•EOR				X	
•Pre-combustion capture	X				
•Post-combustion capture		X		X	X
•Contaminated gas			X		
•Heavy Oil	X				
•Refining					X
•Gas fired power		X	X		
•Coal fired power				X	

PROPOSED PETERHEAD PROJECT AT A GLANCE

- **World First** –the first full-scale CCS project on a gas-fired power station,
- **Status** – proposal currently in Front End Engineering Design phase, seeking regulatory approvals and Government funding for capital and operating expenses
- **Where** – capture at Peterhead Power Station; storage in depleted Goldeneye gas reservoir (100 KM offshore)
- **Impact** –10 to 15 million tonnes of CO_2 captured over a 10 to 15-year period (90% CO_2 capture from one turbine)
- **Technology** – post-combustion capture using amines



INTERFACE MANAGEMENT KEY IN ADDRESSING BROWNFIELD COMPLEXITIES



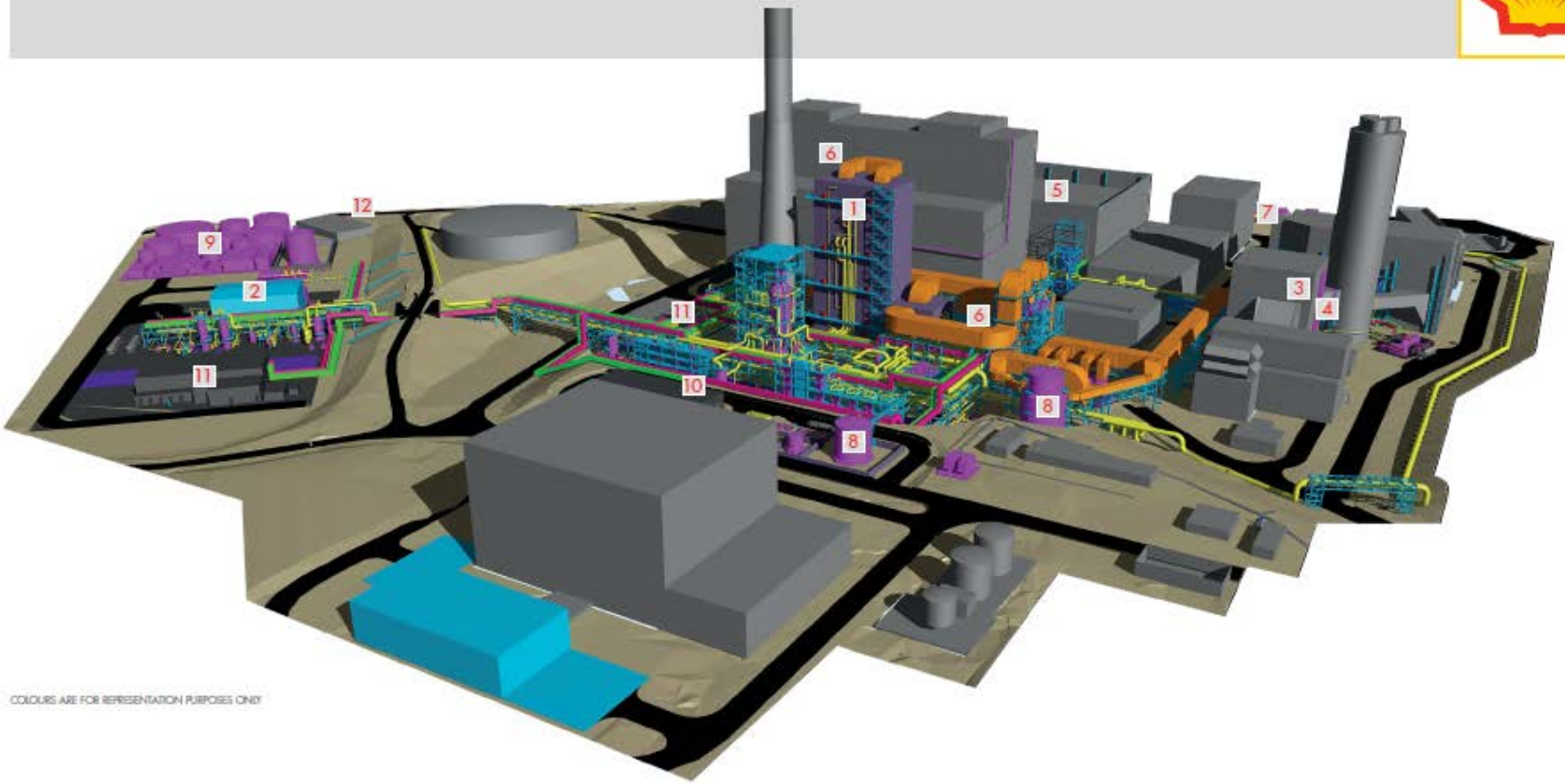
ONSHORE OVERVIEW

PETERHEAD CCS PROJECT

WHAT THE PROJECT REQUIRES

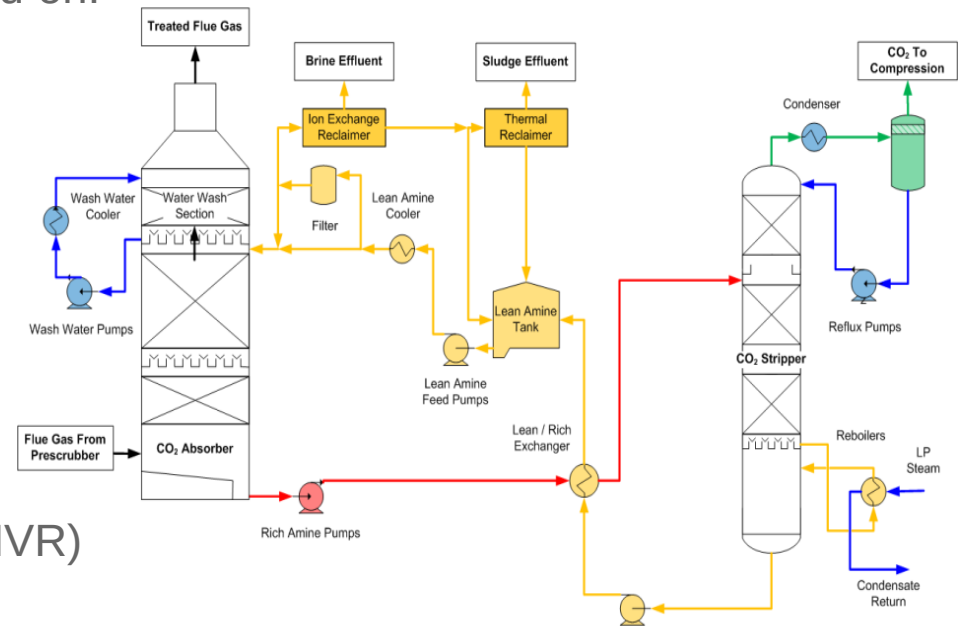
New pieces of equipment and modifications to existing equipment at the Peterhead power station will be required to enable the carbon capture process to be integrated into the site. These will include:

1. A CO_2 absorber tower
2. A compression and conditioning plant
3. The heat-recovery steam generator
4. A selective catalytic reduction system
5. A new steam turbine
6. Replacement auxiliary boilers
7. The seawater cooling system
8. Amine tanks
9. A waste-water treatment plant
10. A control room and office block
11. Power supply and substations
12. An export pipeline.

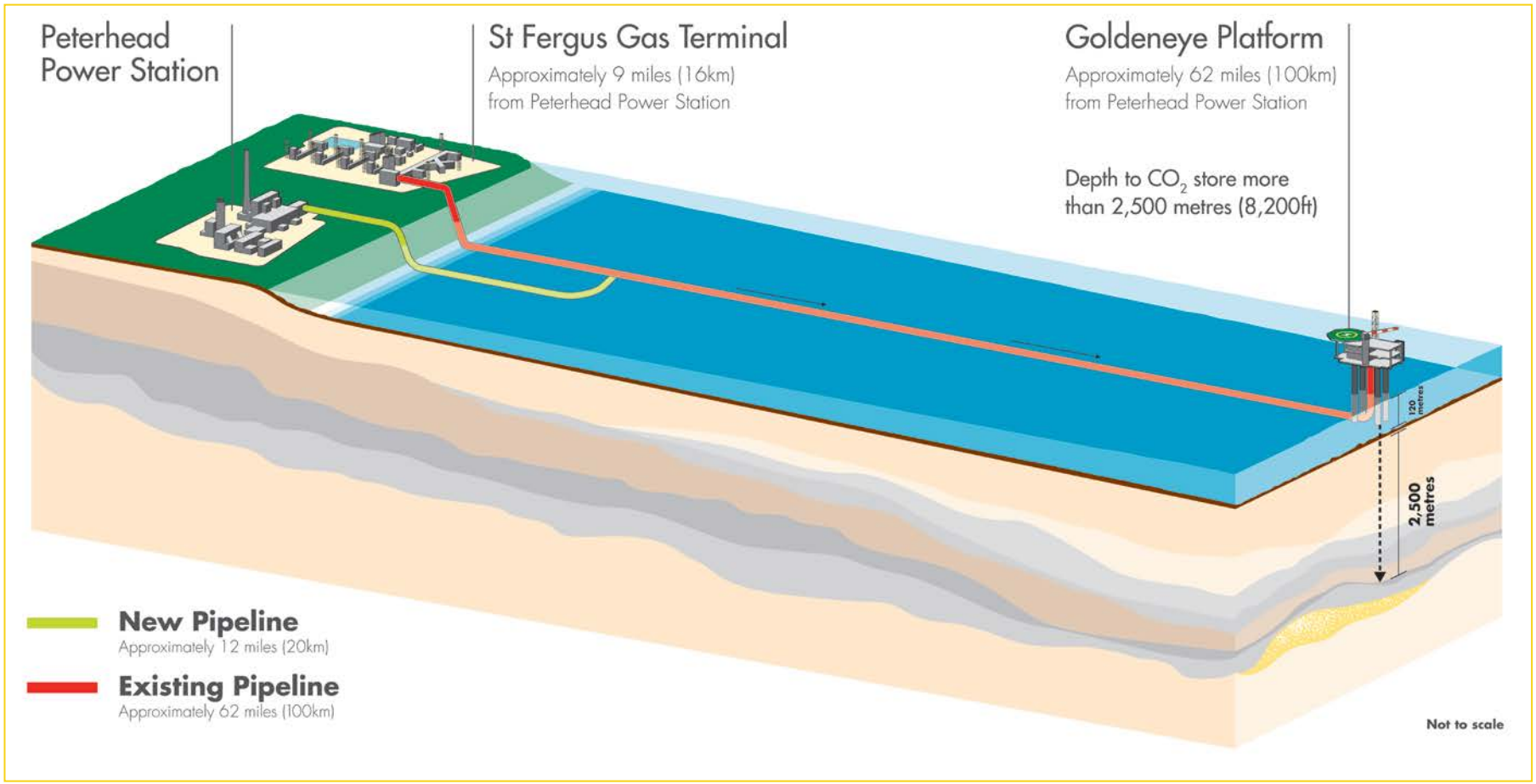


CAPTURE: UTILIZING STATE OF THE ART AMINE TECHNOLOGY

- Shell Cansolv capture technology
  - New solvent DC-201 selected, based on:
    - Improved loading & energy consumption
    - CAPEX savings
- Simplified line-up selected
  - No Absorber Inter-cooling
  - No Heat Recovery Equipment (ex MVR)
  - Optimization of equipment design
    - Absorber area
  - Smaller piping/regeneration equipment

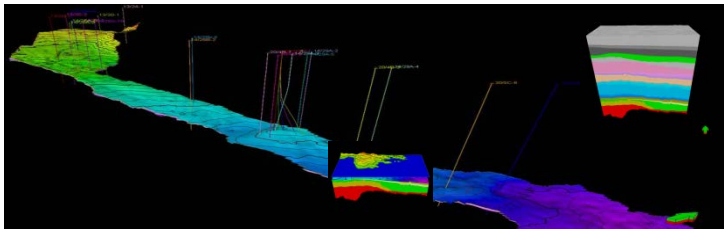


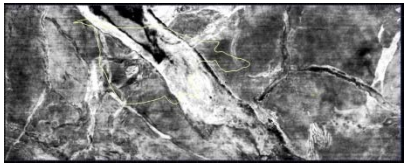
TRANSPORT: IN DENSE PHASE THROUGH 100KM OF OFFSHORE PIPELINE

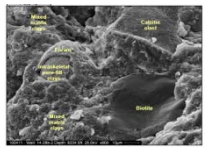


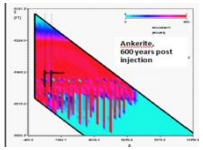
STORAGE: SAFELY STORING 2KM BENEATH THE NORTH SEA BED

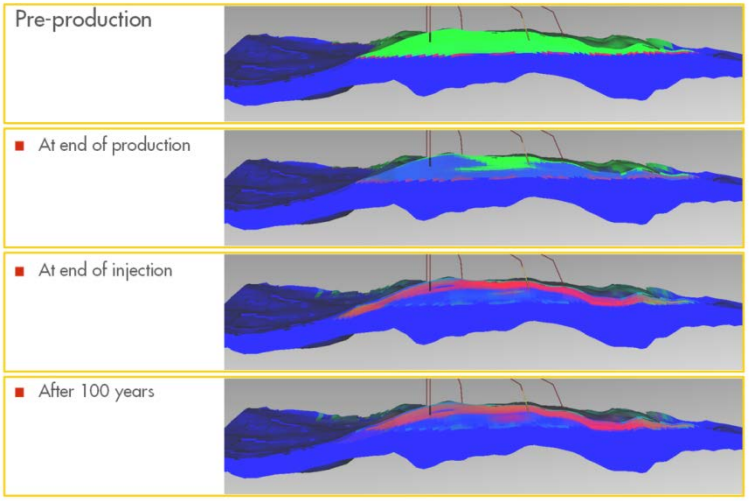
- Using a depleted field as a store brings significant data advantages
  - Exploration, appraisal & development data
  - Long term production history: a "very extended well test"
  - Proven seal over millions of years
- Three years of storage assessment work (on Goldeneye) for the Longannet project
  - Reprocessed seismic to pore-scale studies
  - Three geological models
    - Geomechanical
    - Reactive transport
    - Dynamic



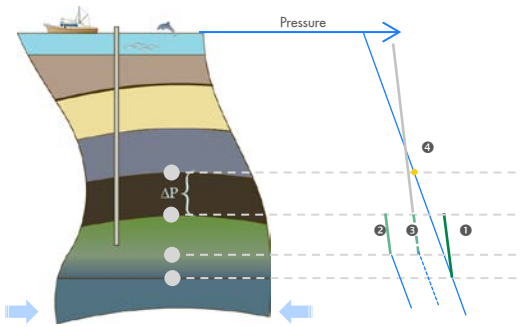


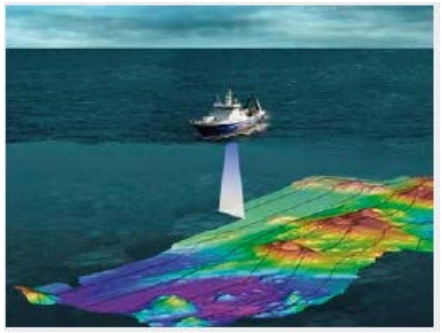


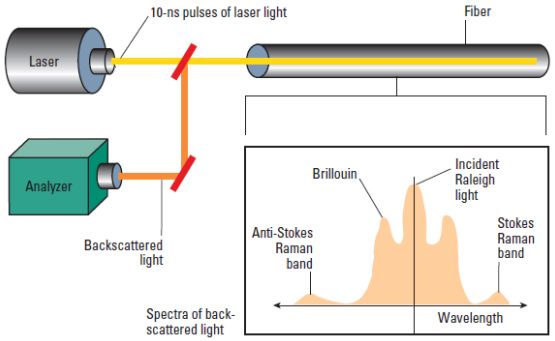




FIT FOR PURPOSE MONITORING PLAN







Base monitoring detect, conformance

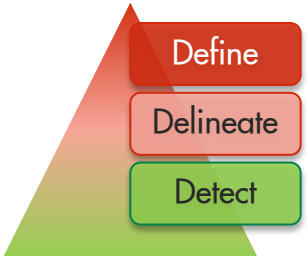
Start

End

Pre-inj	Injection	Post-closure	Post hand over
Baseline	Continuous: well integrity, sea-bed, well by well flow metering, CO_2 quality, reservoir P, DAS, DTS	MBES (+1 y, +6 y)	Multi beam echo sounder x 2
4D seismic (complex) + VSP	Mid: 4D [3D VSP]	4D seismic, store	
		Reservoir P, 1.5 years	

Tracers

Irregularity/contingency monitoring if irregularity suspected



PETERHEAD CCS PROJECT IS GOOD FOR THE COMMUNITY

Power Station Life

Construction Jobs

Operations Jobs

Future Industry Hub

IT IS GOOD FOR SHELL

Facility Re-Use

- The recently depleted Goldeneye reservoir has more than sufficient capacity for the project
- The existing wells are relatively new (<10yrs) and in good condition
- Pipelines are recent and in good condition

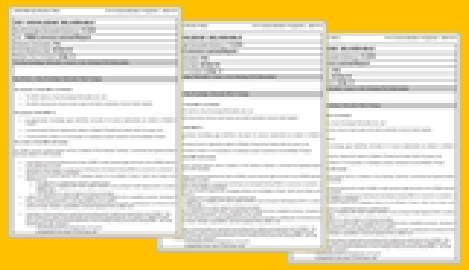
The Carbon Bubble

- Shareholders and analysts question whether our planet can really accommodate all the CO_2 related to fossil fuel providers and have coined the term 'Carbon Bubble'
- CCS operating at scale demonstrates one way these concerns could be addressed

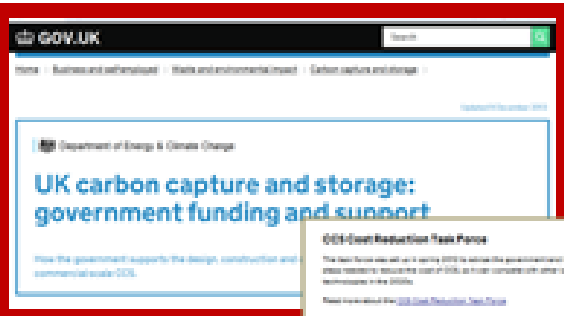
SHARING OUR LEARNINGS

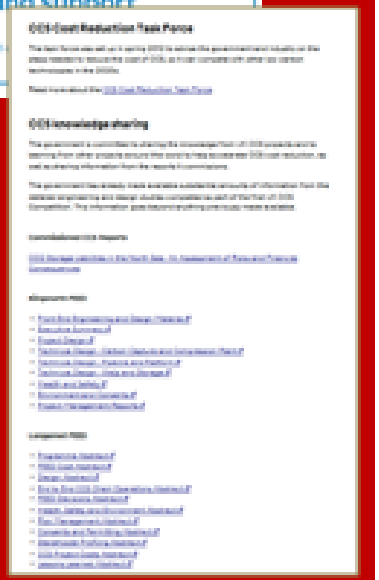
Knowledge Transfer Obligations

- Committed to providing **45 Key Knowledge Deliverables** for public dissemination.
- These deliverables cover **key project aspects** such as Engineering, Subsurface, Commercial, and HSE.
- The deliverable content has been agreed in FEED negotiations between Shell and DECC.
- A specification sheet is provided for each deliverable describing the agreed content.
- Shell have a **dedicated resource** and process to manage the dissemination of these Key Knowledge Deliverables



DECC Knowledge Sharing Site





Public access to (non commercially sensitive) knowledge & information derived from the projects

PROGRESSING CCS INTO THE FUTURE