PETERHEAD LOW CARBON GAS POWER CCS PROJECT

USEA

Washington
April 25, 2014

Peterhead Power plant
Scotland

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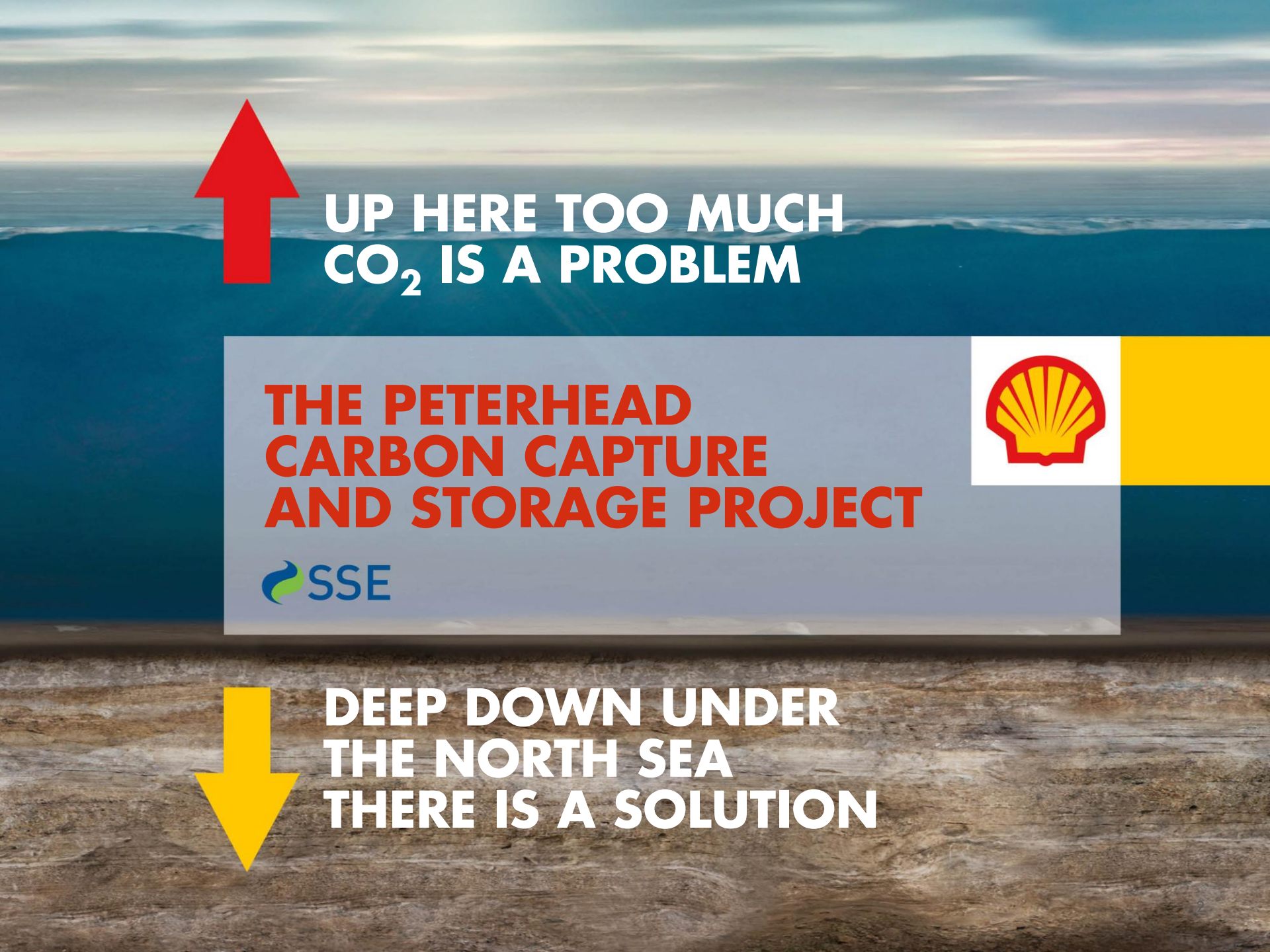
Royal Dutch Shell Projects & Technology


UP HERE TOO MUCH
CO_2 IS A PROBLEM
THE PETERHEAD
CARBON CAPTURE
AND STORAGE PROJECT
SSE
DEEP DOWN UNDER
THE NORTH SEA
THERE IS A SOLUTION

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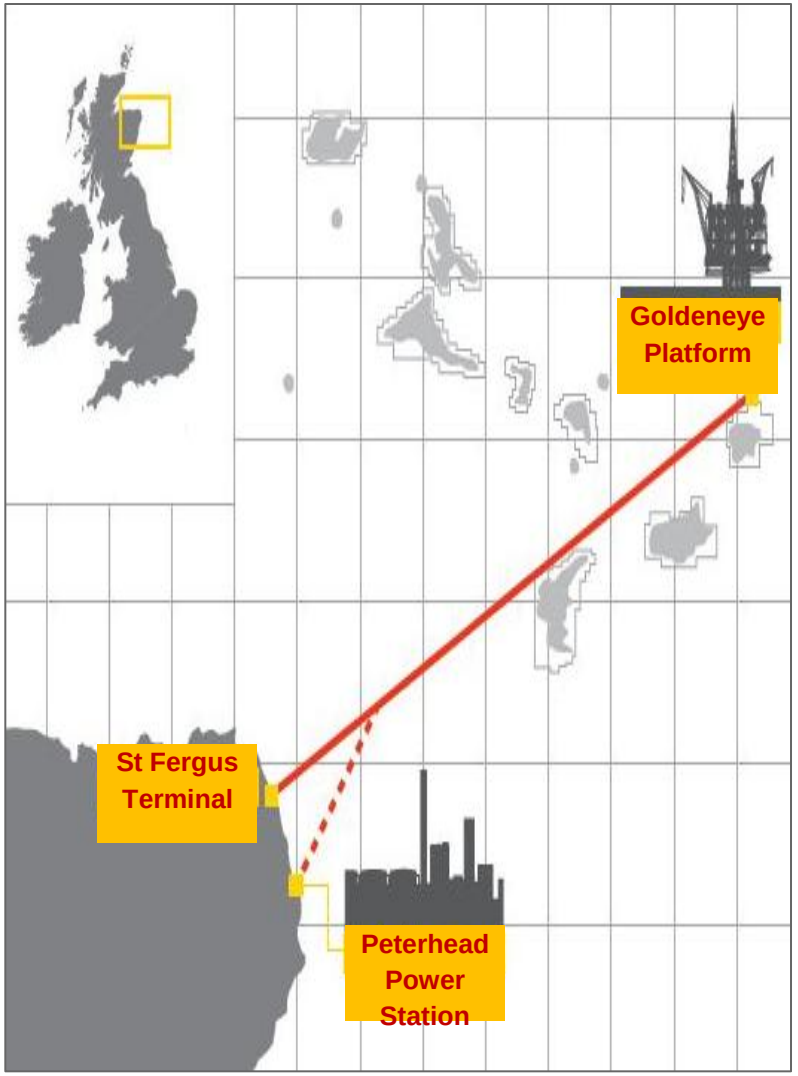
PETERHEAD CCS PROJECT AT A GLANCE

- **WORLD FIRST** – first full-scale CCS project on a gas-based power station 340 MW clean power
- **WHERE?** – capture at Peterhead Power Station; storage in depleted Goldeneye gas reservoir (100 KM offshore)
- **IMPACT** –10 million tonnes of CO_2 captured over a ten-year period (90% CO_2 capture from one turbine)
- **TECHNOLOGY** – post-combustion capture using amines
- **TIMELINE** – could be operational by the end of the decade

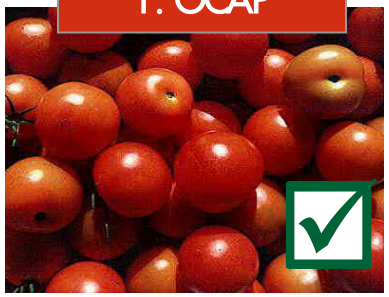


AGENDA

- Shell and CCS
- The Peterhead CCS project
- Why the project works

SHELL – DEVELOPING CCS DEMONSTRATION PROJECTS

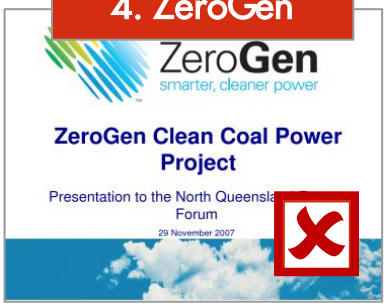
1. OCAP



2. Barendrecht

3. Draugen

4. ZeroGen

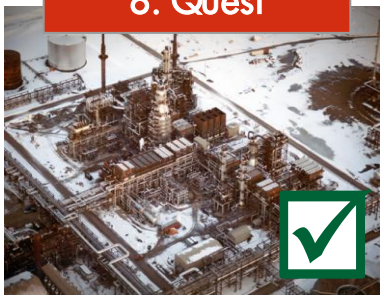


5. Longannet

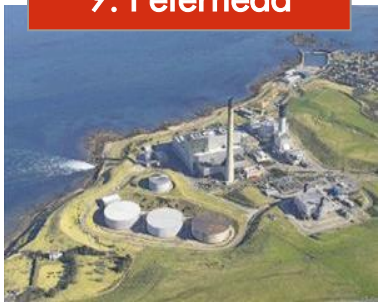
6. Gorgon

7. TCM

8. Quest

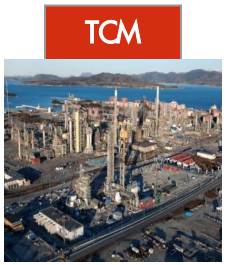


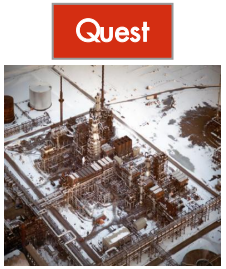
9. Peterhead



IN UK CCS COMPETITION

WHY THESE PROJECTS? - COMPETENCE BASED PROGRAM !





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

DEMONSTRATION PROJECTS – LEARNING CURVES

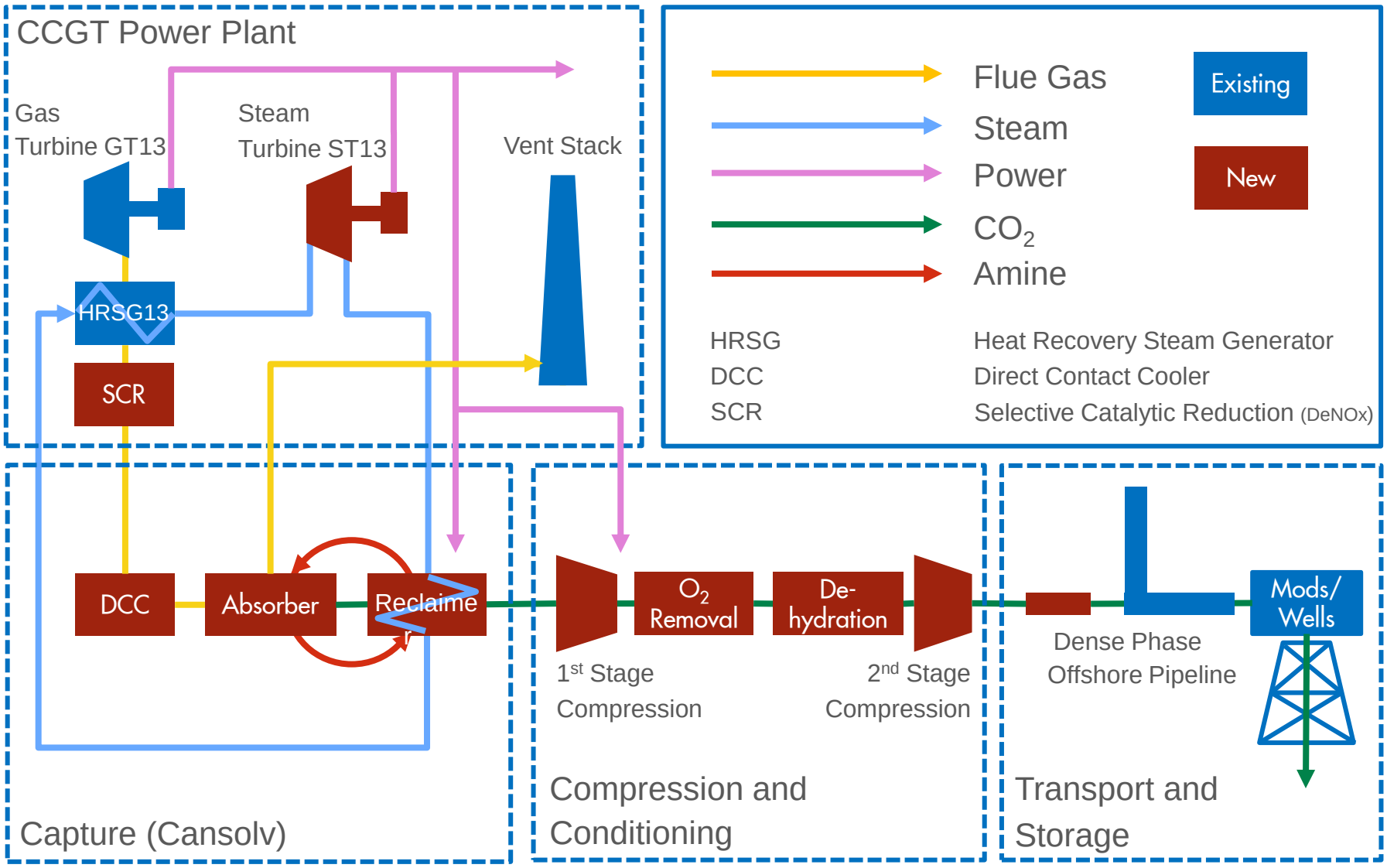
Credit; http://itsasmallweb.files.wordpress.com/2011/02/3.jpg

THE PETERHEAD PROJECT

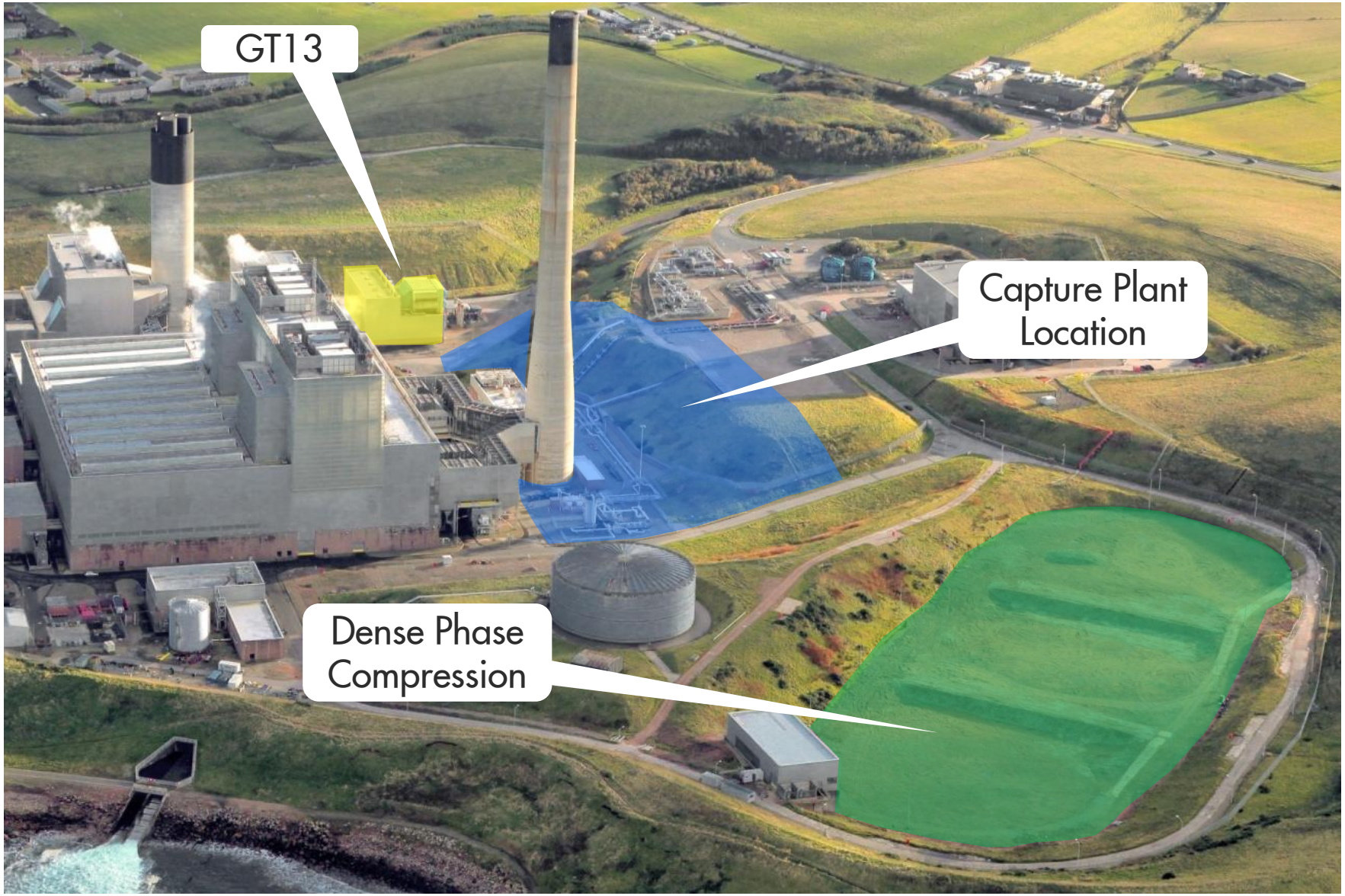
AGENDA

- Look-Back – Historic Success Factors
- The Peterhead CCS project
- Why the project works

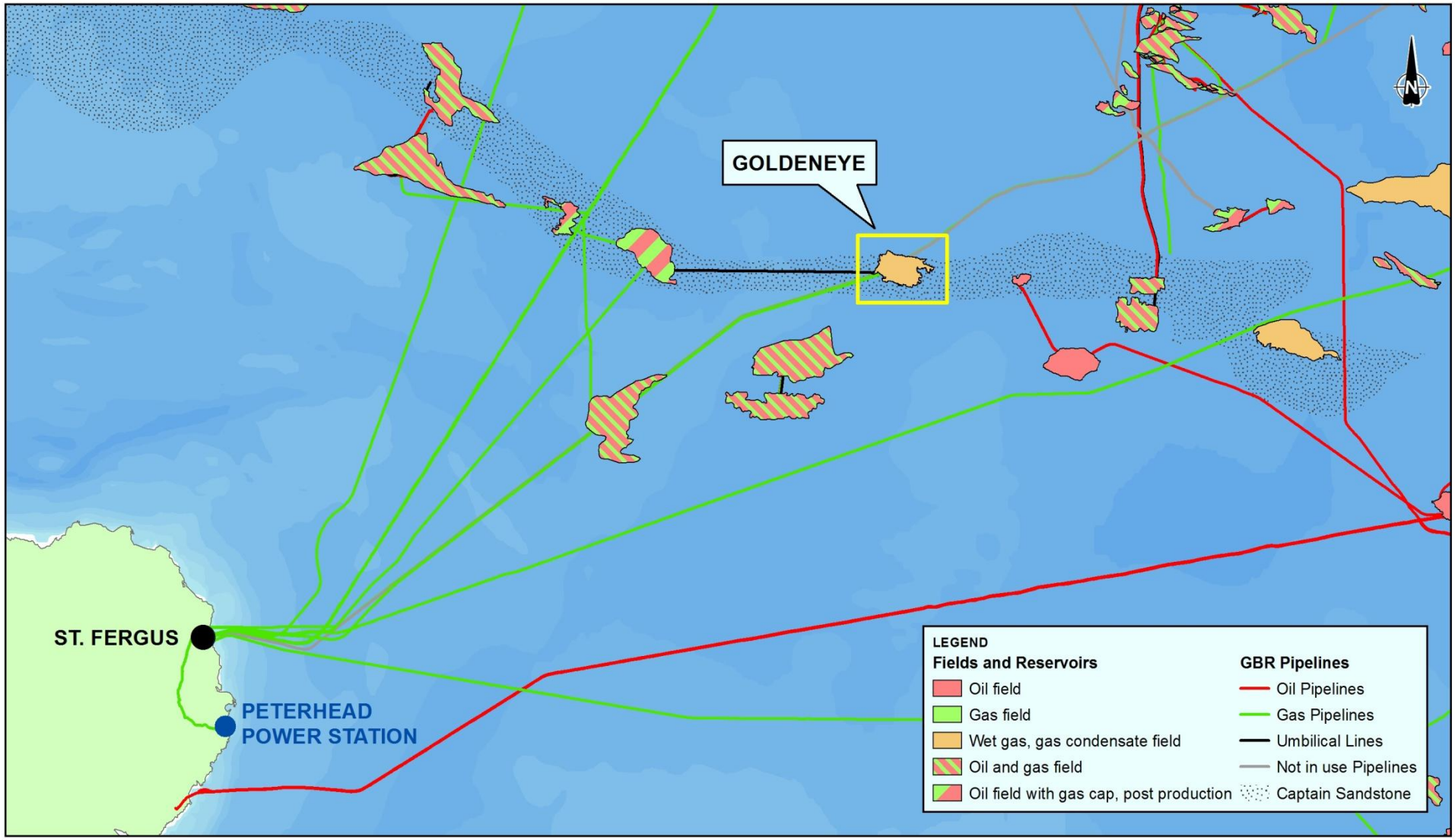
RETROFIT PROJECT TO EXISTING POWER PLANT



CAPTURE: AT PETERHEAD POWER STATION



TRANSPORT: DENSE PHASE PIPELINE TO GOLDENEYE

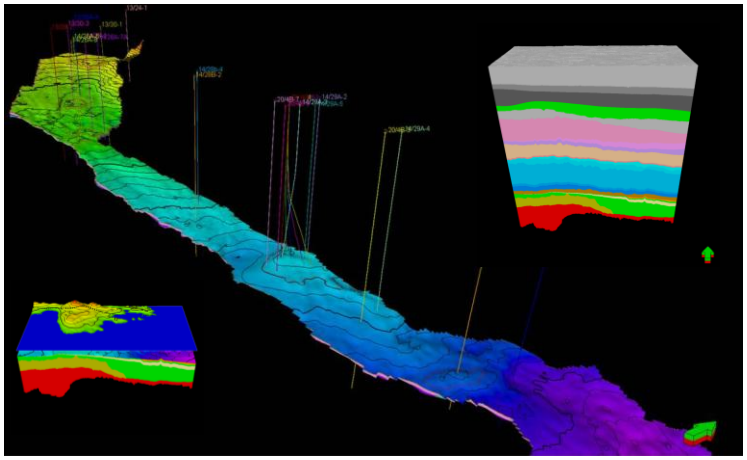


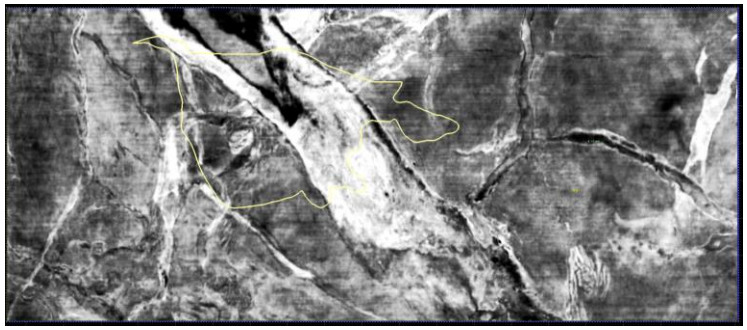
INJECTION: GOLDENEYE OFFSHORE FACILITIES

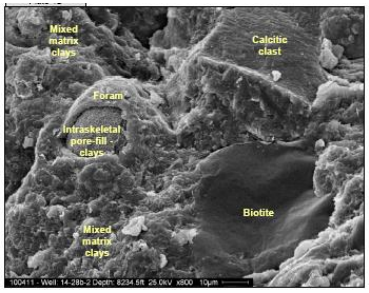
- Majority of platform (say 90% by weight) can be re-used
- Some work needed on pipe-work, valves, instrumentation, vent
- New filters required
- All or most of the 5 wells need partial work-over but are essentially re-used
- Installation of a new 213 barg Maximum Allowable Operating Pressure (MAOP) SSIV
- Replacement of elastomeric seals with material compatible with CO_2 & methanol

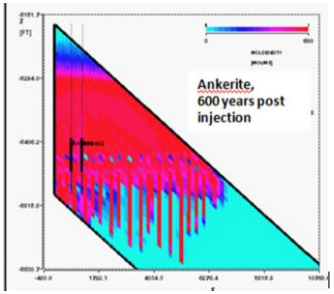
STORAGE: IN DEPLETED GOLDENEYE FIELD

- 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 proejct
  - Reprocessed seismic to pore-scale studies
  - Three geological models
  - Geomechanical, reactive transport and dynamic models



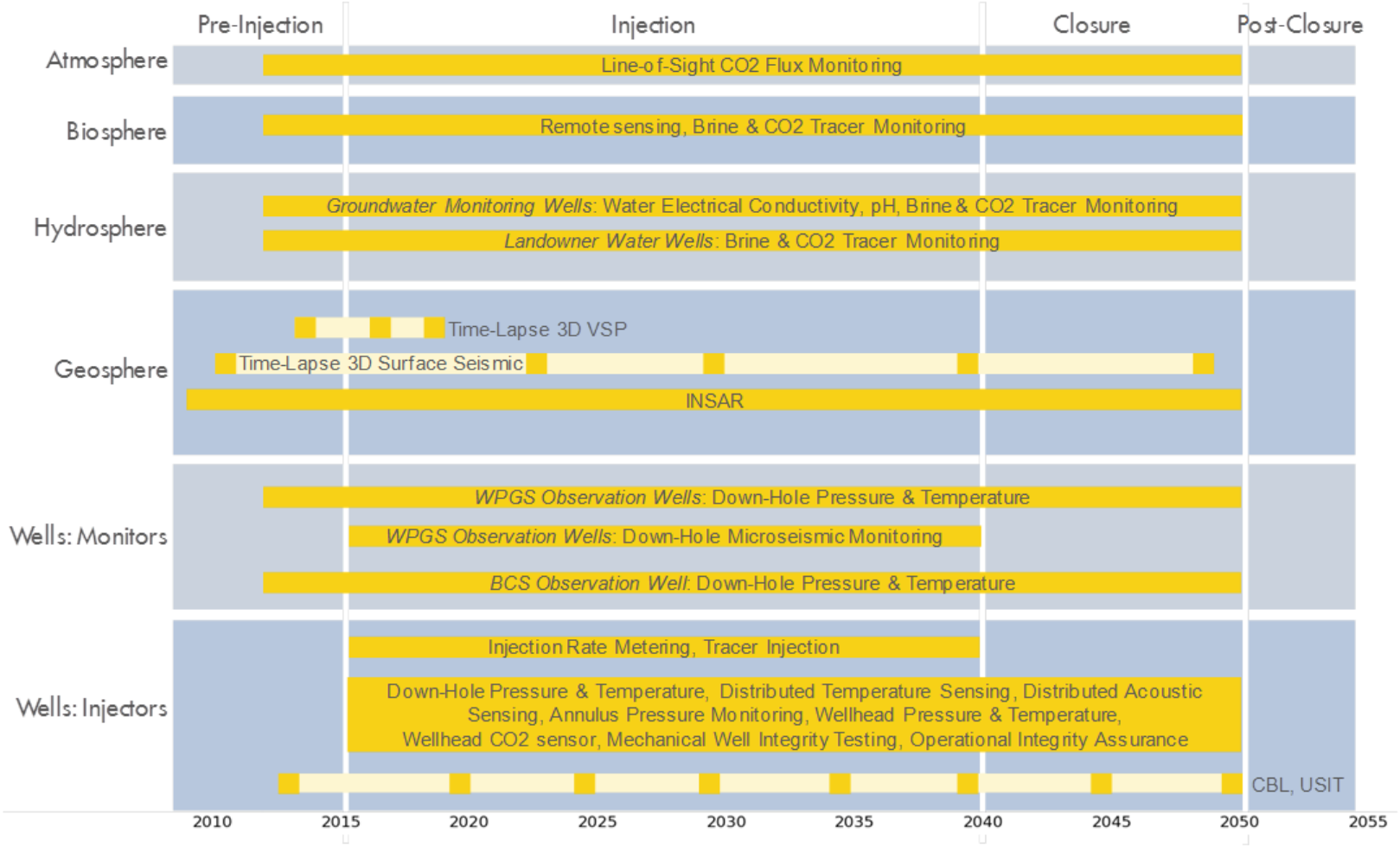






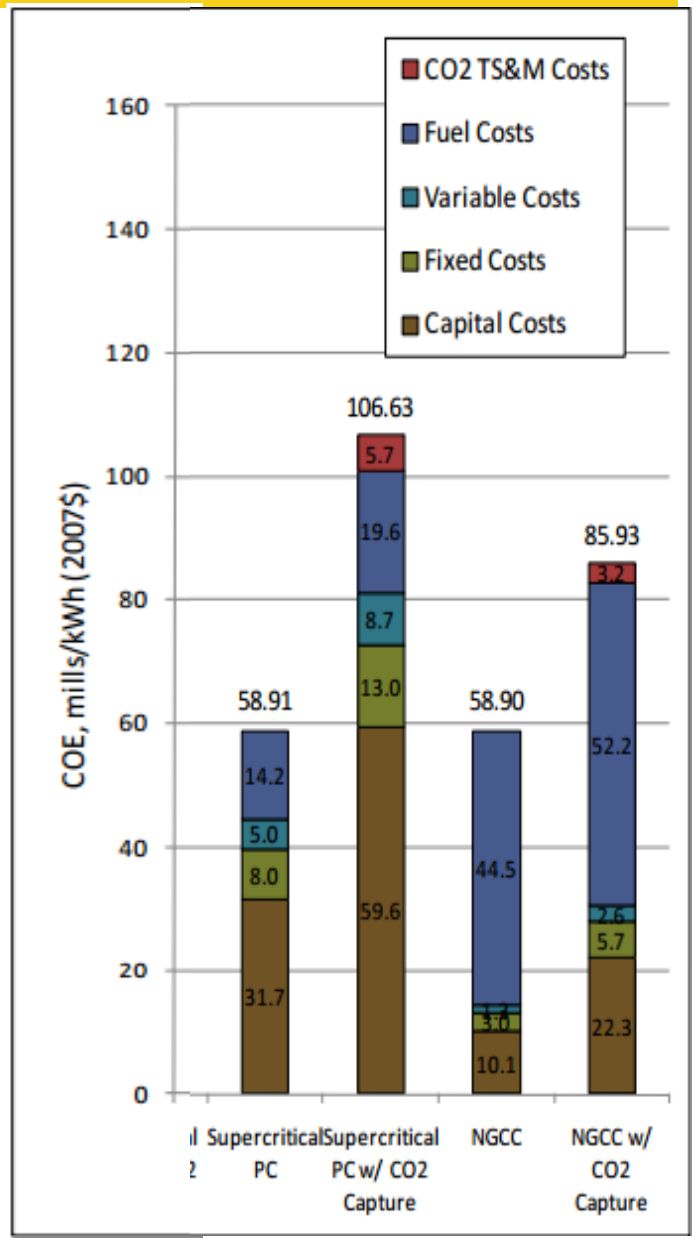
MEASUREMENT, MONITORING AND VERIFICATION PLAN

- Comprehensive plan developed – entire biosphere and lifecycle
- Independently (DNV) certified MMV and storage plan



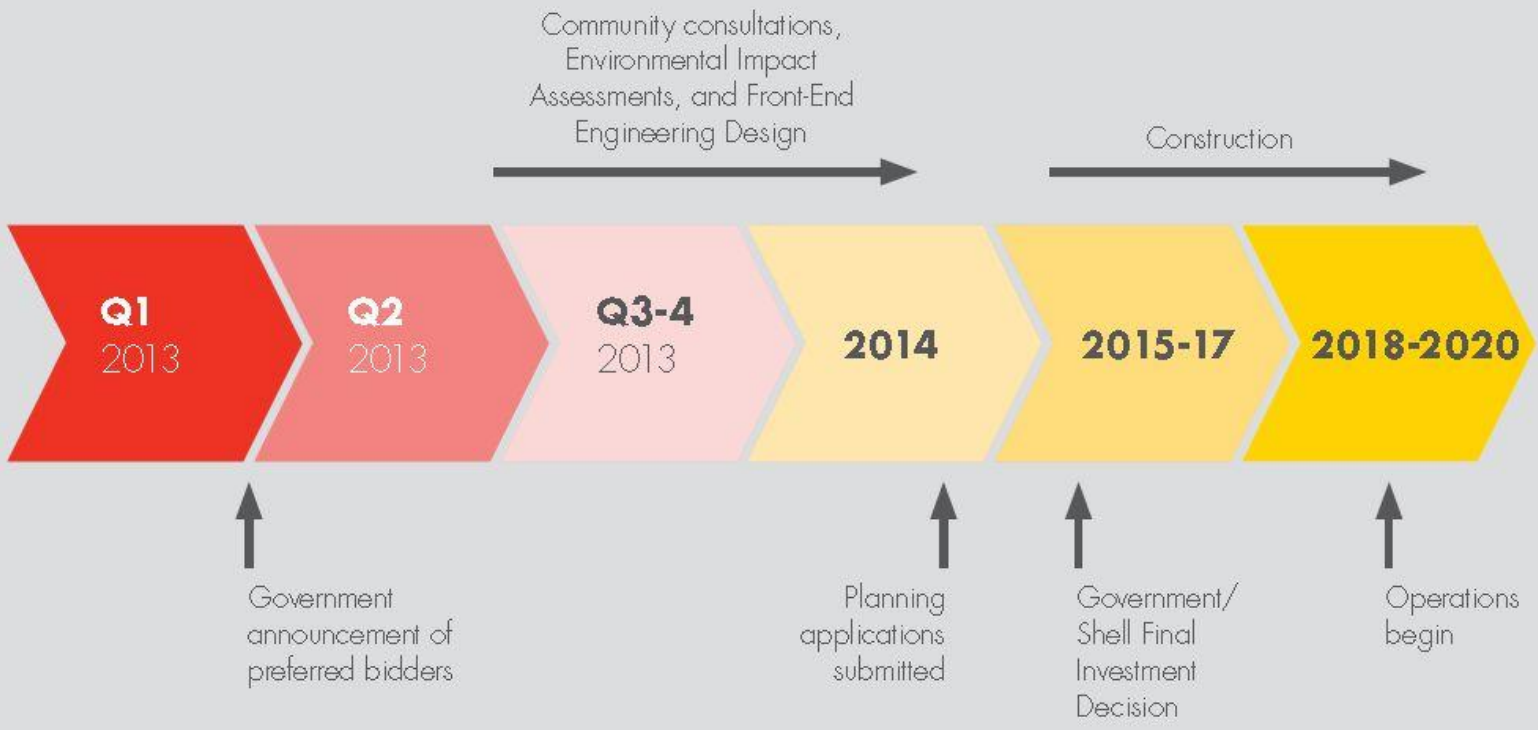
GAS CCS: DIFFERENT DRIVERS, METRICS AND GOALS

- Different cost build up of base costs and of additional cost of CCS:
  - COE, Capex/Opex/Fuel/T&S



NETL Cost and Performance Baseline for Fossil Energy Plants Volume 1: Bituminous Coal and Natural Gas to Electricity Revision 2a, September 2013

ANTICIPATED TIMELINE



WHAT IS MAKING THE PETERHEAD PROJECT WORK?

AGENDA

- Look-Back – Historic Success Factors
- The Peterhead CCS project
- Why the project works

IT IS GOOD FOR THE UNITED KINGDOM

Licence to Operate

Prize for Britain

32£(52$)

Billion/Annum

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

UK Energies Technology Institute

Government Objective

... by the 2020's, private sector electricity companies can take investment decisions to build CCS equipped fossil fuel electricity generation facilities without Government capital subsidy at an agreed contract for difference strike price that is competitive with the strike price for other low carbon generation technologies"

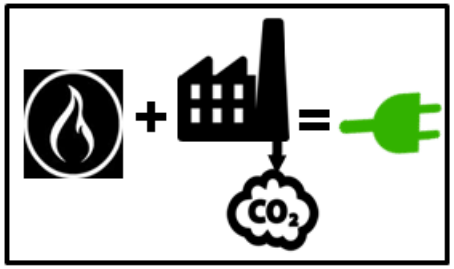
IT IS GOOD FOR SHELL

Licence to Operate

Facility Re-Use

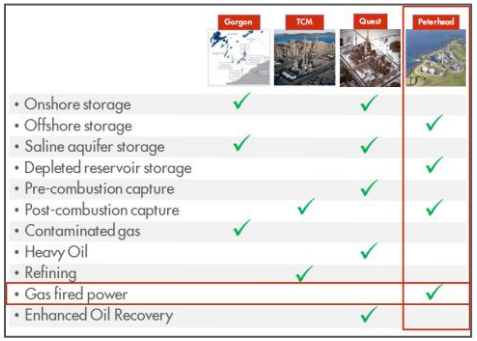
- The recently depleted Goldeneye reservoir has more than sufficient capacity for the project
- The existing wells are relatively new (<10yrs) and in good condition
- Pipelines are recent and in good condition.

Gas Advocacy



- Increased use of gas is a swift, affordable way to reduce CO2 emissions
- CCS commercially deployed on gas post 2030 maintains gas as destination fuel

CCS Competence



Peterhead CCS– key to Shell's competence development programme

- Offshore Storage
- Depleted Reservoir
- Post Combustion Capture
- Gas+CCS

IT IS GOOD FOR THE COMMUNITY

Licence to Operate

- Landmark project for the North-East of Scotland
- Opportunity to diversify and sustain North Sea industry and skills
- Potential for development of a CCS industry in the region
- Learning opportunities for young people – growing up alongside an important new industry

BUILD WITH CONFIDENCE

ENABLING LEGISLATION

CCS Directive Transposed

- Storage Licence granted

Electricity Market Reform (EMR)

- Contracts for Difference (CfD)

CLEAR LIABILITY AGREEMENT

Government accepts the long term liability at handover

DEMO FINANCIAL SUPPORT

- UK CCS Competition offers 'up-front' capital grant
- Partial FEED funding
- Additional R&D support underpinning project

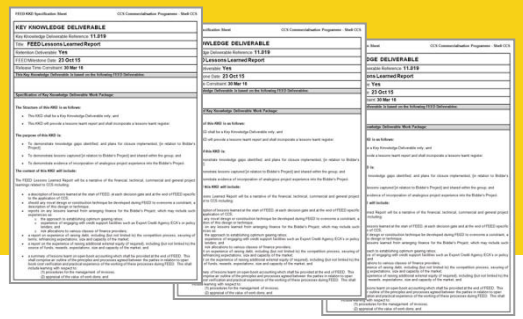
EARLY ADOPTER BENEFITS

- Peterhead Powerplant operates as baseload
- Negotiated CfD

PETERHEAD KNOWLEDGE SHARING

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

9 STEPS TO A SUCCESSFUL CCS DEMONSTRATION PLANT

1. It is good for Government
2. It is good for me (Industry)
3. It is good for the constituents

Licence to Operate

4. Enabling legislation exists
5. Clear liability agreement
6. Financial support for demonstration
7. Early adopter benefits
8. Trust & Certainty

Build with Confidence

9. Knowledge sharing

Replication

PETERHEAD FEED SIGNING – 24-02-14