MAKING GAS CCS A REALITY

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There are a number of factors that could affect the future operations of Royal Dutch Shell and could cause those results to differ materially from those expressed in the forward-looking statements included in this presentation, including (without limitation): (a) price fluctuations in crude oil and natural gas; (b) changes in demand for Shell’s products; (c) currency fluctuations; (d) drilling and production results; (e) reserves estimates; (f) loss of market share and industry competition; (g) environmental and physical risks; (h) risks associated with the identification of suitable potential acquisition properties and targets, and successful negotiation and completion of such transactions; (i) the risk of doing business in developing countries and countries subject to international sanctions; (j) legislative, fiscal and regulatory developments including potential litigation and regulatory measures as a result of climate changes; (k) economic and financial market conditions in various countries and regions; (l) political risks, including the risks of expropriation and renegotiation of the terms of contracts with governmental entities, delays or advancements in the approval of projects and delays in the reimbursement for shared costs; and (m) changes in trading conditions. All forward-looking statements contained in this presentation are expressly qualified in their entirety by the cautionary statements contained or referred to in this section. Readers should not place undue reliance on forward-looking statements. Additional factors that may affect future results are contained in Royal Dutch Shell’s 20-F for the year ended 31 December, 2014 (available at www.shell.com/investor and www.sec.gov ). These factors also should be considered by the reader. Each forward-looking statement speaks only as of the date of this presentation, 30 September, 2014. Neither Royal Dutch Shell nor any of its subsidiaries undertake any obligation to publicly update or revise any forward-looking statement as a result of new information, future events or other information. In light of these risks, results could differ materially from those stated, implied or inferred from the forward-looking statements contained in this presentation. There can be no assurance that dividend payments will match or exceed those set out in this presentation in the future, or that they will be made at all.

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THE DOOR TO THE 2 DEGREES SCENARIO IS CLOSING...
SHELL’S RESPONSE TO THE CO₂ 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 CO₂ 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
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
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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 CO₂ captured over a 10 to 15-year period (90% CO₂ capture from one turbine)
- **Technology** – post-combustion capture using amines
INTERFACE MANAGEMENT KEY IN ADDRESSING BROWNFIELD COMPLEXITIES

1. The carbon capture process will be fitted to an existing gas turbine. CO₂ will be captured from the exhaust gases of Gas Turbine 13 (GT13). The exhaust gases will be redirected from their current emission stack.

2. An existing heat recovery steam generator will recover heat from GT13 exhaust gases before the exhaust gases are transported on for CO₂ removal.

3a. An absorber tower (up to 60m high) will use amine to absorb CO₂ from the exhaust gases which will then be transported to the CO₂ capture plant. The remaining exhaust gas will be emitted up the existing stack.

3b. The existing stack will be used to emit the exhaust gas once the CO₂ has been removed.

4. A conditioning and compression plant will remove oxygen and water from the CO₂ prior to transportation offshore. The pressure of the CO₂ will be increased and the CO₂ will be transported offshore in liquid form for long term storage.

5. Onward transportation route of CO₂.

3c. Carbon capture plant will heat the amine and CO₂ compound to separate them. The amine will be reused and the CO₂ will be transported to the conditioning and compression plant.
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 CO₂ 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.

COLOURS ARE FOR REPRESENTATION PURPOSES ONLY
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

Peterhead Power Station

St Fergus Gas Terminal
Approximately 9 miles (16km) from Peterhead Power Station

Goldeneye Platform
Approximately 62 miles (100km) from Peterhead Power Station
Depth to CO₂ store more than 2,500 metres (8,200ft)

New Pipeline
Approximately 1.2 miles (20km)

Existing Pipeline
Approximately 62 miles (100km)
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

**Baseline**
- Continuous: well integrity, seabed, well by well flow metering, CO₂ quality, reservoir P, DAS, DTS

**Pre-inj**
- 4D seismic (complex) + VSP

**Injection**
- 4D [3D VSP]
- Tracers
- Irregularity/contingency monitoring if irregularity suspected

**Post-closure**
- MBES
  - +1 y
  - +6 y
- 4D seismic, store
- Reservoir P, 1.5 years

**Post hand over**
- Multi beam echo sounder x 2

**Start** - **End**
PETERHEAD CCS PROJECT IS GOOD FOR THE COMMUNITY

Power Station Life

Construction Jobs

Operations Jobs

Future Industry Hub
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.

Shareholders and analysts question whether our planet can really accommodate all the CO₂ related to fossil fuel providers and have coined the term ‘Carbon Bubble’.

CCS operating at scale demonstrates one way these concerns could be addressed.
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

IMAGINE Capturing this much CO₂ every hour

Find out how Shell plans to capture CO₂ at shell.co.uk/peterheadccs

LET'S GO