Up here too much CO₂ is a problem.

The Peterhead Carbon Capture and Storage Project.

Deep down under the North Sea, there is a solution.
The companies in which Royal Dutch Shell plc directly and indirectly owns investments are separate entities. In this presentation “Shell”, “Shell group” and “Royal Dutch Shell” are sometimes used for convenience where references are made to Royal Dutch Shell plc and its subsidiaries in general. Likewise, the words “we”, “us” and “our” are also used to refer to subsidiaries in general or to those who work for them. These expressions are also used where no useful purpose is served by identifying the particular company or companies. “Subsidiaries”, “Shell subsidiaries” and “Shell companies” as used in this presentation refer to companies in which Royal Dutch Shell either directly or indirectly has control. Companies over which Shell has joint control are generally referred to as “joint ventures” and companies over which Shell has significant influence but neither control nor joint control are referred to as “associates”. The term “Shell interest” is used for convenience to indicate the direct and/or indirect ownership interest held by Shell in a venture, partnership or company, after exclusion of all third-party interest.

This presentation contains forward-looking statements concerning the financial condition, results of operations and businesses of Royal Dutch Shell. All statements other than statements of historical fact are, or may be deemed to be, forward-looking statements. Forward-looking statements are statements of future expectations that are based on management’s current expectations and assumptions and involve known and unknown risks and uncertainties that could cause actual results, performance or events to differ materially from those expressed or implied in these statements. Forward-looking statements include, among other things, statements concerning the potential exposure of Royal Dutch Shell to market risks and statements expressing management’s expectations, beliefs, estimates, forecasts, projections and assumptions. These forward-looking statements are identified by their use of terms and phrases such as “anticipate”, “believe”, “could”, “estimate”, “expect”, “goals”, “intend”, “may”, “objectives”, “outlook”, “plan”, “probably”, “project”, “risks”, “schedule”, “seek”, “should”, “target”, “will” and similar terms and phrases. 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 regulatory measures addressing climate change; (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 risk factors that may affect future results are contained in Royal Dutch Shell’s 20-F for the year ended December 31, 2014 (available at www.shell.com/investor and www.sec.gov). These risk factors also expressly qualify all forward looking statements contained in this presentation and should be considered by the reader. Each forward-looking statement speaks only as of the date of this presentation, 25 March 2015. Neither Royal Dutch Shell plc 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.

We may have used certain terms, such as resources, in this presentation that United States Securities and Exchange Commission (SEC) strictly prohibits us from including in our filings with the SEC. U.S. Investors are urged to consider closely the disclosure in our Form 20-F, File No 1-32575, available on the SEC website www.sec.gov. You can also obtain these forms from the SEC by calling 1-800-SEC-0330.
POPULATION – 2 BILLION MORE PEOPLE BY 2050

2015 - 2050

Developing World

- 2015: 6 billion
- 2050: 6 billion

Developed World

- 2015: 1 billion
- 2050: 3 billion
Black Gold

3 large spoonfuls of crude oil =
8 hours of human manual labour

“It’s as if each of us had a team of slaves working for us for next to nothing.”
(Colin Campbell)
WHAT GOES UP ... MUST COME DOWN ... SURELY?

But CO$_2$ can remain in the atmosphere for over 100 years.
FELIX BAUMGARTNER ... 24 MILES ABOVE THE EARTH

80% of our atmosphere is in the first 10 miles, and CO₂ is rapidly accumulating in it.

THE DOOR TO A 2°C (1 Trillion Tonnes) WORLD IS CLOSING
We need:
• ~ twice the energy
• ~ half the $\text{CO}_2$
6 ‘MUST DO’ ACTIONS TO AVOID EXCEEDING 2°C

Fuel Switching
Renewables
Efficiency
Behaviour Change
Nuclear
Carbon Capture & Storage

Being good at 4 or 5 categories is not good enough

http://www.theboardgamefamily.com/2014/01/trivial-pursuit-leave-box/
ENERGY & CLIMATE CHANGE ARE INSEPARABLE

IT IS GOOD FOR THE UNITED KINGDOM

Prize for Britain

32 Billion
£/Annum

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

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”
Prize for Competitors & Competition History

**Prize** – DECC grants £1 billion capital to project(s)

**History**
- July 2012 – Eight initial bids
- October 2012 – DECC select four bidders
- January 2013 – Bid Improvement
- 20 March 2013 – DECC announce Peterhead & White Rose as preferred bidders
- 24 February 2014 – FEED contract signed

Contract for Difference

- Mechanism to guarantee a pre-defined price per MWh which the Generator will receive for its clean electricity (“Strike Price”)
“Today’s announcement moves us a significant step closer to a Carbon Capture and Storage industry – an industry which will help reduce carbon emissions and create thousands of jobs.”

UK Government, March 2013 – on announcing preferred bidders in the CCS Programme Competition

“The Scottish Government supports CCS as a critical new technology that can assist Scotland, and other countries, to help meet significant carbon emissions reductions, as well as make a significant contribution to security of supply and promote economic growth opportunities.”

Scottish Government, December 2011
ENERGY & ENVIRONMENT – HIGH ON THE POLITICAL AGENDA
**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 necessary 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 million tonnes of CO$_2$ captured over a ten-year period (90% CO$_2$ capture from one turbine)
- **Technology** – post-combustion capture using amines
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.
STORING CO₂ SAFELY BENEATH THE NORTH SEA

SUBSURFACE BARRIERS

GOLDEN EYE PLATFORM, 102KM FROM LAND

NORTH SEA

SHALE

SANDSTONE AND COALS

SHALE

SANDSTONE

CHALK

SEALS:
Several layers of impermeable shale, sandstone and chalk, plus a thick layer of chalk rock, lie above the storage formation and will keep the CO₂ trapped.
PRODUCTION BEHAVIOUR HISTORY MATCHED AND FORWARD MODELLED

Pre-production

- At COP
- At end of injection
- After 100 years
SIMULATION EXAMPLE: BEFORE INJECTION

Original contact

HC is green
2 YEARS OF INJECTION

CO2 is red

HC is green

Original contact

Plot: CO2.Movie1_3Dplot
Timestep: 6616 (3000.0 * YEAR)
Creation date: Mon Jun 9 12:16:05 2014
Run file: gesrm31tc0263_finaqi10aa_1only_staged_rate10_10mte_incl_relax_v2012_2.run

Shell UK

03/04/2015
3 YEARS OF INJECTION

CO2 is red
HC is green

Original contact

Plot: CO2_Movie1_SDplot
Timestep: 6616 (3000.0 * YEAR)
Creation date: Mon Jun 9 12:16:05 2014
Run file: gesrm31fc0263_finaqi10aa_1only_staged_rate10_10mte_incl_relax_v2012_2.run
5 YEARS OF INJECTION

CO2 is red
HC is green

Original contact
6 YEARS OF INJECTION

- CO2 is red
- HC is green
- Original contact

Grid: SIMDATA.CO2_Movie
File: CO2_Movie1_SDplot
Timestep: 6616 (3000.0 * YEAR)
Creation date: Mon Jun 9 12:16:05 2014
Run file: gescm31fc0263_finaqi10aa_Only_staged_rate10_10mte_incl_relax_v2012_2.run
10 YEARS OF INJECTION, 10MT CO₂

CO₂ is red
HC is green
Original contact

Plot: CO₂.Movie1_SDplot
Timestep: 6616 (3000.0 * YEAR)
Creation date: Mon Jun 9 12:16:05 2014
Run file: gesrm31fc0263_finaqi10aalonly_staged_rate10_10mte_incl_relax_v2012_2.run
1 YEAR AFTER INJECTION STOPPED, 10MT CO$_2$

CO$_2$ is red
HC is green

Original contact

Grid: SIMDATA.CO2_Movie
F:MAT
T:14

Plot: CO2_Movie1_SDplot
Timestep: 6616 (3000.0 * YEAR)
Creation date: Mon Jun 9 21:16:05 2014
Run file: gesrm31fc0263_finaqi10aa_only_staged_rate10_10mte_incl_relax_v2012_2.run
11 YEARS AFTER INJECTION STOPPED, 10MT CO₂
20 YEARS AFTER INJECTION STOPPED, 10MT CO₂

CO₂ is red
HC is green
Original contact

Plot: CO₂_Movie1_SDplot
Time step: 6616 (3000.0 * YEAR)
Creation date: Mon Jun 9 12:16:05 2014
Run file: gesrm31fc0263_finaqi10aa_lonly_staged_rate10_10mte_incl_relax_v2012_2.run

Shell UK 03/04/2015 29
50 YEARS AFTER INJECTION STOPPED, 10MT CO₂

CO₂ is red

HC is green

Original contact

Plot: CO₂ Movie1_SDplot
Timestep: 6616 (3000.0 * YEAR)
Creation date: Mon Jun 9 12:16:05 2014
Run file: gesr31fc0263_finaqi10aa_only_staged_rate10_10mte_incl_relax_v2012_2.run
180 YEARS AFTER INJECTION STOPPED, 10MT CO₂

CO₂ is red

HC is green

Original contact
CCS RISK MITIGATION
PLAN FOR THE WORST BUT OPERATE TO YOUR BEST

Measures to avoid a loss of containment

Measures to manage a loss of containment

Legend
- **Passive** safeguards; these are always present
- **Active** safeguards, these are only present when a decision to intervene is made triggered by monitoring information
CCS RISK MITIGATION
WHEN HAVE YOU DONE ENOUGH

- Based on collective expert judgement
- Informed by appraisal data and feasibility studies
CLEAN ELECTRICITY TO 500,000 HOMES

http://www.vacation-rentals.com/blog/2013/01/18/top-10-beautiful-places-you-should-visit-in-edinburgh,-scotland/
Natural Gas is supplied to the Peterhead Power Station in NE Scotland where it is burned in a combined cycle gas turbine (CCGT) to deliver ‘grey’ electricity to the grid.

Shell removes the CO$_2$ from the power station flue gas, compresses it and pipelines it offshore into the depleted Goldeneye gas reservoir for permanent storage. The resulting electricity is rewarded with a ‘green premium’

Under the UK’s Electricity Market Reform, all low carbon energies are eligible for a green premium putting Gas+CCS on par with nuclear and renewables. Gas is recognised as a destination Fuel.
THE LOCAL COMMUNITIES
THE LOCAL COMMUNITIES – IMPACTS & BENEFITS

Power Station Life

Construction Jobs

Operations Jobs

Future Industry Hub

Noise

Traffic

Visual Impact

Waste
PETERHEAD – A TRUE FIRST OF A KIND

1 of a Kind

1st of a kind
DEMONSTRATION PROJECTS – LEARNING CURVES

First of a Kind (FOAK)

Nth of a Kind (NOAK)

Cost of each phone

Total number of phones ever built

Credit: http://itsasmallweb.files.wordpress.com/2011/02/3.jpg
GAS + CCS – COMPETITIVE LOW CARBON ENERGY


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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.
ANTICIPATED PROJECT TIMELINE

2014
Technical FEED

2015
Supply chain tendering & commercial agreements

2016
Detailed engineering

2016-18
Commissioning & start-up

2019-20
Construction
DR ROGER BANNISTER

http://bigstory.ap.org/content/roger-bannister
IMAGINE CAPTURING THIS MUCH CO₂ EVERY DAY
Find out how Shell plans to capture CO₂ at shell.co.uk/peterheadccs