Sky scenario, quantification and decision making

Royal Dutch Shell plc
March 20, 2019

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Welcome and Moderation
Tjerk Huysinga
EVP Investor Relations

Scenarios in Shell
Ed Daniels
EVP Strategy and Portfolio

Sky Scenario and sneak-preview Sky interactive tool
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This presentation contains data and analysis from Shell’s new Sky scenario. Unlike Shell’s previously published Mountains and Oceans exploratory scenarios, the Sky scenario is based on the assumption that society reaches the Paris Agreement’s goal of holding the rise in global average temperatures this century to well below two degrees Celsius (2°C) above pre-industrial levels. Unlike Shell’s Mountains and Oceans scenarios which unfolded in an open-ended way based upon plausible assumptions and quantifications, the Sky scenario was specifically designed to reach the Paris Agreement’s goal in a technically possible manner. These scenarios are a part of an ongoing process used in Shell for almost 50 years to challenge executives’ perspectives on the future business environment. They are designed to stretch management to consider even events that may only be remotely possible. Scenarios, therefore, are not intended to be predictions of likely future events or outcomes and investors should not rely on them when making an investment decision with regard to Royal Dutch Shell plc securities.

Additionally, it is important to note that Shell’s existing portfolio has been decades in development. While we believe our portfolio is resilient under a wide range of outlooks, including the IEA’s 450 scenario (World Energy Outlook 2016), it includes assets across a spectrum of energy intensities including some with above-average intensity. While we seek to enhance our operations’ average energy intensity through both the development of new projects and divestments, we have no immediate plans to move to a net-zero emissions portfolio over our investment horizon of 10-20 years. Although, we have no immediate plans to move to a net-zero emissions portfolio, in November of 2017, we announced our ambition to reduce the Net Carbon Footprint of our energy products in accordance with society’s implementation of the Paris Agreement’s goal of holding global average temperature to well below 2°C above pre-industrial levels. Accordingly, assuming society aligns itself with the Paris Agreement’s goals, we aim to reduce the Net Carbon Footprint of our energy products, which includes not only our direct and indirect carbon emissions, associated with producing the energy products which we sell, but also our customers’ emissions from their use of the energy products that we sell, by around 20% in 2035 and by around 50% in 2050.

We also refer to “Shell’s Net Carbon Footprint” in this presentation. This includes Shell’s carbon emissions from the production of our energy products, our suppliers’ carbon emissions in supplying energy for that production, and our customers’ carbon emissions associated with their use of the energy products we sell. Shell only controls its own emissions but, to support society in achieving the Paris Agreement goals, we aim to help and influence such suppliers and consumers to likewise lower their emissions. The use of the terminology “Shell’s Net Carbon Footprint” is for convenience only and not intended to suggest these emissions are those of Shell or its subsidiaries.

The companies in which Royal Dutch Shell plc directly and indirectly owns investments are separate legal 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 Royal Dutch Shell plc and subsidiaries in general or to those who work for them. These terms are also used where no useful purpose is served by identifying the particular entity or entities. “Subsidiaries”, “Shell subsidiaries” and “Shell companies” as used in this presentation refer to entities over which Royal Dutch Shell plc either directly or indirectly has control. Entities and unincorporated arrangements over which Shell has joint control are generally referred to as “joint ventures” and “joint operations”, respectively. Entities 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 an entity or unincorporated joint arrangement, after exclusion of all third-party interest.

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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.
Exploring alternative futures

- Energy transition and digital: major disruptors
- Past does not predict the future
- Forecasts are inappropriate

- Radically uncertain future needs
  - Scenario thinking
  - Agile decision-making
  - Scenarios are a distinctive Shell capability

From complicated to complex

The Present

The Path

The Future

FORECAST

SCENARIOS
Shell’s Strategy

Our Purpose
We power progress together by providing more and cleaner energy solutions

#makethefuture

Strategic Ambitions
World Class Investment Case
Thrive in the Energy Transition
Strong Societal Licence to Operate

Aspired Portfolio
- Cash engines
- Growth priorities
- Emerging opportunities

Winning Capabilities
- Customer Centricity
- Commercial Value Delivery
- Technology Commercialisation
- Project Delivery
- Operational Excellence

Underpinned by our Values, Goal Zero, and People
Framework for decision making in uncertainty

- Consider “minimise maximum regret”
- Make investment and portfolio decisions

Consider multiple futures in decision-focused scenarios
Business environment/value chain understanding

Clarity of objectives
Strategy and aspired future

Analytic tools
Apply lenses to support the ‘hard’ input to decisions
Multiple lenses

Decisions based on ‘hard’ and ‘soft’ inputs
From individual decisions to shaping the aspired portfolio

Current portfolio
Energy transition
Aspired portfolio

Royal Dutch Shell | March 20, 2019
Shell Scenario

Sky
Meeting the Goals of the Paris Agreement

Wim Thomas
Chief Energy Advisor
The Sky scenario illustrates a technically possible, but challenging pathway for society to achieve the goals of the Paris Agreement. Sky builds on previous Shell scenarios publications and is our most optimistic scenario in terms of climate outcomes.

**Highlights**
Learn how a new energy system could unfold between now and 2070. Scroll through the pages as we tell the story of a possible vision of the future.

**Signposts**
Explore the Sky scenario timeline to the end of the century. Roll over the icons to read about the key milestones in this journey to a net-zero emissions world.

**Dashboard**
Explore the numbers behind the Sky scenario using our data dashboard. Select a geographic region and a data table and view in chart form.
A new energy system is emerging

The Paris Agreement has sent a signal around the world: climate change is a serious issue that governments are determined to address.
The Paris Agreement calls for an early peak in emissions
Net-zero emissions must be achieved during the second half of the century

Peaking of emissions
Positive emissions
Atmospheric CO₂ rises
Net-negative emissions
Atmospheric CO₂ falls
Net-zero emissions
Emission sinks

Source: Shell Schematic
Achieving net-zero emissions requires change at every level of the energy system

Sky relies on a complex combination of mutually reinforcing drivers

Carbon pricing  Energy efficiency  Electrification  New energy systems  Carbon capture and storage  End deforestation

Changing socio-political mindset
Achieving net-zero emissions requires change at every level of the energy system.

Sky relies on a complex combination of mutually reinforcing drivers.

Carbon pricing

A change in consumer mindset means that people preferentially choose low-carbon, high-efficiency options to meet their energy service needs.

Energy efficiency

Electrification

New energy systems

Carbon capture and storage

End deforestation

Changing socio-political mindset
Deep electrification transforms global final energy consumption in Sky

Nevertheless, the need for liquid and gaseous fuels in hard-to-electrify sectors remains significant, with biofuels and hydrogen emerging as major fuels to satisfy growth in overall energy services demand.

Source: Shell analysis, Sky scenario
Global primary energy undergoes major shifts in Sky
Renewables dominate by mid-century as wind and solar deployment ramps-up

Source: Shell analysis, Sky scenario
Fossil fuel demand peaks in the 2030s but remain in sectors where substitution is difficult

Global coal demand declines in the mid-2020s. Oil demand peaks in 2025 but remain critical for air transport and non-energy use. Natural gas serves as a transition fuel into the 2030s prior to a large-scale shift to non-fossil power generation.

Source: Shell analysis, Sky scenario
Sky achieves net-zero emissions by 2070

The scale of global change in Sky is unprecedented

Explore the icons below to learn more

First few countries to reach net-zero emissions
All regions meet net-zero emissions
Last countries to reach net-zero emissions

Energy systems CO₂ emissions, Gt per year

Explore the Sky signposts in more detail
Sky achieves net-zero emissions by 2070
The scale of global change in Sky is unprecedented

Explore the icons below to learn more

First few countries to reach net-zero emissions
All regions meet net-zero emissions
Last countries to reach net-zero emissions

Action plans developed in C40 cities targeting net-zero emissions by 2050

Explore the Sky signposts in more detail
Sky achieves net-zero emissions by 2070
The scale of global change in Sky is unprecedented

Explore the icons below to learn more

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All regions meet net-zero emissions
Last countries to reach net-zero emissions

Governments reach a common understanding as to the appropriate level of the cost of emissions

Explore the Sky signposts in more detail
Sky achieves net-zero emissions by 2070

The scale of global change in Sky is unprecedented

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All regions meet net-zero emissions
Last countries to reach net-zero emissions

Global cumulative storage of CO₂ passes the one Gt milestone

Explore the Sky signposts in more detail
Sky achieves net-zero emissions by 2070

The scale of global change in Sky is unprecedented

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- First few countries to reach net-zero emissions
- All regions meet net-zero emissions
- Last countries to reach net-zero emissions

Energy systems CO₂ emissions, Gt per year

- 2010
- 2020
- 2030
- 2040
- 2050
- 2060
- 2070
- 2080
- 2090
- 2100

India and China each reach one Gt CO₂ per year stored

Explore the Sky signposts in more detail
Sky achieves net-zero emissions by 2070

The scale of global change in Sky is unprecedented

Explore the icons below to learn more

First few countries to reach net-zero emissions
All regions meet net-zero emissions
Last countries to reach net-zero emissions

Net deforestation comes to an end
Sky achieves net-zero emissions by 2070
The scale of global change in Sky is unprecedented

Explore the icons below to learn more

First few countries to reach net-zero emissions
All regions meet net-zero emissions
Last countries to reach net-zero emissions

Energy systems CO₂ emissions, Gt per year

2010 2020 2030 2040 2050 2060 2070 2080 2090 2100

Explore the Sky signposts in more detail

Biofuels overtake oil as the biggest component of liquid fuels.
Sky achieves net-zero emissions by 2070

The scale of global change in Sky is unprecedented

Explore the icons below to learn more

First few countries to reach net-zero emissions
All regions meet net-zero emissions
Last countries to reach net-zero emissions

CO₂ storage reaches 12 Gt per year

Explore the Sky signposts in more detail
Sky shows a pathway to meeting the Paris goal of well below 2°C

A stretched 1.5°C ambition can be achieved by net global reforestation to the size of Brazil

Source: Shell analysis, MIT
Sky requires effective re-wiring of the global economy in just 50 years

Significant change is needed across all sectors
Power generation in 2070
We could live in an increasingly electric world, powered mostly by renewables

In Sky, the rate of electrification by 2070 is more than triple the historical rate of 2% per decade since the 1960s.
Power generation in 2070
We could live in an increasingly electric world, powered mostly by renewables

Electricity provides over 50% of energy consumed by 2070
Industry & Agriculture in 2070

A mix of government policies and consumer demand could help industry and agriculture become more energy efficient.

In Sky, some 10,000 carbon capture and storage facilities are needed by 2070 to address emissions from industries like steel, cement and iron.
Industry & Agriculture in 2070
A mix of government policies and consumer demand could help industry and agriculture become more energy efficient

Net CO₂ emissions from land-use change reaches zero by 2070
Transport in 2070

Electric cars could be the norm, alongside new fuels for trucks, ships and planes

In Sky, electric vehicles reach cost parity with internal combustion engine cars by 2025
Transport in 2070
Electric cars could be the norm, alongside new fuels for trucks, ships and planes

By 2025
all new passenger vehicles bought in the OECD and China are electric

By 2050
this is true globally
Buildings & Cities in 2070
Homes and cities of the future could be carbon neutral, and super-efficient

Buildings are almost 100% electrified by 2070
Explore the numbers behind the Sky scenario using our data dashboard.
All energy sources (EJ / year)

Legend:
- Oil
- Biomass
- Hydrogen
- Natural Gas
- Nuclear
- Biogas
- Biogas: Traditional
- Hydro-electricity
- Other renewables
- Coal
- Geothermal

Source: Shell analysis, 5% scenario, 2018
Units of Measurement

EJ = An SI unit of energy. 1 EJ = 10^{18} joules.

Mtoe = Billion tonnes of oil equivalent. 1 EJ/year = 0.5 Mtoe/day.

Mtoe = Million tonnes of oil equivalent. 1 EJ/year = 23.9 Mtoe/year.

Bcm = Billion cubic meters of natural gas equivalent. 1 EJ/year = 29.3 Bcm/year.

TWh = Terawatt hours. Units of electrical energy. 1 EJ/year = 278.5 TWh/year.

Gt = Gigatonne: A unit of mass. 1 Gt = 1,000 Megatonnes.

Bt km = Billion tonnes km = Distance covered by trucks transporting freight measured by mass.

GDP measured in PPP, 2010 USD = A measure of GDP at an exchange rate based on an equivalent basket of goods in each country, expressed in US dollars of 2010.

Source: Shell analysis, Sky scenario, 2018

Legend

- Oil
- Biomass / Waste Solids
- Solar
- Biofuels (gasoline)
- Nuclear
- Wind
- Other Renewables
- Hydro-electricity
- Coal
- Geothermal

Add a comparison or second chart
Natural gas (EJ/year)

Source: Shell analysis, 3by scenario, 2018

Legend
- Liquid Hydrocarbon Fuels
- Gas-to-X Hydrocarbon Fuels
- Electricity - Commercial
- Hydrogen
- Heat - Commercial

Add a comparison or second chart
Solar (EJ / year)

Source: Shell analysis, SMy scenario, 2018

Legend:
- Electricity - Commercial
- Electricity - Distributed Solar PV
- Hydrogen
- Heat - Commercial
- Heat - Distributed Solar Thermal

Add a comparison or second chart +
Road freight transport (Trillion tonne km / year)

Source: Shell analysis, Sky scenario, 2018

Legend:
- Liquid Hydrocarbon Fuels
- Gas-based Hydrocarbon Fuels
- Electricity
- Hydrogen
**CO₂ emissions captured by CCS (Gt CO₂ / year)**

Legend:
- Heavy Industry
- Agriculture & Other Industry
- Liquid Hydrocarbon Fuels
- GasNatural Gas Fuels
- Electricity - Commercial

Source: Shell analysis, S16y scenario, 2018
### Emissions Captured by CCS - By Point of Emission (Gt CO2/year)

**North America**

<table>
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<th>Year</th>
<th>Heavy Industry</th>
<th>Agriculture &amp; Other Industry</th>
<th>Liquid Hydrogen Plants</th>
<th>Natural Gas Hydratation Plants</th>
<th>Electricity - Commercial</th>
<th>Hydrogen</th>
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</table>

**Legend**

- Heavy Industry
- Agriculture & Other Industry
- Liquid Hydrogen Plants
- Natural Gas Hydratation Plants
- Electricity - Commercial
- Hydrogen
- Heat - Commercial

**North America - Emissions Captured by CCS - By Point of Emission (Gt CO2/year)**

- Heat - C
- Hydrogen
- Electricity
- Natural Gas
- Liquid Hydrogen
- Agriculture
- Heavy Industry
Online material available

Interactive tool launch on 26th March

The Sky scenario illustrates a technically possible, but challenging pathway for society to achieve the goals of the Paris Agreement. Sky builds on previous Shell scenarios publications and is our most optimistic scenario in terms of climate outcomes.

www.shell.com/skyscenario

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