Shell Scenario
Sky
Meeting the Goals of the Paris Agreement

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This presentation contains data from Shell’s new Sky Scenario. Unlike Shell’s previously published Mountains and Oceans exploratory scenarios, the Sky Scenario is targeted through the assumption that society reaches the Paris Agreement’s goal of holding global average temperatures to well below 2°C. 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 over 40 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 our net carbon footprint 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 our net carbon footprint, 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 20% in 2035 and by 50% in 2050.

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 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 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 a venture, partnership or company, after exclusion of all third-party interest.

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Exploring alternative futures

- Societal and Energy systems are complicated
- Energy transition and digitalisation: major disruptors
- Past does not predict the future
- Forecasts are inappropriate in a radical uncertain future
- Complex future: needs agility
  - Scenario thinking
  - Decision-making
- Scenarios are a distinctive Shell capability, supporting strategic thinking
The Paris Ambition: well below 2°C
A signal sent around the world
Challenges for the 21st century: development and decarbonisation

Human Development Index: Energy supports a better life

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<th>Country</th>
<th>GJ/capita</th>
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</table>

Source: Shell analysis – UN Human Development Index 2016

From “A better life and a healthy planet”, Shell publication 2016

Decarbonisation: Sector-specific perspective is key

Source: Shell analysis, World Energy Model

Industry: Less difficult to decarbonise
Built environment: Less difficult to decarbonise
Power generation: Less difficult to decarbonise
Transport: More difficult to decarbonise
A possible primary energy mix for a net-zero emissions world

- Natural Gas
- Oil
- Coal
- Bio-energy
- Nuclear
- Solar
- Wind
- Others

TODAY:
- Solar: 5%
- Wind: 3%
- Bio-energy: 27%
- Natural Gas: 32%

SCENARIO 2070:
- Solar: 11%
- Wind: 32%
- Bio-energy: 14%
- Natural Gas: 6%
- Oil: 13%
- Nuclear: 10%
- Coal: 8%

The size of the pie chart indicates growth of the energy system.

Source: Shell Sky Scenario
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Includes some Carbon Capture and Storage
The New Lens Scenarios Family
Looking beyond Mountains and Oceans...

...to Sky
Sky relies on a complex combination of mutually reinforcing drivers being accelerated by society, markets, and governments.
In Sky, seven big steps forward from now to 2070

- Carbon pricing
- Energy efficiency
- Electrification of final energy
- Grow new energy systems
- Carbon capture and storage
- End deforestation
- Changing consumer mind-set
Energy efficiency is key

Rising incomes in developing regions drive global energy demand

This is moderated by significant energy efficiency improvements

World total final energy consumption, EJ/year

Source: Sky Scenario, Shell analysis
Copyright of Shell International B.V.
The deep electrification story – sector by sector

World electrification rates by sector

- Accelerates across sectors at three times the historical rate
- Global power generation growing by a factor of five

Source: Sky Scenario, Shell analysis
Copyright of Shell International B.V.
Deep electrification, but molecules remain important

Electrification increases from 20% today to ~55%

Fossil molecules largely replaced by renewable ones

Source: Sky Scenario, Shell analysis
Copyright of Shell International B.V.
Governments establish essential policies

Carbon Pricing mechanisms are adopted rapidly by governments
Carbon equivalent price, $/tonne CO$_2$

Unwavering acceleration and coordination:
- Market & Fiscal mechanisms
- Standards & Mandates
- Investments in infrastructure & technology

Source: Shell Sky Scenario
Copyright of Shell International B.V.
Achieving the balance

Biofuels with carbon capture and storage play a leading role

Source: Sky Scenario, Shell analysis
Copyright of Shell International B.V.
Sky meets the Paris goal

MIT assessment of climate impact

Average world surface temperature rise (°C)

Reforestation can be a further game changer to push delivery to the stretched 1.5°C ambition of the Paris Agreement

Source: Massachusetts Institute of Technology, Shell Sky data
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Renewables dominate 2nd half of the century

World Total Primary Energy by Source, EJ/year

- Other Renewables
- Wind
- Solar
- Geothermal
- Biomass - Traditional
- Biomass & Waste
- Biofuels
- Hydro-electricity
- Nuclear
- Coal
- Natural Gas
- Oil

Source: Sky Scenario, Shell analysis

Oil and Natural Gas grow significantly till the 2030s, but so will energy from renewables, eclipsing fossil fuels in the 2050s
Fossil fuel demand peaks

World Total Primary Energy, EJ/year

- Coal peaked in 2014
- Oil peaks in 2025
- Natural gas plateau 2030s

Oil demand peaks due to high ICE efficiency and EV uptake
Gas – the long transition fuel

Source: Sky Scenario, Shell analysis
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Meeting the Paris ambition: re-wiring the global economy in 50 years

- Promoting critical new pre-commercial technologies
- Developing key infrastructures
- Framing new market structures

Governments

- The engine for commercial innovation and scaling
- Mass-deployment and integration of new technologies
- Providing customers with new possibilities

Private sector

Acceleration is achieved through policy and technology uptake, and unprecedented degrees of cross-boundary collaboration
“The future depends on what we do in the present”

Mahatma Gandhi
Discussion

www.shell.com/skyscenario
#ShellScenarios
Shell’s role in the transition to a low-carbon world

Developing our gas business
New fuels
Renewable power
Advancing CCS
R&D in low carbon technologies
Shell Technology Ventures
Advocate CO₂ pricing
Scenarios thought leadership
Coalitions & government advisory
Today, the USA emits around 5 Gt CO$_2$ /yr (~15% of global emissions) This needs to decrease to 1 Gt CO$_2$ /yr by 2050 (~7% of global emissions)

Source: Shell WEM – Sky Scenario
Efficiency improvements and substitution by electricity, enabled through high renewables uptake, could lead to a ~70% emissions reduction in the USA between 2020 and 2050.

Source: Shell WEM – Sky Scenario
US Primary energy demand already peaked in the 2000s, with further efficiencies to go for.

Sky in the US is foremost a technology / costs story, but CO₂ pricing and policy support is also needed to accelerate the transition required for meeting the Paris goals.

Source: Shell WEM – Sky Scenario
EV uptake in Sky is astronomical
Others’ outlooks are revised upwards every year

- Sky assumes EVs being 100% of new sales by 2030 in leading economies
- Mountains scenario assumes 50% new sales EVs by 2040.

Source: Shell, BNEF, BP, XOM, OPEC, IEA

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