SHELL: ENERGY TRANSITIONS AND PORTFOLIO RESILIENCE
Disclaimer
The ‘New Lens Scenarios’ and ‘A Better Life and a Healthier Planet’ publications are part of an ongoing process – scenario-building – used in Shell for more than 40 years to challenge executives’ perspectives on the future business environment. We base them on plausible assumptions and quantification, and they are designed to stretch management to consider a wide range of outlooks, including events that may be only 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.

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, 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.

Cautionary Note
The companies in which Royal Dutch Shell plc directly and indirectly owns investments are separate legal entities. In this report “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 report 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.

This report 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 report, 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 report 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, 2015 (available at www.shell.com/investor and www.sec.gov ). These risk factors also expressly qualify all forward looking statements contained in this report and should be considered by the reader. Each forward-looking statement speaks only as of the date of this report, May 11, 2016. 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 report.

We may have used certain terms, such as resources, in this report 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.
Shell has long recognised both the importance of climate change and the critical role energy must play in enabling a decent quality of life for people across the world. The big challenge, for society and for a company like Shell, is how to provide much more energy while at the same time significantly reducing carbon dioxide (CO₂) emissions.

We hear broadly two questions from investors and commentators on this crucial topic. How does Shell view the energy transition to a low-carbon future? And how is the company positioned for the changes that are to come?

In parallel with this report, we have recently published a new scenarios study that examines the plausible pathways needed to achieve net-zero CO₂ emissions by the second half of this century. This study looks in depth at the first of the two questions. You can find it at www.shell.com/scenarios. To summarise, a transition to a low-carbon future is both desirable, and possible. However, this will need strong policy choices and actions, and continued investment in oil and gas, as well as rapid growth in lower-carbon fuels.

There are questions for society today about whether the pace of change is sufficient.

In this report, we seek to address the second question: Shell’s approach and portfolio resilience to the energy transition, and our strategy to succeed through changing times. We describe the key drivers in the energy mix and set out how Shell is investing in low-carbon energy – “new energies”– while reflecting on the wide range of business choices we can make until 2035, and beyond.

Shell has a track record of successfully adapting our business model, and delivering profitable growth, over more than 100 years. Our assessment is that there will continue to be commercial opportunities for Shell in oil and gas for decades to come, providing a foundation to position the company successfully for the energy transition to a lower-carbon system. In the near term, this means growing our natural gas business, further improving our company’s energy efficiency, and adapting our portfolio. Over the longer term, we plan to develop a new and profitable lower-carbon new energies business.
Shell has used scenarios analysis for more than 40 years to challenge our perspectives of the future business environment. They sit alongside the scenarios produced by independent bodies such as the International Energy Agency (IEA). Shell’s New Lens Scenarios (2013) describe two potential pathways – Mountains and Oceans – that could deliver the energy necessary for the global economy, while achieving net-zero CO₂ emissions from energy by the end of the century.

Source: Graph based on L. Barreto, et al., Int. J. H₂ Energy 28 (2003) 267. Data prior to 1960 was taken from the IIASA PFU database (Version 0.0.2) https://trcat.iiasa.ac.at/PFUDB; data 1960-2014: IEA and Shell; data 2015-2100: Shell NLS scenarios.
The International Energy Agency’s World Energy Outlook Scenarios

**New Policies Scenario** serves as the IEA baseline scenario. It takes account of broad policy commitments and plans that have been announced by countries, including national pledges to reduce greenhouse gas emissions and plans to phase out fossil-energy subsidies, even if the measures to implement these commitments have yet to be identified or announced.

**Current Policies Scenario** assumes no changes in policies from the mid-point of the year of publication (previously called the Reference Scenario).

**450 Scenario** sets out an energy pathway consistent with the goal of limiting the global increase in temperature to 2°C by limiting concentration of greenhouse gases in the atmosphere to around 450 parts per million (ppm) of CO₂.

(Source: http://www.iea.org/publications/scenariosandprojections)
Energy is essential to the global economy, and for the lifestyles that many of us enjoy today. Global demand for energy will grow, and we expect dramatic changes in the types of energy consumed over the decades ahead. The pace of change will differ depending on where people live, what they can afford, or are willing to pay. These changes will be profound, capital-intensive, different by location, and will span decades. Effective policies, significant investment, technology development and a different consumer mindset will be essential to drive the emergence of a low-carbon energy system.
KEY DRIVERS OF EMISSIONS TRAJECTORIES

These four key drivers shape different expectations of emissions trajectories to 2040

- Population
- Economic growth
- Energy efficiency
- Energy system decarbonisation

Source: IHS Energy © 2015 [Illustrations sourced from Shutterstock by IHS]
1.a **Growth in energy demand – a better, cleaner world**

Just 20% of the world’s population live in the OECD countries, and yet they consume around half of the world’s energy today. Billions of people around the world still lack the access to energy that many of us take for granted, such as heating, light, air conditioning, refrigeration and transport. Access to low-cost and reliable energy can transform quality of life and underpin economic growth.

At the same time, the world’s population is rising rapidly – from some 7.5 billion today, to perhaps 9-10 billion by the end of the century1. These forces together – rising living standards and population growth – mean that energy demand should continue to grow. The IEA, under its New Policies, or central baseline scenario, estimates that by 2035, energy demand could be a quarter higher than 2015 levels. Even in its significantly constrained 450 outlook, that requires significant energy policy change to keep global warming to 2°C, energy demand is still expected to rise over this period2.

---

2 IEA World Energy Outlook 2015
The energy transition will require long-term vision and investments

A successful energy transition will require a mixture of vision, urgency and realism. Vision for a long-term approach to policy-setting, business planning, and investments. Urgency and realism about the scale and costs of orderly transformations, both for energy suppliers and energy consumers.

Society has to be ambitious to achieve its climate-change and development goals. Decisions must tackle the breadth and complexity of the challenge. Conversely, rapid, poorly-considered policy-driven changes could result in unexpected consequences and fail to achieve their intended goals.

This transition will require a combination of hydrocarbons and renewables to meet all types of energy needs. It will also require huge investments in industrial, civic and residential infrastructure.

Today, oil, gas and coal account for over 80% of primary energy supply world-wide. A global network of mines, oil and gas fields, power plants, pipelines, refineries, filling stations and distribution systems is in operation and has been developed over the past 150 years.
ENERGY NEEDS AND DEMAND

Current energy needs are met primarily by oil, gas and coal, with consumer preferences driving demand.

13.7 Btoe
Total primary energy supply (2014)

32% Oil
29% Coal
21% Gas
18% Biomass/nuclear/renewables*

9.4 Btoe
energy consumption

28% Transport
34% Domestic
31% Industry
7% Feedstock

Oil supports 92% of transport demand
Electricity and natural gas support half of domestic demand
Coal fires more than a third of global industrial consumption
Feedstock demand met by oil, gas and coal alone

ENERGY CONSUMPTION

*biomass ~10%, nuclear ~4%, renewables ~4%
(Source: Shell estimates)

Pace of Change
Average infrastructure turnover in years

40 YEARS
Power plants

25 YEARS
Commercial Shipping

24 YEARS
Aircraft

20 YEARS
Heating Systems

15 YEARS
Light vehicles

SOURCE: IHS Energy © 2015 [Illustrations sourced from Shutterstock by IHS]
**Energy Change Requires Enormous Investment Throughout the Economy**

### Infrastructure Investment

- **Light-duty vehicles**: 30%
- **Heavy-duty trucks**: 28%
- **Refrigeration**: 11%
- **Fossil fuel power plants**: 7%
- **Aircraft**: 6%
- **Motorcycles/Other land transport**: 6%
- **Heating and cooking systems**: 5%
- **Steel mills**: 4%
- **Shipping**: 2%
- **Cement plants**: 1%

#### $55 Trillion

Of energy-related infrastructure uses fossil fuels

### IEA New Policies Scenario

**Average annual investment**

- **2000-2013**: $550 billion
- **2014-2020**: $1.1 trillion
- **2021-2025**: $1.5 trillion
- **2026-2030**: $2 trillion
- **2031-2035**: $2.5 trillion


### Avoiding Emissions Growth

To avoid 1 gigatonne of CO₂ equivalent (GtCO₂e) of annual emissions growth:

- **Replacement of 263 coal-fired power stations** with zero carbon sources
- **Installation of 275,225 wind turbines**
- **Removal of 211 million vehicles from the road**

**Source**: IHS Energy © 2015 (Illustrations sourced from Shutterstock by IHS)
The high cost of energy is sometimes under-estimated. The $55 trillion invested in fossil fuels today is the equivalent of 70% of global gross domestic product (GDP). Annual spending of $1.6 trillion on energy is the equivalent of some 2% of global GDP, or around half of the GDP of the UK. It is clearly not possible to replace the energy system in a short time frame.

Major changes to electricity systems, industrial and residential infrastructure and vehicle fleets will be required. This takes time and substantial investment.

Today, emissions from the global energy system stand at some 32 gigatonnes of CO₂ a year. In the IEA’s 450 scenario, these CO₂ emissions are reduced to 19 gigatonnes of CO₂ by 2040. To give some idea of the scale of that challenge, it would take the replacement of 263 coal-fired power stations with zero-carbon sources of energy to avoid annual emissions growth of just 1 gigatonne per year of CO₂, of the 13 gigatonnes reduction that is needed. A reduction of 1 gigatonne is the equivalent of emissions from two-thirds of all the coal-fired power plants in the USA.

As another example, over the last 30 years biofuels have grown to reach just a 3% share of global transport fuels after decades of research and development. In Brazil, where Shell has a successful biofuels joint venture, sugar-cane ethanol provides around 25% of road transport fuel, but it is unlikely many countries have the required combination of natural conditions and land availability to replicate this achievement.

Biomass makes up 10% of total primary energy. Renewables (solar, wind and hydro) are developing quickly, and are making impressive inroads into decarbonising the power sector. However, today, renewables and nuclear account for 4% each of primary energy supply, and electricity is just 18% of final energy consumption.

---

2 WEO 2015 Table 9.3 page 348
Oil and gas remain important primary energy sources

According to the IEA, and Shell’s own scenarios, oil and gas will remain integral to the global economy for decades to come. Today, oil and gas provide around 50% of the world’s primary energy. In the IEA’s more stretching 450 scenario, oil and gas are expected to provide 47% of primary energy in 2030 – more gas and less oil in the mix than today.

Suppliers of energy are often singled out in the discussion on climate change. But in fact, this is an issue that affects the entire global economy, including consumers of energy. Equipment used by many industries is powered by oil, gas and coal, and renewable energy technologies still cannot provide the intense energy required by heavy industry, aviation and mass transport, for example.

Nearly half of industry is powered by oil and gas. There are currently no easy replacements for hydrocarbons in heavy industries, such as in petrochemicals or in iron and steel manufacturing where extremely high temperatures need carbon-intensive processes.

Over 90% of transport is currently fuelled by oil. Oil is also the basis for many of the chemicals and synthetic materials required for modern life.

Natural gas is used more in the power and heating sectors, but can also be processed into plastics and other products.

Both oil and natural gas can work well alongside growing sources of energy such as renewables and other lower-carbon alternatives. For example, natural gas can combine with intermittent wind and solar power to provide the base-load and flexible power for a lower-carbon electricity grid. In transport, petrol, diesel and liquefied natural gas (LNG) can work alongside plug-in or hydrogen-electric engines to provide greater versatility, range and reliability.
CURRENT GLOBAL ENERGY DEMAND

ENERGY CONSUMPTION by sector and consumer trends

WORLD ENERGY DEMAND

Shell’s capacity to innovate and take a long-term view of investment can help us make an important and commercial contribution to the energy transition. We are reducing our emissions; we have a leadership position in natural gas; we are continuing to establish and grow a new energies business; and we are looking for business opportunities that match our skills and capabilities.
2.a A strong voice in the energy debate

Shell has taken a proactive and public stance on climate change, including adopting a high level of transparency around our own operations (www.shell.com/ghg).

As we describe in this report, the sheer scale and shift in investment that will be required to move to a low-carbon energy system means that governments, businesses and society will all have a significant part to play. Energy consumers will need to make substantial and lasting changes. Energy suppliers like Shell will need to adapt their business models, and the energy transition is embedded in Shell’s strategy today.

The conversation around energy and climate change in the public sphere can sometimes be oversimplified, although with clear ambitions and aspirations. These ambitions must be channelled to create pragmatic and realistic policies able to tackle one of the world’s most complex challenges.

As shown in this report, the global energy system cannot change quickly or easily. Energy-related infrastructure worth some $55 trillion uses oil, gas and coal today. Oil, gas and coal provide over 80% of primary energy world-wide. Low-carbon power generation – renewables in tandem with natural gas – has enormous potential, and yet electricity has just an 18% market share of energy consumption today.

There are important choices to be made by suppliers and consumers in the energy transition. Many of the services that we take for granted use oil, gas and coal. For example, oil powers more than 90% of transport, with aircraft, motor vehicles and ships in use for between 15 and 25 years. It will take new technologies and significant investment over decades to change this energy mix.
A HISTORY OF SHELL CO₂ PRICING ADVOCACY

1999

- Founding member of the International Emissions Trading Association (IETA)

2000

- Founding member of UK Emissions Trading Group (ETG), commented on design of UK Emissions Trading Scheme (ETS)

2001

- Creation of a carbon trading desk
- First company to trade a CO₂ allowance under the EU ETS

2002

- Participated in the voluntary UK ETS

2003

- Creation of a Singapore carbon trading desk in anticipation of Australia and New Zealand ETS
- Participated in the voluntary UK ETS

2004

- Successful advocacy for low-carbon technology, including carbon capture and storage for Phase III EU ETS (2013-2020)

2007

- Participated in the US CAP coalition in support of US-wide ETS

2008

- Creation of a Singapore carbon trading desk in anticipation of Australia and New Zealand ETS

2009

- Joined government-led Business Roundtable in support of climate action and carbon pricing in Australia

2010

- 2009

2011

- 2010

2014

- Signed up to World Bank's statement on carbon pricing

2015

- Advocacy for carbon pricing in South Africa

- Supported International Emissions Trading Association (IETA) proposals for international carbon market development adopted under Article 6 of the Paris Agreement

- Made successful first trade for China ETS

- Signed the “six CEO letter” to the Executive Secretary of the United Nations Framework Convention on Climate Change (UNFCCC) and President of COP21 promoting government-led carbon-pricing systems

- Became a member of the Carbon Pricing Leadership Coalition (CPLC) in 2015. Worked with others in the industry to promote carbon pricing in the run-up to COP21.
OIL RESERVES
Of the 15 large companies that produce half the world’s oil, private sector companies hold only 5% of reserves

EMISSIONS EMBEDDED IN RESERVES
The 20 largest private-sector oil and gas companies account for less than 2% of the total CO₂ emissions that are embedded in global fossil fuel reserves

56 Gt CO₂ (less than 2%)

351 Gt
from natural gas reserves

721 Gt
from oil reserves

1,856 Gt
from coal reserves

Source: IHS Energy © 2015 [Illustrations sourced from Shutterstock by IHS]
The largest 20 private-sector oil companies have less than 2% of the CO₂ emissions embedded in oil, gas and coal reserves in the ground. Coal accounts for more than 60% of this total. Shell’s CO₂ is a fraction of global totals; both our CO₂ embedded in our reserves, and our annual direct emissions. Shell’s actions alone – or the actions of any single company – cannot change the global energy mix.

We advocate areas where we have leadership in technology or portfolios – such as LNG and carbon capture and storage (CCS). We see a greater role for natural gas in the power sector, in particular as a replacement for coal. We also see a greater role for governments in supporting CCS technology.

Shell believes that the public and policy debates should focus on building long-term energy policy and financial frameworks that will enable increased access to energy, including low-carbon commercial energy. We also believe that government-led carbon-pricing mechanisms are the single most effective policy instrument for widespread and permanent reductions in emissions. Around a third of total man-made greenhouse gas emissions come from sources other than the energy sector, such as agricultural activity, land use change, cement production, and certain chemicals processes. All sectors of commerce and society must play a part.

The energy transition is a significant issue for business, government and society today. Shell is playing a positive and active role.

2.b Shell in the energy mix

One of the world’s largest listed companies, Shell has provided commercial energy solutions to the world for a century. We are proud of our global brand presence and customer base. However, Shell is a relatively small player in the energy equation and cannot influence the energy mix alone. The top 10 national, government-controlled oil companies produce around a third of global oil and gas supply.
2.c Reducing our emissions

We continue to look for ways to further reduce Shell’s greenhouse gas (GHG) emissions.

Our direct GHG emissions have fallen by 40 million tonnes of CO₂ equivalent or 35% since their peak in 2003, partly reflecting our portfolio actions and efficiency programmes. We strive for improved energy efficiency across all our upstream and downstream operations. Better energy efficiency can be achieved by improving the reliability of our equipment, by smart scheduling of maintenance activities or by installing more energy-efficient equipment.

For example, Shell-operated refineries identify measures to improve energy efficiency each year. In 2015, we installed a cogeneration unit at our Bukom refinery in Singapore. This unit improves energy efficiency by recovering waste heat from the gas turbine’s exhaust to generate steam. Between 2009 and 2015, the energy intensity of our refineries decreased by about 6%.

In addition to reducing our own emissions, we work to help our customers conserve energy through the development and sale of advanced fuels, lubricants and chemicals.

2.d A leader in natural gas and liquefied natural gas

The use of more natural gas, especially in power generation, will be vital to building a sustainable energy system. From the extraction of the fuel to the generation of electricity, modern gas-fired power plants emit around half the CO₂ of modern coal plants. Today, natural gas makes up around half of Shell’s oil and gas production.

We are one of the world’s leading suppliers of LNG. Even after liquefying, transporting and turning it back into natural gas, LNG emits around half the CO₂ compared to coal when burnt to generate electricity.

Shell is exploring ways to extend the use of LNG beyond power generation to transport. LNG is a fuel for heavy-duty road transport and shipping. It can be used as an alternative transport fuel to diesel and heavy fuel oil.

We are also looking to increase the use of LNG in our own operations. For example, since 2015 Shell has been operating two offshore supply vessels for our deep-water operations in the Gulf of Mexico, mainly running on LNG, with one more LNG-fuelled vessel to follow.
Many human activities produce greenhouse gases
Global GHG emissions for 2012 ~48 GtCO₂e

GHG emission sources
- Buildings: 6%
- Waste: 10%
- Transport: 14%
- Industry: 21%
- Agriculture, forestry, and land use: 24%
- Electricity and heat production: 25%

GHG emission types
- Fluorinated gases: 2%
- Nitrous oxide: 6%
- Methane: 11%
- Land use-related CO₂: 16%
- Energy-related CO₂: 65%

Energy-related CO₂ emissions
- Coal: 43% 29%
- Oil: 37% 31%
- Gas: 20% 21%
- Renewables and other: 0% 18%

% of global energy-related CO₂ emissions (2013) % of global primary energy supply (2013)
SHELL NEW ENERGIES

SHELL LOW-Carbon R&D And INVESTMENT STRATEGIES

- **GAS**
  - Exploration
  - Qatar Carbonates and Carbon Storage Research Centre
  - LNG
  - LNG (6.5 MTPA)
  - LNG (6.3 MTPA)
  - LNG (24 MTPA)

- **CCS**
  - Glasspoint Solar Technology
  - Technology Centre Mongstad
  - Cansolv Technology
  - Quest
  - Gorgon
  - Technology Centre Mongstad
  - Otway Basin Project
  - Cansolv Technology
  - Quest

- **BIOFUELS**
  - Bangalore R&D Advanced Biofuels
  - Westhollow Research Centre Advanced Biofuels
  - Raízen Advanced Biofuels
  - Raízen Biofuels

- **SOLAR**
  - Solar Photovoltaic Cells
  - Absorption Technology CCS Alternative
  - Solar Photovoltaic Cells
  - Glasspoint Solar Technology
  - Technology Centre Mongstad
  - Otway Basin Project
  - Cansolv Technology
  - Quest

- **ALTERNATIVE ENERGY CARRIERS**
  - Future Energy Technologies
  - E-Mobility Battery Technology
  - 2 & Energy Turbine Technology
  - H2 Network (Europe, USA)
  - H2 Network (Germany)
  - H2 Network (5 Sites)
  - Offshore (50 Mw net)
  - Onshore (450 Mw net)

- **WIND**
Investing in new energies

For the longer term, Shell’s new energies business is actively exploring opportunities where the commercial value is clear. We have invested in the past, and we intend to continue to invest in new opportunities at scale in the future.

New energies covers a number of important themes: new fuels for mobility, such as biofuels and hydrogen; integrated energy solutions, that combine, for example wind and solar energy; and connecting customers with new business models for energy, enabled by digitalisation, and the decentralisation of energy systems.

Shell’s capital employed in new energies activities today is some $1.7 billion and we are currently spending around $200 million a year to explore and develop these new opportunities. Our focus will largely be on capital-light plays, in areas that share aspects with our core businesses, such as location and ease of fit with existing infrastructure. These can be a key source of competitive advantage for Shell compared to the specialist players in the renewables industry.

Our biofuels investments include Raízen, a joint venture in Brazil that produces ethanol from sugar cane. This comes alongside continued efforts to commercialise new technology to make competitive low-carbon biofuels from sustainable, non-food sources.

Hydrogen as a transport fuel can have links to Shell’s current downstream retail infrastructure, supply and distribution capabilities, and natural gas businesses. We are part of a joint venture in Germany which will invest in some 390 hydrogen retail sites, 230 of which will be Shell-branded. At the end of 2015 we operated three hydrogen filling stations in Germany. We are also exploring hydrogen opportunities in other countries, including the UK and the USA.

Wind. Shell entered the onshore wind business in the USA in 2001, and we have interests in eight onshore wind projects, with installed capacity of 450 MW net. Shell also maintains a 50% interest in the 108-MW NoordZee Wind offshore project in the Netherlands. We continue to consider further opportunities in wind energy where we can put our broader experience and capabilities to best use.

Solar. Shell is exploring ways to deploy solar technologies which lower the carbon intensity of our operations. Shell has a minority investment in Glasspoint, a company which has successfully demonstrated its solar steam technology for use in thermal enhanced oil recovery operations. Glasspoint is building some 1GW of capacity in Oman. As costs for solar photovoltaic (PV) continue to fall, we see further potential to profitably deploy solar PV in our operations to reduce the use of oil, gas and coal and lower the carbon intensity of our assets.
2.f A leader in carbon capture and storage (CCS)

Shell is playing a leading role in the demonstration of CCS technology. This, we believe, is the only currently available technology that can significantly reduce CO₂ emissions from industrial sectors of the economy.

- In November 2015, Shell’s Quest CCS project officially opened at our oil sands operations in Canada. It can capture and store more than 1 million tonnes of CO₂ each year. The CO₂ will be safely stored more than two kilometres underground.
- We are involved in the Gorgon CO₂ injection project in Australia, the CCS test centre in Mongstad, Norway, and the Qatar Carbonates and Carbon Storage Research Centre in London, UK.
- In addition, we have technology that can remove both CO₂ and sulphur dioxide from industrial flue gases. Shell Cansolv technology is being used at the Saskpower Boundary Dam coal-fired power plant in Canada.

Shell’s investments in CCS projects, as well as Shell’s Cansolv CCS technology, mean that together with our partners and customers, we have more than 5 million tonnes of annual CO₂ capture capacity on-stream or under construction.
SHELL ENERGY INTENSITY

Gj/tonne (energy required to produce a tonne of oil equivalent)

SHELL EMISSIONS PERFORMANCE

Million tonnes CO₂ equivalent

Information reported on an operated basis
We continuously assess Shell’s portfolio, strategy and resilience against a wide range of outlooks. This is how we identify new business opportunities and asset sales, and ensure the resilience of the company in the future. Our strategy reflects our recognition that we are in an era of transition and volatility for the energy industry.
SHELL PORTFOLIO MANAGEMENT

THEMES
- Risk, performance and uncertainty

RESILIENCE
- Growth and returns opportunity scale

ATTRACTIVENESS
- Performance

PORTFOLIO
- RESULTS
- AND PAY-OUT

SHELL BUSINESS VALUE, IMPACTS AND RISK

SHELL’S BUSINESS VALUE CHAIN

INPUTS
- Water costs/availability

ASSETS
- Flooding/drainage
- Storm damage
- Sea level rise
- Capacity derating

COMMERCIAL ENVIRONMENT
- Regional compliance
- Demand destruction
- Liability
- Reputation
- Capital availability

POTENTIAL CLIMATE IMPACTS

TYPE OF RISK
- Physical
- Regulatory
- Market
- Societal

SHELL MANAGEMENT OF CO₂-INTENSIVE PROJECTS

Project economics

CO₂ Project screening value

Low NPV impact

High NPV impact

Upside sensitivities

Downside sensitivities

ADDITIONAL TOOLS
- Option thinking
- Stranded asset testing
- Value erosion calculator
- Performance standards

Cost pass through

Most-likely scenarios

Product risks

Stranded asset risks
3.a **Global portfolio and capital allocation**

Shell’s activities and know-how span the value chain in oil, natural gas and many of the products that come from them. This diverse portfolio helps us mitigate the impact of price volatility and other risks that can develop regionally.

Investment decisions taken today on new oil and gas developments typically involve construction times of five years, and revenue streams that run for many decades. New technologies, new markets, and the natural decline of oil and gas fields all spur Shell towards continuous innovation and new business models. For example, we pioneered the commercial LNG industry in 1964, led the way in deep-water oil and gas production in the 1970s, advanced gas-to-liquids (GTL) in the 1980s, and entered the sustainable biofuels business in 2011.

Shell is a major player in a series of distinct but linked strategic themes, such as downstream, deep water, LNG, conventional oil and gas, and new energies. As we allocate capital on behalf of shareholders to these themes, and the assets within them, the opportunities are assessed against both their attractiveness, and their resilience. This includes the attractiveness of financial returns, and resilience to the risks of changing oil and gas prices, regulatory regimes, geopolitical situations, and carbon costs.

In 2016, Shell acquired BG Group, increasing our investment in deep water and LNG, and creating a platform for a more significant shift in our portfolio, including asset sales. This increase in gas, in particular, and the size of the overall company, means that Shell is better positioned for the energy transition than in the past.

The decision on which of the company’s assets to divest, as well as future investment decisions, will reflect the potential CO₂ footprint, alongside other financial and strategic considerations.

3.b **Managing asset-level resilience to climate change**

Shell has a rigorous approach to understanding, managing and mitigating climate risks in our assets.

We reflect future regulatory costs by typically applying a common $40 per tonne project screening value (PSV) to the CO₂ emissions associated with investments. This incentivises investments in CO₂ abatement, highlights projects with the most exposure to rising carbon prices and helps screen early-stage opportunities. We have greenhouse gas and energy management plans at key sites to illustrate and identify potential ways to reduce CO₂ emissions. High-emitting projects undergo additional sensitivity testing.

This can lead to projects being stopped, designs being changed, and potential GHG mitigation investments being identified, in preparation for when regulations would make these investments commercially compelling.

Such considerations, for example, influenced Shell’s decision to invest in a gas-gathering system to reduce our flaring activities at the Majnoon field in Iraq.

As another example, we evaluate options to integrate readiness for CCS into the design of our new projects. This was the case at our Scotford Upgrader in Alberta, Canada, which is now the site of our Quest CCS facility.
3.c Portfolio resilience in a low-carbon world

Shell looks at wide-ranging scenarios and outcomes, and maintains a risk-balanced global portfolio. This takes into account the long timescales in the industry, and the potential for substantial shifts in the macroeconomic outlook.

Analysis against our own and other scenarios shows that Shell’s portfolio is generally resilient to developments related to climate change. This is a dynamic and ongoing analysis, and will include the new BG portfolio and the impact of future asset sales.

Carbon intensity, and potential changes in carbon prices and the regulatory environment all have an important role to play when we look at how we want to shape our portfolio for the future.

On the table on page 31 (“Shell Portfolio Resilience by Strategic Theme”) we provide a qualitative assessment of the key trends facing our portfolio. Down arrows represent trends signifying a more challenging future business environment; up arrows represent potential upside from these developments, should they be realised. We seek to balance our exposure to these trends.

Technology and innovation can also have an important role. For example our joint venture PDO in Oman uses solar energy to make the steam it needs for enhanced oil recovery – replacing conventional power generation and improving the emissions footprint there.

We also assess the potential impact of rising CO₂ prices on our portfolio, by making long-range forecasts of our CO₂ emissions, and mapping these against trends in CO₂ pricing and regulations.

The chart on page 32, called Distribution of Shell CO₂ emissions and costs, shows Shell’s emissions by region in 2016, and an outlook for these emissions in 2030. The final outcome, of course, will depend on investment decisions and divestment choices that have yet to be made. We have also assessed the potential for net CO₂ costs by region, before any customer pass through in 2020 and 2030, and we assess their financial impacts using sensitivity analysis.
## Shell Portfolio Resilience by Strategic Theme

<table>
<thead>
<tr>
<th>Demand shift in existing markets</th>
<th>New markets for low carbon products</th>
<th>Technology innovation</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Conv. Oil</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| ![Conv. Oil](icon.png)           | ![New markets for low carbon products](icon.png) | ![Technology innovation](icon.png) | - Alternative fuels and efficiency may weaken underlying demand  
- In-field innovation can reduce emissions |
| **Conv. Gas**                    | ![New markets for low carbon products](icon.png) | ![Technology innovation](icon.png) | - Transition from coal to gas in power will support gas demand  
- Potential for increased use of gas and electricity in transportation  
- Decarbonisation through CCS can support long-term demand |
| **Integrated Gas**               | ![New markets for low carbon products](icon.png) | ![Technology innovation](icon.png) | - Transition from coal to gas in power will support gas demand  
- Potential for increased use of gas and electricity in transportation  
- CCS technologies can improve CO₂ footprint and support long-term demand |
| **Oil Sands Mining**            | ![New markets for low carbon products](icon.png) | ![Technology innovation](icon.png) | - Operating costs and market access pressured by CO₂ regulations  
- Low-steam solvent and CCS technologies can improve CO₂ footprint and competitiveness |
| **Oil Products**                | ![New markets for low carbon products](icon.png) | ![Technology innovation](icon.png) | - Alternative fuels and efficiency may weaken underlying demand  
- Longevity of transport fleet and cleaner fuels technology |
| **Deep Water**                  | ![New markets for low carbon products](icon.png) | ![Technology innovation](icon.png) | - Alternative fuels and efficiency may weaken underlying demand  
- In-field innovation can reduce emissions |
| **Chemicals**                   | ![New markets for low carbon products](icon.png) | ![Technology innovation](icon.png) | - Increasing material prosperity will drive chemical demand  
- Chemicals enable improved energy efficiency of homes, cars, buildings  
- Novel chemistries can enable wider variety of end users and markets |
| **Shale Oil**                   | ![New markets for low carbon products](icon.png) | ![Technology innovation](icon.png) | - Alternative fuels and efficiency may weaken underlying demand  
- Advances in shale oil recovery can improve competitiveness |
| **Shale Gas**                   | ![New markets for low carbon products](icon.png) | ![Technology innovation](icon.png) | - Transition from coal to gas in power will support gas demand  
- Potential for increased use of gas and electricity in transportation  
- Decarbonisation through CCS can support long-term demand |
| **New Energies**                | ![New markets for low carbon products](icon.png) | ![Technology innovation](icon.png) | - Business will grow alongside need for low-carbon energy sources and connected systems for service delivery  
- Next generation biofuels and battery technology can improve competitiveness |
The area represents the relative proportion of Shell’s share of estimated direct and indirect CO₂ emissions. The CO₂ cost levels reflect the average of Shell’s exposed emissions in each region. Excludes BG.
3.d The IEA 450 scenario

By the year 2030, the IEA’s 450 Scenario (the 2°C scenario) foresees an energy sector with significant renewables penetration, marked improvement in energy efficiency, and widespread replacement of coal by natural gas in power generation. Under this scenario, CCS is expected by 2030 to be storing around 40 times the volume of CO₂ it does today. The IEA has assumed oil and gas prices in 2030 of around $97 per barrel and $9 per MMbtu respectively, and global CO₂ equivalent costs of $100 per tonne (all in real terms).

The related impact on expected production is that global demand for oil would fall by 17% between 2015 and 2030, while demand for natural gas would grow by 8% during that period.

We have evaluated our portfolio under the 450 Scenario. The IEA’s projected GHG regulation would lead to lower demand for some of our products and potential impairments to some of our less energy-efficient assets. However, we could also see certain benefits as robust global CO₂ pricing mechanisms would make some forms of energy, such as natural gas and renewables, more competitive compared with coal. Robust CO₂ pricing mechanisms would also help encourage the development of CCS.

Our preliminary view, looking at 2030, is that the aggregate impact under the IEA’s 450 Scenario would be more positive overall for us than our own outlook. This is primarily due to the higher oil and gas prices assumed by the IEA than in Shell’s planning. While the IEA assumes significant global CO₂ costs of $100/tonne (in real terms) in 2030, our portfolio sensitivity to oil and gas prices significantly exceeds our sensitivity to CO₂ costs associated with our GHG emissions.

The net impact on our company of the assumed GHG regulatory costs by 2030 will be influenced by developments in the allocation of free allowances under CO₂ pricing regimes, as well as the ability to recover the increased costs from customers.

Shell has provided earnings sensitivities, which should help our shareholders understand the potential impacts of changing oil, natural gas and CO₂ prices.

On a 2015 basis, these were as follows:
- $10 per barrel movement in Brent prices, $3.3 billion earnings impact
- $1 per mmbtu movement in Henry Hub, $250 million earnings impact
- $10 per tonne CO₂ movement in global CO₂ price, $400 million earnings impact

2015 underlying earnings excluding identified items were $10.7 billion.
3.e **Exploration and "stranded assets"

Investors have asked us if Shell’s oil and gas reserves will become stranded, as energy markets evolve to low-carbon solutions.

Shell has around 10.5 years of oil and gas reserves, part of about 25 years of resources in design, under construction or in operation. However, our assessment is that Shell’s reserves will not become stranded in the energy transition.

The natural decline rate in oil and gas fields, which occurs when reservoir pressures reduce as the oil and gas is produced, could leave world energy demand unmet without current and future investment in supply. For example, today’s world-wide natural decline in oil production is some 5 million barrels per day each year, from a production base of some 90 million barrels per day, and demand growth of 1-2 million barrels per day. The supply-demand gap by 2030 could be significant without sustained investment in exploration and development of new reserves.

In Shell’s portfolio, we have been seeing natural decline rates in the 4-6%/year range, which translates into some 150,000 barrels of oil equivalent per day each year. Without sustained investment in new production, our oil and gas fields would become depleted, substantially before our customers could make a transition to lower-carbon energy. In the meantime, replacing that production with profitable new barrels is a key element of our strategy today.

Part of this replacement comes from exploration for new fields, which are typically brought on stream within a few years of discovery. These production streams underpin the company’s earnings and cash flow, and fund both future investments and returns to shareholders.

More fundamentally, natural decline marks an opportunity to refresh the portfolio on a continuous basis, depending on how the investment climate and growth opportunities continue to evolve. Far from having a "stranding" problem, we have time to make decisions on selective investments and divestments to build a resilient portfolio for the future.
WORLD OIL DEMAND
New policies scenario and 450 scenario

Source 2: Shell analysis

WORLD GAS DEMAND
New policies scenario and 450 scenario

Source 2: Shell analysis
Closing comment

Shell has provided energy to the world for over a century. We have been preparing for, and investing in, the challenges and opportunities of the energy transition for some time. We have significantly increased our production of lower-carbon natural gas and invest in low-carbon biofuels, wind and solar power. We have also invested in CCS, and hydrogen as a transport fuel, and funded new, promising technologies.

Shell will play its role in providing more energy and less CO₂, especially in areas where we have the expertise and skills such as natural gas, new energies and CCS. We will do this because we recognise the changing energy landscape, and we will do this if it makes good business sense for the future of our company.

Moving too slowly risks the company missing market opportunities or losing its competitive edge. Moving too quickly could waste valuable investments or valuable expertise. This is the challenge for our company.

We know that our long-term success depends on our ability to anticipate demand for more energy and less carbon, and we are preparing to remain competitive in a changing world. We are confident that Shell will adapt and thrive as the energy system evolves.
More information can be found on www.shell.com