




BP Energy Outlook 2019 edition



The Energy Outlook explores the forces shaping the global energy transition out to 2040 and the key uncertainties surrounding that transition

The Outlook considers a number of different scenarios. These scenarios are not predictions of what is likely to happen or what BP would like to happen. Rather, they explore the possible implications of different judgements and assumptions by considering a series of “what if” experiments. The scenarios consider only a tiny sub-set of the uncertainty surrounding energy markets out to 2040; they do not provide a comprehensive description of all possible future outcomes.

For ease of explanation, much of the Outlook is described with reference to the ‘Evolving transition’ scenario. But that does not imply that the probability of this scenario is higher than the others. Indeed, the multitude of uncertainties means the probability of any one of these scenarios materializing exactly as described is negligible.

The Energy Outlook is produced to aid BP’s analysis and decision-making, and is published as a contribution to the wider debate. But the Outlook is only one source among many when considering the future of global energy markets. BP considers the scenarios in the Outlook, together with a range of other analysis and information, when forming its long-term strategy.



Welcome to the 2019 edition of BP's Energy Outlook

The outlook facing major energy providers, like BP, is both challenging and exciting.

One of the biggest challenges of our time is a dual one: the need to meet rising energy demand while at the same time reducing carbon emissions.

The emissions-reduction side of this dual challenge will mean shifting to a lower-carbon energy system, as the world seeks to move to a pathway consistent with meeting the climate goals outlined in the Paris Agreement. Much more progress and change is needed on a range of fronts if the world is to have any chance of moving on to such a pathway.

Meeting the other side of the dual challenge will require many forms of energy to play a role. There's a strong correlation between human development and energy consumption – and our analysis of this relationship in this year's Outlook highlights the

need for much more energy to meet demand as prosperity rises.

There are many other challenges facing our industry as the global energy system evolves. The centre of gravity of energy demand is shifting, with the expanding middle classes in Asia accounting for much of the growth in global GDP and energy consumption over the next 20 years. The pattern of energy supply is also changing, with the shale revolution catapulting the US to pole position as the world's largest producer of oil and gas, and the rapid growth of liquefied natural gas (LNG) transforming how natural gas is transported and traded around the globe. Meanwhile, the way in which energy is consumed is changing in real time, as the world electrifies and energy increasingly becomes part of broader services that are bought and sold in ever more competitive and efficient digital markets.



The challenge is to understand, adapt and ultimately thrive in this changing energy landscape. Along with these challenges, come opportunities – and that's what makes this a really exciting time for our industry. Billions of people are being lifted out of low incomes, helping to drive economic growth and the demand for energy. New technologies are revolutionizing the way in which that energy is produced, transported and consumed. And the transition to a lower-carbon energy system is opening up a wide range of business possibilities.

This year's Energy Outlook provides fresh insight into these trends and many more. The value of the Outlook is not in trying to predict the future. Any such attempt is doomed to fail – the uncertainty surrounding the energy transition is here to stay. Rather the value of the Energy Outlook is in providing a structure and discipline

to our thinking and decision-making. It helps us gauge the range of uncertainties, judge how the risks can be managed, and determine how best to encourage change that puts the world on a more positive and sustainable path. Ultimately, we are all part of the energy transition and the decisions all of us make today can shape the future for many years to come.

The Energy Outlook plays an important role in helping to inform and shape our strategic decision-making in BP. I hope you find this year's Outlook a useful contribution to your own discussions and thinking.

Bob Dudley
Group chief executive

The demand for energy is set to increase significantly driven by increases in prosperity in the developing world

Key points

- ▶ The *Energy Outlook* considers different aspects of the energy transition and the key issues and uncertainties these raise.
- ▶ In all the scenarios considered, world GDP more than doubles by 2040 driven by increasing prosperity in fast-growing developing economies.
- ▶ In the Evolving transition (ET) scenario this improvement in living standards causes energy demand to increase by around a third over the Outlook, driven by India, China and Other Asia which together account for two-thirds of the increase.
- ▶ Despite this increase in energy demand, around two-thirds of the world's population in 2040 still live in countries where average energy consumption per head is relatively low, highlighting the need for 'more energy'.
- ▶ Energy consumed within industry and buildings accounts for around three-quarters of the increase in energy demand.
- ▶ Growth in transport demand slows sharply relative to the past, as gains in vehicle efficiency accelerate. The share of passenger vehicle kilometres powered by electricity increases to around 25% by 2040, supported by the growing importance of fully-autonomous cars and shared-mobility services.

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- ▶ The world continues to electrify, with around three-quarters of the increase in primary energy absorbed by the power sector.
 - ▶ Renewable energy is the fastest growing source of energy, contributing half of the growth in global energy supplies and becoming the largest source of power by 2040.
 - ▶ Demand for oil and other liquid fuels grows for the first part of the Outlook before gradually plateauing.
 - ▶ The increase in liquids production is initially dominated by US tight oil, but OPEC production subsequently increases as US tight oil declines.
 - ▶ Natural gas grows robustly, supported by broad-based demand and the increasing availability of gas, aided by the continuing expansion of liquefied natural gas (LNG).
 - ▶ Global coal consumption is broadly flat, with falls in Chinese and OECD consumption offset by increases in India and Other Asia.
 - ▶ In the Evolving transition scenario, carbon emissions continue to rise, signalling the need for a comprehensive set of policy measures to achieve 'less carbon'.
 - ▶ The *Outlook* considers a range of alternative scenarios, including the need for 'more energy', 'less carbon' and the possible impact of an escalation in trade disputes.

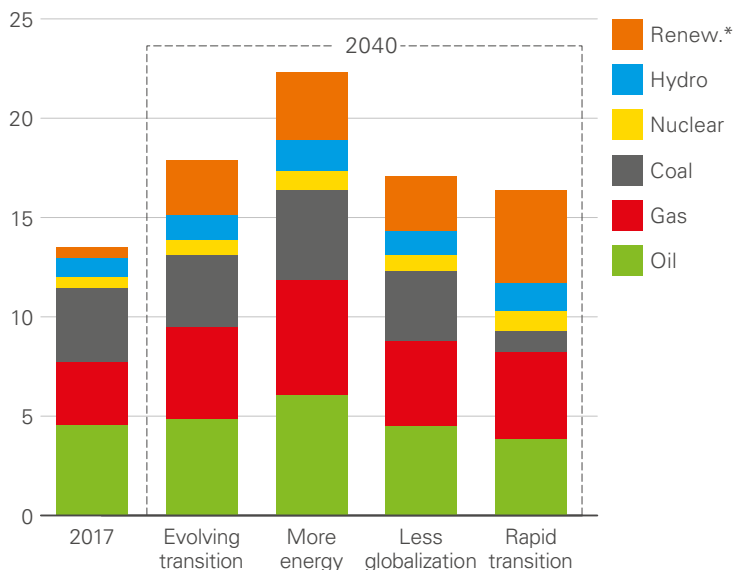
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Overview

The *Energy Outlook* considers a range of scenarios to explore different aspects of the energy transition

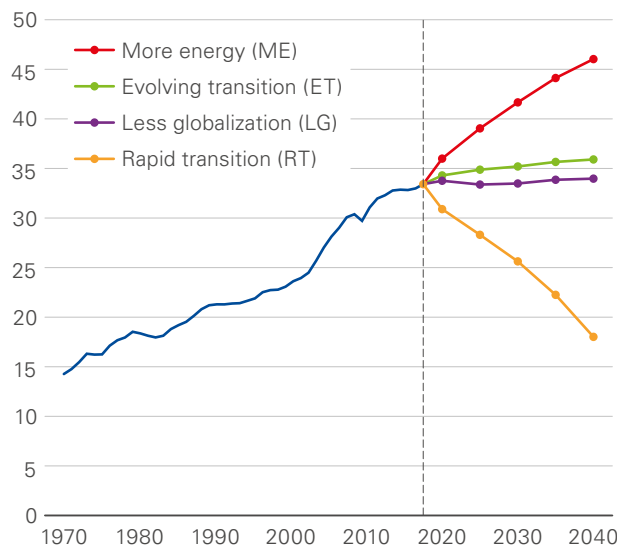
Primary energy consumption by fuel

Billion toe



CO₂ emissions

Gt of CO₂



*Renewables includes wind, solar, geothermal, biomass, and biofuels. For full list of data definitions see p138

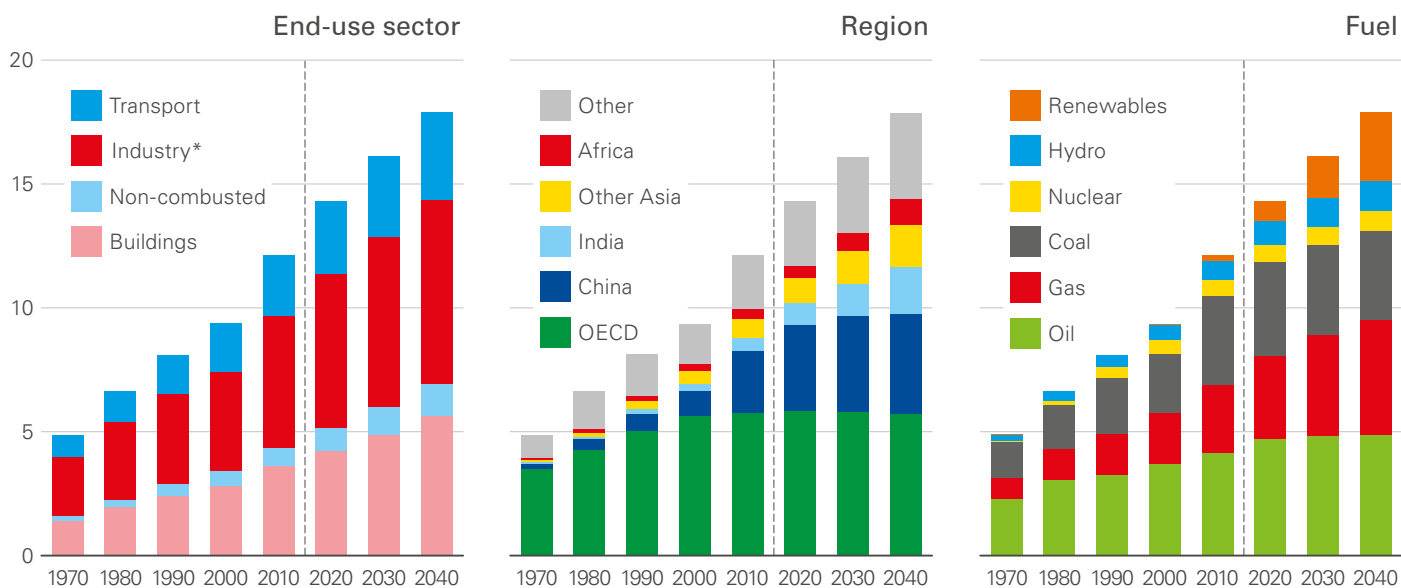
Key points

- ▶ The *Energy Outlook* considers a range of scenarios to explore different aspects of the energy transition. The scenarios have some common features, such as ongoing economic growth and a shift towards a lower-carbon fuel mix, but differ in terms of policy, technology or behavioural assumptions.
- ▶ In what follows, the beginning of each text page (unless stated otherwise) highlights features of the energy transition common across all scenarios considered. For ease of exposition, much of the subsequent description and text boxes are based on the Evolving transition (ET) scenario, which assumes that government policies, technology and social preferences continue to evolve in a manner and speed seen over the recent past.
- ▶ Some scenarios focus on specific fuels or policies, e.g. a possible ban on single-use plastics (pp 34-35). Others focus on impact of possible changes in behaviour, e.g. an escalation in trade disputes (pp 72-75) or major oil producers reforming their economies faster-than-expected (pp 88-89). The Outlook also considers the dual challenge facing the energy system: the need for ‘more energy’ (pp 22-23) and ‘less carbon’ (pp 24-25), including the contribution reducing carbon emissions in different sectors of the energy system – transport (pp 48-51), power (pp 58-61) and industry and buildings (pp 38-41) – can make to achieving the Paris climate goals.

The *Outlook* considers the energy transition through three different lenses: sectors, regions and fuels

Primary energy demand

Billion toe



*Industry excludes non-combusted use of fuels

Key points

- ▶ The *Energy Outlook* considers the energy transition from three different perspectives each of which helps to illuminate different aspects of the transition: the sectors in which energy is used; the regions in which it is consumed and produced; and the consumption and production of different fuels.
- ▶ In the ET scenario, global energy demand grows by around a third by 2040 – a significantly slower rate of growth than in the previous 20 years or so.
- ▶ Growth in energy consumption is broad-based across all the main sectors of the economy, with industry and buildings accounting for three-quarters of the increase in energy demand (Sectors pp 28-61).
- ▶ By region, all of the growth in energy demand comes from fast-growing developing economies, led by India and China. Differing regional trends in energy production lead to noticeable shifts in global energy trade flows (Regions pp 64-75).
- ▶ Renewable energy is the fastest growing source of energy, accounting for around half of the increase in energy. Natural gas grows much faster than either oil or coal. The growing abundance of energy supplies plays an increasing role in shaping global energy markets (Fuels pp 78-109).

Global backdrop

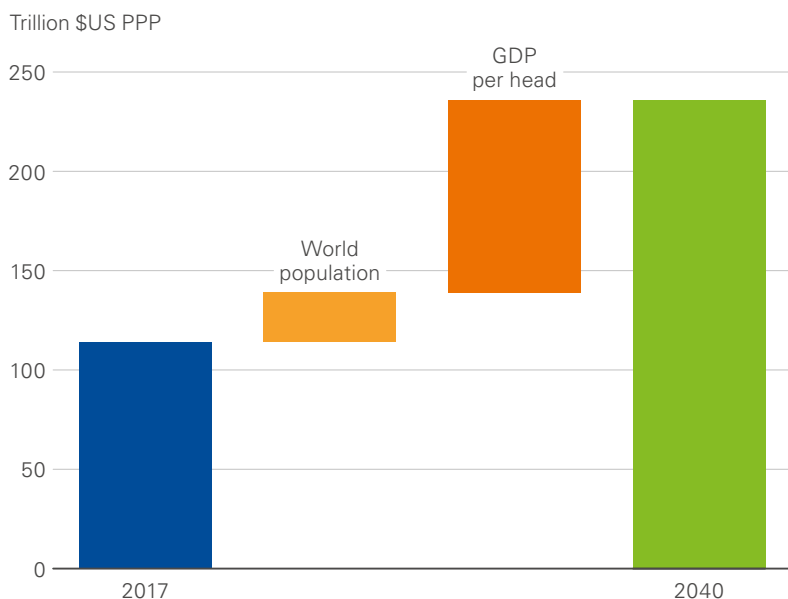
GDP, prosperity and energy intensity

Alternative scenario: More energy

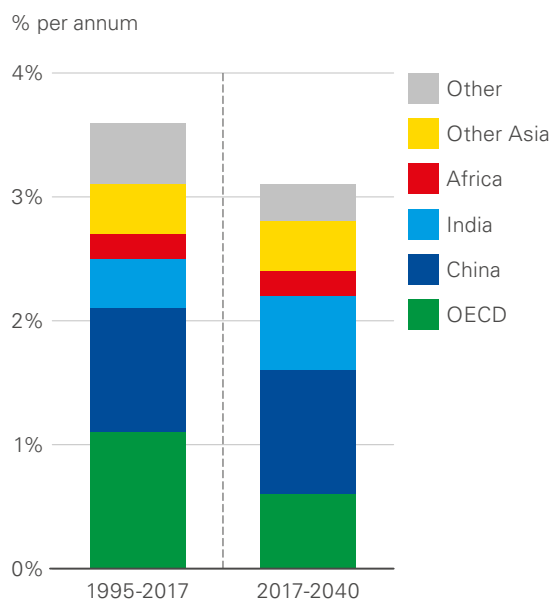
Dual challenge: More energy, less carbon

Global economic growth is driven by increasing prosperity in developing economies, led by China and India

Increase in global GDP, 2017-2040



Global GDP growth and regional contributions



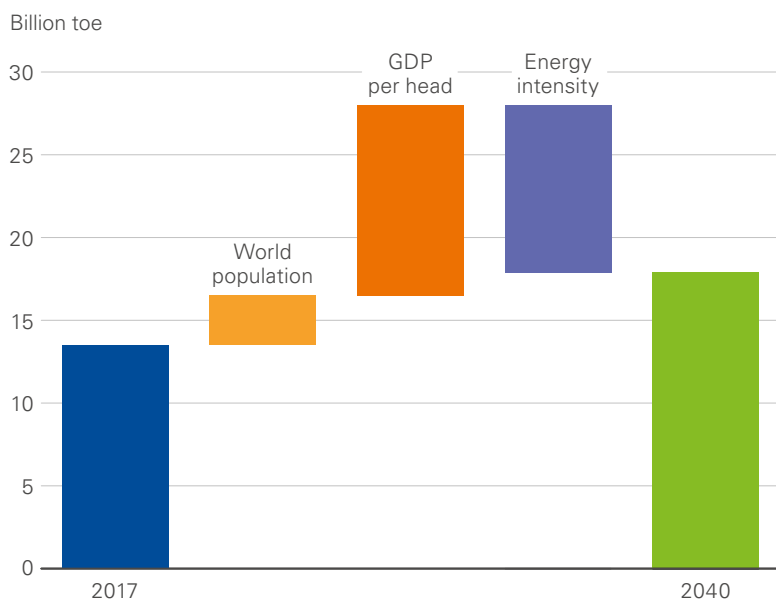
Billions of people move from low-incomes driving global economic growth and energy demand

Key points

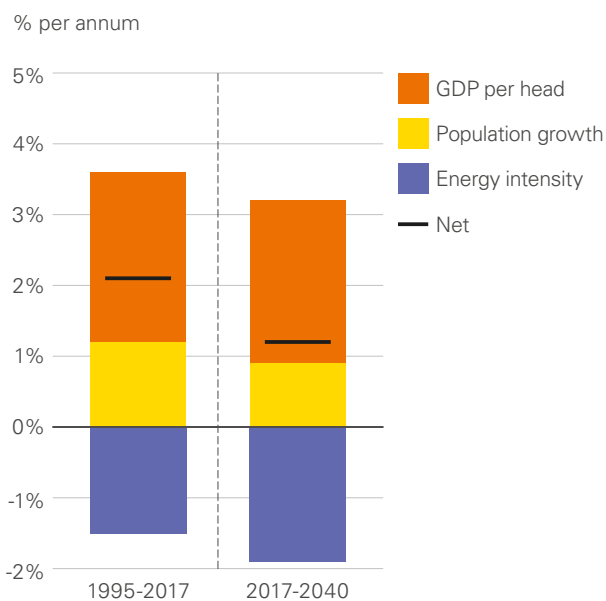
- ▶ The world economy continues to grow, driven by increasing prosperity in the developing world.
- ▶ In the ET scenario, global GDP grows around 3¼% p.a. (on a Purchasing Power Parity basis) – a little weaker than average growth over the past 20 years or so.
- ▶ Global output is partly supported by population growth, with the world population increasing by around 1.7 billion to reach nearly 9.2 billion people in 2040.
- ▶ But the vast majority of world growth is driven by increasing productivity (i.e. GDP per head), which accounts for almost 80% of the global expansion and lifts more than 2½ billion people from low incomes. The emergence of a large and growing middle class in the developing world is an increasingly important force shaping global economic and energy trends.
- ▶ Developing economies account for over 80% of the expansion in world output, with China and India accounting for around half of that growth.
- ▶ Africa continues to be weighed down by weak productivity, accounting for almost half of the increase in global population, but less than 10% of world GDP growth.

Higher living standards drive increases in energy demand, partly offset by substantial gains in energy intensity

Increase in primary energy demand, 2017-2040



Contributions to primary energy demand growth



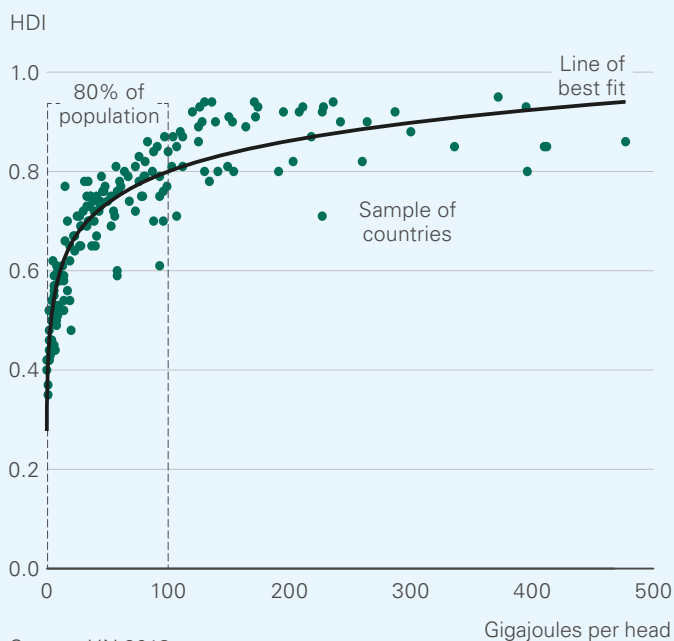
Key points

- ▶ Expansion in global output and prosperity drives growth in global energy demand.
- ▶ Energy consumption in the ET scenario increases by around a third over the Outlook. As with GDP growth, the vast majority of this increase stems from increasing prosperity, as billions of people move from low to middle incomes, allowing them to increase substantially their energy consumption per head.
- ▶ The overall growth in energy demand is materially offset by declines in energy intensity (energy used per unit of GDP) as the world increasingly learns to produce more with less: global GDP more than doubles over the Outlook, but energy consumption increases by only a third.
- ▶ Global energy grows at an average rate of 1.2% p.a. in the ET scenario, down from over 2% p.a. in the previous 20 years or so. This weaker growth reflects both slower population growth and faster improvements in energy intensity.
- ▶ Despite significant growth in prosperity and energy consumption over the next 20 years, a substantial proportion of the world's population in the ET scenario still consumes relatively low levels of energy in 2040. The need for the world to produce 'more energy' as well as 'less carbon' is discussed in pp 22-25.

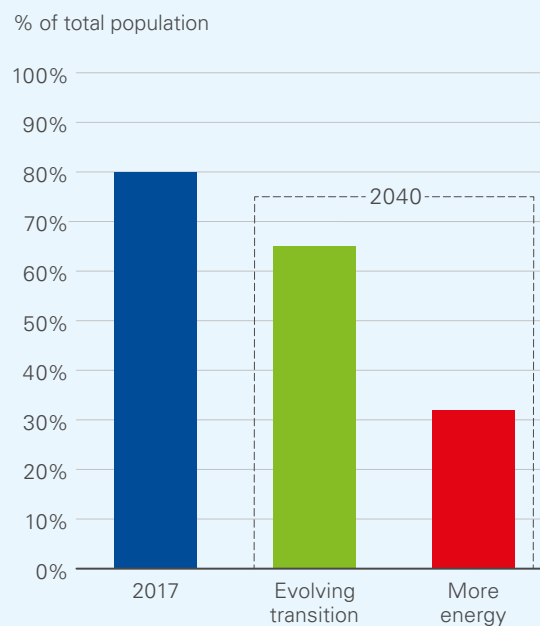
Alternative scenario: More energy

Alternative scenario: the world needs 'more energy' to allow global living standards to continue to improve

Human development index and energy consumption per head, 2017



Share of world population consuming less than 100 Gigajoules per head



Key points

- ▶ There is a strong link between human progress and energy consumption.
 - ▶ The United Nation's Human Development Index (HDI) suggests that increases in energy consumption up to around 100 Gigajoules (GJ) per head are associated with substantial increases in human development and well-being, after which the relationship flattens out.
 - ▶ Around 80% of the world's population today live in countries where average energy consumption is less than 100 GJ per head. In the ET scenario, this proportion is still around two-thirds even by 2040. In the alternative 'More energy' scenario this share is reduced to one-third by 2040.
- ▶ This requires around 25% more energy by 2040 – roughly equivalent to China's energy consumption in 2017.
 - ▶ This assumes that countries in which energy consumption is much greater than 100 GJ/per head do not economize on their energy use. If all those countries reduced average consumption levels to the EU average in 2040 (around 120 GJ/per head), this would provide almost the entire energy required.
 - ▶ Improving energy efficiency in countries which use disproportionate amounts of energy is likely to be key to solving the dual challenge of providing 'more energy and less carbon' (pp 22-25).

80% of the world's population live in countries where average energy consumption is less than 100 GJ per head