# *The 2016 Edition of the BP Energy Outlook*

**By Mark Finley and Arminé Thompson**

## EXECUTIVE SUMMARY

The *BP Energy Outlook* attempts to look beyond the here and now and consider what current conditions may tell us about the future of global energy markets over the next 20 years. While the long term outlook presents many uncertainties, three main themes are highlighted in this year's edition of the *BP Energy Outlook.*

First, global demand for energy is likely to continue to grow over the next 20 years. As the global economy expands, more energy will be needed to drive the higher levels of activity and living standards. The growth in energy will be reduced by faster gains in energy efficiency. While there is significant uncertainty as to how quickly global GDP will grow over the Outlook, and how rapidly energy intensity will decline, it seems clear that more energy will be required over the next 20 years to enable the world to grow and prosper.

Second, the fuel mix is likely to change significantly over the next 20 years, given a boost by the commitments made during the COP21 in Paris. Renewable energy is expected to grow strongly over the forecast period because of favorable environmental policies, improving technology and falling costs. Those same forces will support growth in natural gas, while the prospects for oil are likely to be less robust. Coal becomes the main loser as China rebalances towards a more sustainable economic growth path and a less carbon-fuelled economy.

Third, we expect a considerable slowing in the global growth of carbon emissions relative to the past 20 years. The rate of growth of carbon emissions is projected to more than halve over the Outlook period compared to the past 20 years. The slowing growth in carbon emissions reflects faster increases in energy efficiency and a shift towards lower-carbon fuels, both aided by the pledges made in Paris.

The value of the Energy Outlook is that it provides a consistent framework which can be used to explore and analyse the forces shaping energy markets over the next 20 years. This year's Energy Outlook also looks backwards and asks what events over the past few years turned out differently than what we expected. We also ask what are the key uncertainties over the Outlook and how might they turn out differently than expected. The Outlook includes a clear base case, a review of past revisions to the Outlook and a series of alternative cases exploring key uncertainties. More detail is available at www.bp.com/energyoutlook.

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## GLOBAL ECONOMIC GROWTH DRIVES ENERGY DEMAND OVER THE NEXT 20 YEARS

Over the Outlook, global economic growth is expected to increase by 3.5% per annum (p.a.), just slightly slower than growth over the past 20 year period. This equates to GDP roughly doubling over the Outlook. The increase in GDP is partially driven by population growth, however the vast majority, four-fifths, is driven by increases in productivity, especially in emerging Asian economies. China and India account for almost half of the projected increase in global GDP.

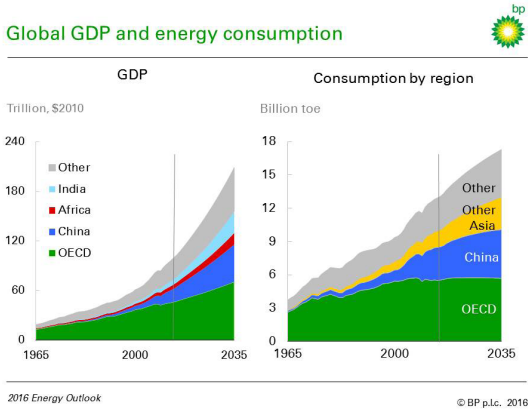


**Chart 1**

The growing global economy means that more energy is required. We expect energy consumption to grow by 34% between 2014 and 2035, or 1.4% p.a. for the next 20 years. Virtually all the growth in energy consumption is consumed in fast-growing emerging economies, while energy demand in the OECD barely grows. Global energy demand growth over the Outlook is slower than the recent past, reflecting both a sharp deceleration in China's energy demand as the country rebalances to a more sustainable pace and the plateauing in energy demand within the advanced economies. The sharp slowing in China's energy demand growth is partially offset by a pickup in other developing countries.

In an alternative case we explore what happens if Chinese GDP grows slower than expected (3.5% p.a. vs 5% p.a. in the base case). In this alternative case global GDP grows by a little less than 3% p.a. and global energy demand grows by just 1% p.a., slower than any 20-year period in history. Even in this case, however, energy demand still grows by almost 25% by 2035.

## SIGNIFICANT SHIFTS IN THE GLOBAL FUEL MIX EXPECTED

The fuel mix is projected to evolve over the Outlook. Fossil fuels remain the dominant source of energy powering the global economy, providing 60% of energy growth over the Outlook. However, the share of fossil fuels in the global fuel mix declines from 86% in 2014 to 80% by 2035. Gas is the fastest growing fossil fuel, increasing by 1.8% p.a., and its share in primary energy gradually increases. Gas overtakes from coal as the second-largest fuel by the end of the Outlook. Coal suffers a sharp reversal of fortunes, with its growth slowing to just 0.5% p.a., such that by 2035 the share of coal in primary energy is at an all-time low. Oil grows steadily over the Outlook; however its share in primary energy declines slowly. Renewables are the fastest growing group of fuels, increasing by 6.6% p.a., over the Outlook, with their volume almost quadrupling. Their share in the fuel mix increases from 3% today to 9% by 2035.

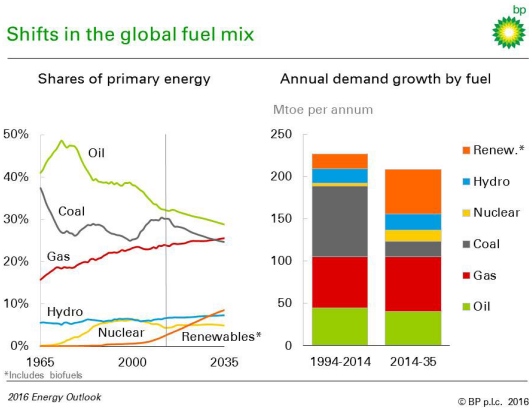


Chart 2

## GROWTH IN EMERGING ECONOMIES DRIVE OIL CONSUMPTION

The judgment underlying the Energy Outlook is that the oil market gradually rebalances, with the current level of low prices boosting demand and dampening supply. Over the longer term, global oil demand increases by around 20 Mb/d to reach 112 Mb/d by 2035. Demand growth is concentrated in the emerging economies, with China and India accounting for over half the increase. Oil consumption in the OECD continues its secular decline, dropping by 5 Mb/d by 2035. Around two-thirds of the increase in oil demand reflects higher transport demand, as the number of vehicles outside of the OECD is expected to triple over the next 20 years to around 1.5 billion vehicles. The impact of this increase on fuel demand is partly offset by gains in vehicle efficiency, which is assumed to improve even more rapidly than in the past.

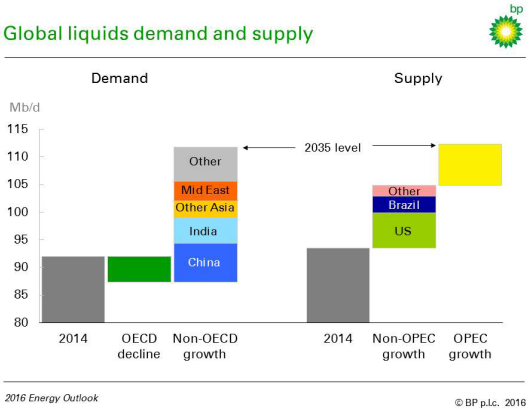


Chart 3

The increased demand for oil is met by increases in both non-OPEC and OPEC supply. Non-OPEC supply is projected to grow by 11 Mb/d and all the net increase comes from the Americas: U.S. shale, Brazilian deepwater and Canadian oil sands. In terms of OPEC, we assume the group acts to maintain its market share of around 40%, increasing production by 7 Mb/d by 2035.

As the market gradually rebalances, U.S. tight oil production returns to growth, rising by almost 4 Mb/d to reach just under 8 Mb/d by 2035 and account for around 40% of total U.S. production. North America is expected to continue to dominate global tight oil production, however during the last ten years of the Outlook, growth from the rest of the world accounts for half of the global increase. Global tight oil output reaches 10 Mb/d by 2035, but still accounts for less than 10% of all liquids production in 2035, compared to 5% today.

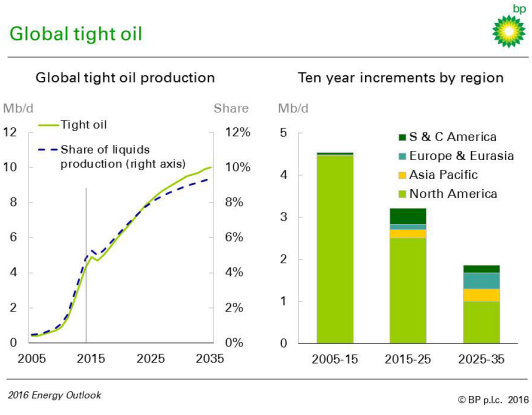


Chart 4

The strength of the U.S. shale revolution has continued to surprise and over the past three Outlooks we have revised up our forecast for U.S. tight oil and shale gas production. In an alternative case we consider a world where the resource base for both tight oil and shale gas are much larger than assumed in our base case and productivity is significantly higher. As a result, global tight oil production is 10 Mb/d higher than in our base case by 2035 and shale gas production is 75 Bcf/d higher. The implications of this supply shock for conventional supply and demand for oil, gas and other fuels are explored in the Outlook.

## NATURAL GAS SUPPLIES GROW ROBUSTLY

Natural gas is the fastest growing fossil fuel over the Outlook.

Growth is driven by gas gaining market share relative to coal in the power sector and by its increased use in industry as emerging economies industrialize. The majority of natural gas consumption growth is from emerging economies, with China and India together accounting for around 30% of the increase and the Middle East over 20%. Demand growth in emerging markets is fairly evenly split between use in the industrial sector, as these economies continue to industrialize, and use for power generation. In contrast, growth in the OECD is more concentrated in the power sector.

Natural gas supply growth is roughly evenly split between increases in conventional production and shale gas. Much of the increase in conventional production is from the Middle East, China and Russia. Shale gas production grows by 5.6% p.a. throughout the Outlook, with the share of shale gas in total production increasing from just over 10% in 2014 to nearly a quarter in 2035. The growth in shale gas supply is dominated by North American production, which accounts for around two-thirds of the increase in global shale gas supplies. Over the Outlook, growth outside of North America expands, most notably in Asia Pacific and in particularly in China, where shale gas production reaches 13 Bcf/d by 2035.

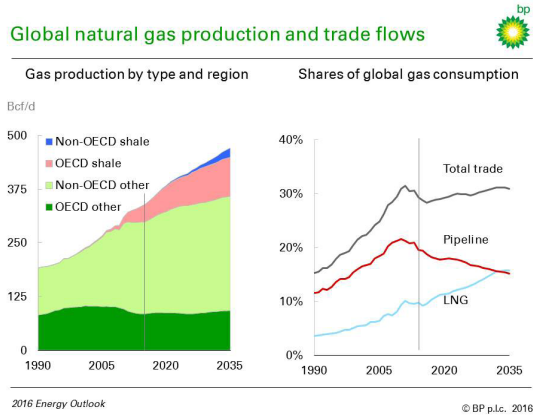


Chart 5

A key feature of the gas Outlook is the sharp increase in global supplies of Liquefied Natural Gas (LNG), which is expected to more than double over the Outlook. Over 40% of the increase in global LNG supplies is expected to occur over the next five years as a series of in-flight projects come online. This equates to a new LNG train coming on stream every eight weeks for the next five years. By 2035, LNG surpasses pipeline imports as the dominant form of traded gas.

## COAL DEMAND GROWTH SLOWS SHARPLY

Coal suffers a sharp reversal of fortune over the Outlook, with demand growing by just 0.5% p.a. compared with almost 3% p.a. growth over the past 20 years. The slowdown can largely be attributed to the deceleration in China's coal consumption as its economy rebalances away from heavy industrial growth towards more consumer-led growth. China's demand for coal grows by just 0.2% p.a. over the Outlook; compared to growth of over 8% p.a. from 2000-14, and by 2030 coal consumption is in decline. Despite the slowdown, China remains the world's largest coal market, consuming half of global coal supplies in 2035. India shows the largest growth in coal consumption, overtaking the U.S. to become the world's second largest consumer of coal. Coal consumption is projected to fall sharply in the OECD countries due to a combination of cheaper natural gas and renewable energy, as well as stronger environmental regulation.

## NON-FOSSIL FUELS GROW OVER THE OUTLOOK, LED BY RENEWABLES

Hydroelectric and nuclear energy are both projected to increase steadily, growing at 1.8% p.a. and 1.9% p.a. respectively. The period of unprecedented growth of hydro in China is coming to an end and China hydro is expected to grow at 1.7% p.a. over the Outlook, compared with almost 10% p.a. over the previous two decades. Brazil supplies the second largest increase in hydro power (after China), overtaking Canada to be the world's second largest hydro producer. China's nuclear output increases rapidly (11.2% p.a.) over the Outlook, more than doubling by 2020 and increasing nine-fold by 2035. Nuclear output declines in the EU (-29%) and North America (-13%), as ageing plants are gradually decommissioned and the economic and political challenges of nuclear energy stunt new investments. Japanese reactors are expected to restart over the next five years to reach 60% of their 2010 levels by 2020.

Renewables are projected to be the fastest growing group of fuels (6.6% p.a.), almost quadrupling over the Outlook. Renewables account for over a third of the growth in power generation, causing their share of global power to increase to 16% by 2035, from 6% today. The EU continues to lead the way in the use of renewable power. By 2035, the penetration of renewables in some OECD markets is expected to reach levels where the challenge of integrating intermittent sources into the power grid becomes an increasing constraint: for example, renewables are expected to account for more than a third of EU power generation by 2035. The rapid growth in renewables is supported by both government policy as well as expected cost reductions: the costs of onshore wind and utility-scale solar PV are likely to fall by around 25% and 40%, respectively, over the next 20 years.

## THE CHANGING OUTLOOK FOR CARBON EMISSIONS

The growth of carbon emissions from energy use should slow significantly relative to the past, growing by 0.9% p.a. versus 2.1% p.a. over the past 20 years. Given that GDP is projected to grow just slightly slower than the historical trend, this represents a significant degree of 'decoupling' of carbon emissions from GDP. This decoupling reflects significant increases in the expected pace of decline of both energy intensity (energy used per unit of GDP) and carbon intensity (carbon emissions per unit of energy consumption).

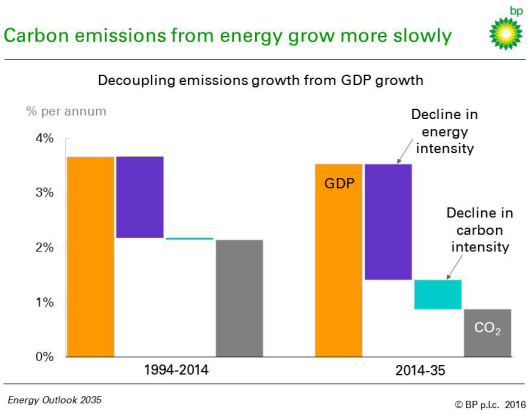


Chart 6

Energy intensity over the Outlook is expected to fall more quickly than in the past, declining by 2.1% p.a. from 2014 to 2035, compared to a decline of 1.5% p.a. over the past 20 years (which is already the fastest 20-year improvement in our data set). The shift in the fuel mix means that carbon intensity also falls far more quickly than in the past. Carbon intensity is projected to decline by 0.5% p.a. over the Outlook, compared to a decline of just 0.04% p.a. from 1994 to 2014. The world is embarking on a transition to a lower-carbon energy system. The agreements and pledges made during the COP21 meeting in Paris have increased our confidence that the world will achieve this break from past trends. Despite the slowdown in growth, emissions are projected to continue to grow by around 20% by 2035. A meaningful global price for carbon is likely to be the most efficient mechanism for responding to this challenge, since it provides incentives for greater improvements on both sides of the market: on the demand side, reducing energy intensity and on the supply side, reducing the carbon intensity of the fuel mix.

A major uncertainty to the Outlook is the speed of transition to a lower carbon world. This uncertainty is explored in an alternative case, where a carbon price reaches $100 per tonne in the OECD and other leading economies. Other policy and technology assumptions include tougher fuel efficiency standards in transport, and additional measures to drive significant gains in energy efficiency in industry and buildings. As a result, both energy intensity and carbon intensity are projected to decline at historically unprecedented rates in this alternative case. Emissions peak in 2020 and by 2035 are around 8% lower than their 2014 level. Energy demand still grows, but at around two-thirds of the pace in the base case; non-fossil fuels account for all of the net growth in global energy demand.

## CONCLUSION

The demand for energy is likely to increase greatly over the next 20 years as the world economy expands and more energy is required to power higher levels of activity and rising living standards. Increased energy enables that growth. The rate of GDP growth and the pace of improved energy intensity are key uncertainties. The global fuel mix is likely to change significantly with coal losing ground, renewables gaining, and oil and gas combined broadly holding their own. And finally, the Outlook for carbon emissions is changing significantly; with emissions likely to grow far less quickly than in the past, but it is not changing quickly enough, suggesting the need for further policy action.