

# The future of global energy: oil or gas?

Richard Herbert

Chief operating officer exploration, Upstream executive office

3 March 2016



Good morning everyone, it's a pleasure to be here today

I'm sure that a lot of the conversations we'll be having here this year will be focussed on the immediate challenges we are facing as a sector - and that is of course understandable.

Between September 2014 and the end of 2015 we saw the price of oil fall by over \$60 per barrel. And as we enter 2016, the fundamentals that caused this are still in play, which means prices are likely to remain very volatile in the near term.

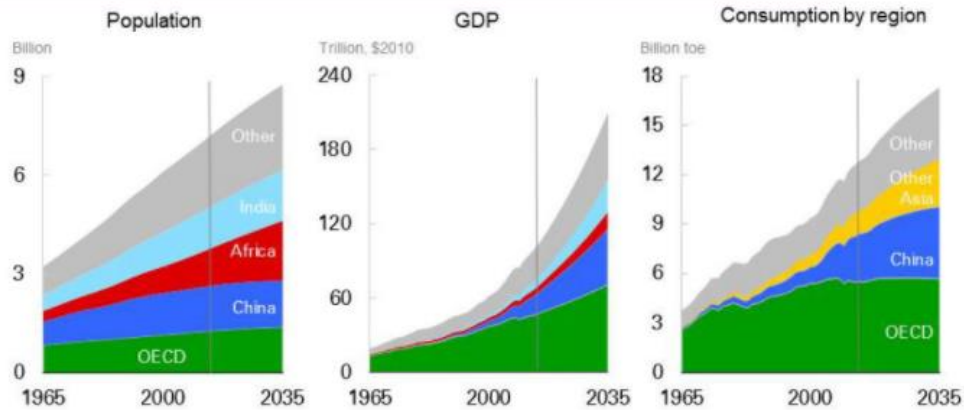
It's a tough time. Companies are having to make difficult decisions and adapt to this new reality. At BP, we expect prices to stay lower for longer - but not forever.

It looks to us that supply may converge with levels of demand sometime in the second half of this year - and crucially as we move into the longer term demand should begin to exceed supply.

It's this longer term view that I'd like to focus on today - particularly as we consider the future of global energy and the role of oil or gas in that mix. The title of my talk is 'The Future of Global Energy: Oil or Gas?'

Now I'm sure there will be some out there who would argue the answer to that question is 'neither' but I intend to demonstrate for you why that's not the case, and why both have an important role to play for decades to come!

## Growing population and GDP drives demand...



Source: 2016 Energy Outlook

Every year, BP publishes an Energy Outlook, which considers a base case, outlining the 'most likely' path for energy demand by fuel based on assumptions and judgements about future changes in policy, technology and the economy.

Our latest data, published a couple of weeks ago, shows that global GDP is expected to more than double by 2035, alongside a projected population growth of 1.5 billion people to reach 8.8 billion.

Africa accounts for almost half of the increase in the world's population, such that by 2035 it is projected to have 30% more people than China and 20% more than India. Despite this, Africa accounts for less than 10% of the increase in both global GDP and energy consumption over the next two decades.

China and India together account for almost half of the projected increase in global GDP, with OECD economies accounting for around a quarter.

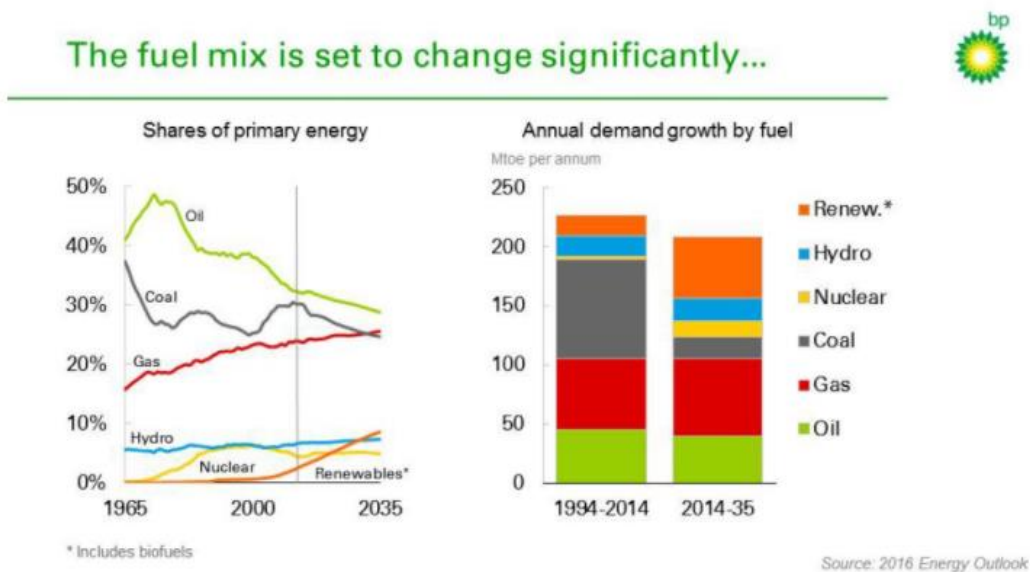
This growth means more energy is required - with energy consumption expected to increase by 34% between 2014 and 2035.

Virtually all of the additional energy will be consumed by fast-growing emerging economies like China and India - energy demand within the OECD barely grows. This is due in part to significant

improvements in energy efficiency which has helped slow the growth in energy demand compared to recent years.

But it is still growing - by around 1.4% p.a.

So how will this increasing demand be met? And what does it mean for the global fuel mix?



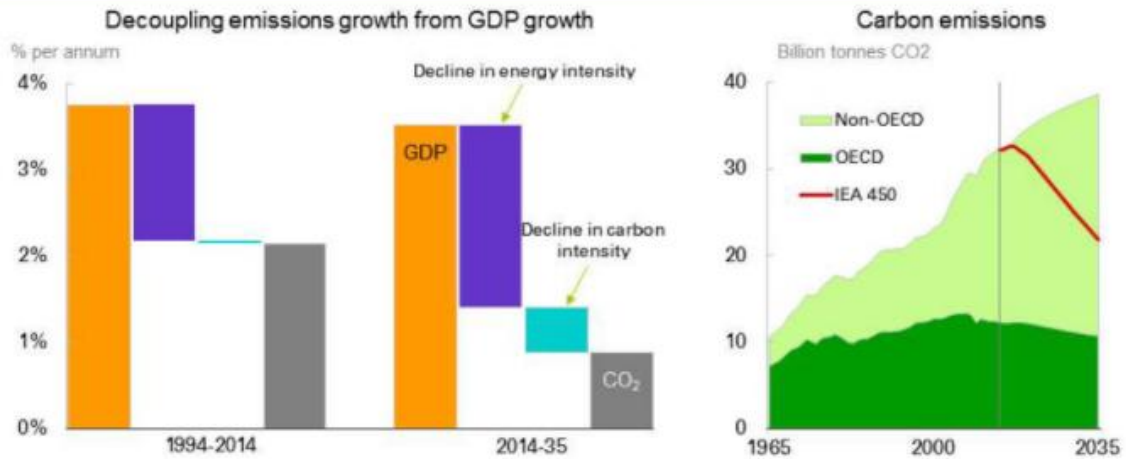
In response to these changing patterns of economic growth, fuel availability and strengthening environmental policies we expect to see a significant change to the global fuel mix.

This includes rapid growth in non-fossil fuels - in particular renewables, which, according to our base case, will grow 6.6% p.a. causing their share in primary energy to rise to 9% in 2035.

Fossil fuels will, however, remain the dominant source of energy for the world - accounting for almost 80% of the fuel mix in 2035. Oil and particularly gas will continue to play a key part in this - with gas as the fastest growing fossil fuel.

So our industry has a central role to play in meeting the world's energy challenges for decades to come - and that also includes in helping the world meet climate change related aims.

## Growth in carbon emissions slows...but not completely



Source: 2016 Energy Outlook

Our current Outlook shows that the growth rate of carbon emissions over the next 20 years is expected to more than halve relative to the past 20 years - a significant change in previous trends given the projected growth in GDP and population. This reflects both faster gains in energy efficiency and a more pronounced shift towards lower-carbon fuels.

But... and unfortunately there is a but... carbon emissions are still predicted to grow, increasing by 20% between 2014 and 2035.

As we saw in Paris at the end of last year, the world is embarking on a transition to a lower carbon future with individual countries making important pledges ahead of the COP21 meeting.

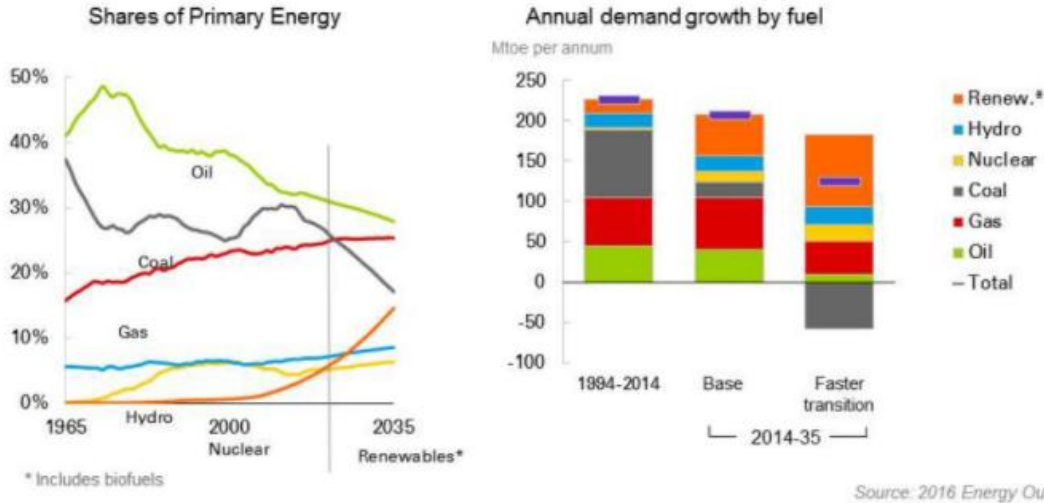
These pledges and the Paris agreement itself were certainly clear evidence of the world's desire to move the trend in the right direction - but the widening gap between the path we project for emissions and the ambition shown in Paris suggests that there remain significant hurdles to overcome.

For example, to achieve anything close to the IEA's 450 scenario, which is often used as a benchmark for achieving the goal of limiting increases in mean temperatures to 2 degrees, would require an unprecedented pace of improvement in energy and carbon intensity.

In tackling climate change, as we must, society faces a real challenge in how to balance climate action with energy security, affordability and economic development.

At BP, we believe a meaningful global price for carbon is likely to be the most efficient way for policymakers to respond to the climate change challenge - with regional and national approaches a good first step, provided temporary financial relief is given to sectors that are exposed to international competition.

### Faster transition to a lower-carbon world...

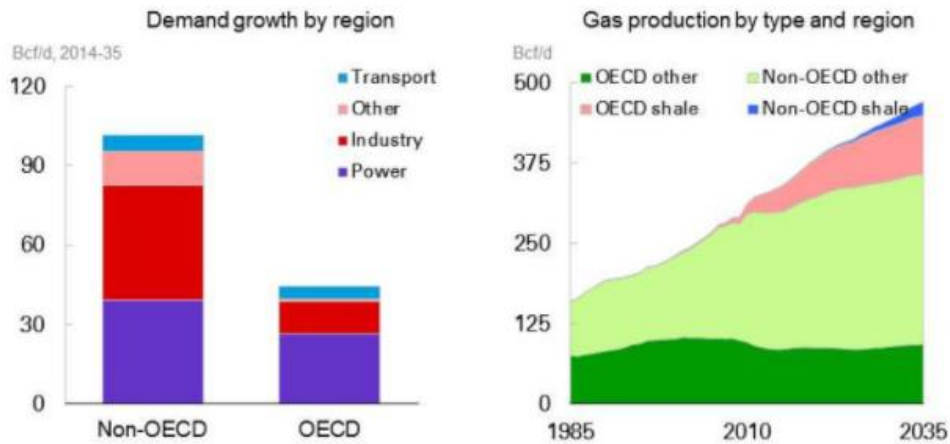


The speed of the world’s transition to a lower-carbon future is a key source of uncertainty when we look to make projections around future energy trends.

To illustrate that uncertainty, we included an alternative scenario in the Energy Outlook where the world undergoes a much faster transition to a lower-carbon energy system, driven by the implementation of higher and more widespread carbon pricing and by stronger measures to encourage energy efficiency in transport, in industry and in buildings.

In this scenario total energy demand still grows, albeit at a reduced pace. Renewables are the ‘big winner’ with an almost six-fold increase in output and a 15% share of energy by 2035. However, oil and gas will still account for over 50% of total energy supplies. The growth of oil demand is significantly reduced, but gas demand growth proves more robust.

## Growing demand for gas....



Source: 2016 Energy Outlook

This all leads me back to gas. We see a robust growth in demand for gas, helped not just by increasing supplies but also by supportive environmental policies.

This is because gas has a key role to play in the transition to a lower-carbon future, as the cleanest and lowest carbon fossil fuel emitting about 50% of the CO<sub>2</sub> of coal per unit of power.

In fact, our economists estimate that if we were to switch just 1% of total global power generation from coal to gas that would cut emissions as much as increasing renewable energy worldwide by 10%. Gas is cleaner, secure and affordable - helping society find a way to meet those challenges I just touched on.

So where will the future sources of gas come from? Well, the increase in supplies is likely to be roughly evenly split between increases in conventional production in places like the Middle East, China and Russia, and a growth in shale gas.

## Material plays over the last decade....



To look more closely at this, let's examine the industry's track record for discovering new material plays over the past decade, and the mix of oil vs. gas discovered.

The map on the screen shows the material (and by that I mean greater than 1bnboe) new plays discovered over the last decade.

For conventional resources, the vast majority of large material plays have been in the deepwater (both oil and gas) particularly for example the Brazilian Pre-salt, where the largest volumes have been discovered.

As a result of going deeper in established basins, improving our understanding of complex carbonate reservoirs and increasing our imaging below salt, we've been able to tap into these larger volumes.

The industry has attempted to replicate this along the conjugate margin of West African, with limited success to date. On the Equatorial Margin, only Ghana has developed its deepwater with discoveries.

Just last year we saw the announcement of the Liza discovery in Guyana by ExxonMobil, showing us that there still may be more to play for along this margin.



Turning now to unconventional resources, it is difficult not to notice the very large bubble associated in the onshore United States.

The so-called shale revolution has certainly changed the dynamics of global energy supply, both in terms of tight oil and gas.

We see almost all of the growth in shale coming from this market in the next decade or so. However, looking further out we could also see a significant growth in other countries, like China.

But from an exploration perspective, perhaps the biggest headlines of all in the past few years have come from the discovery of large gas resources around the world.

Exploration success in East Africa, the Nile Delta and the Mauritania/Senegal margin has delivered multi-TCF discoveries. These new gas resources, when combined with the start-up of significant LNG gas production from Australia and the US, provides an unprecedented amount of new gas. We're now seeing signs of an increasing globalization of gas markets, where new gas resources will compete for markets at a global scale.

### In focus: the Caspian region



One region that BP knows well and plays an important part in meeting future gas demand is the Caspian. The South Caspian is a significant hydrocarbon province with large resources. The basin

has produced to date 17bnbo oil and ~5bnboe of gas. Over 25 bnboe of discovered liquids and gas remain to be produced.

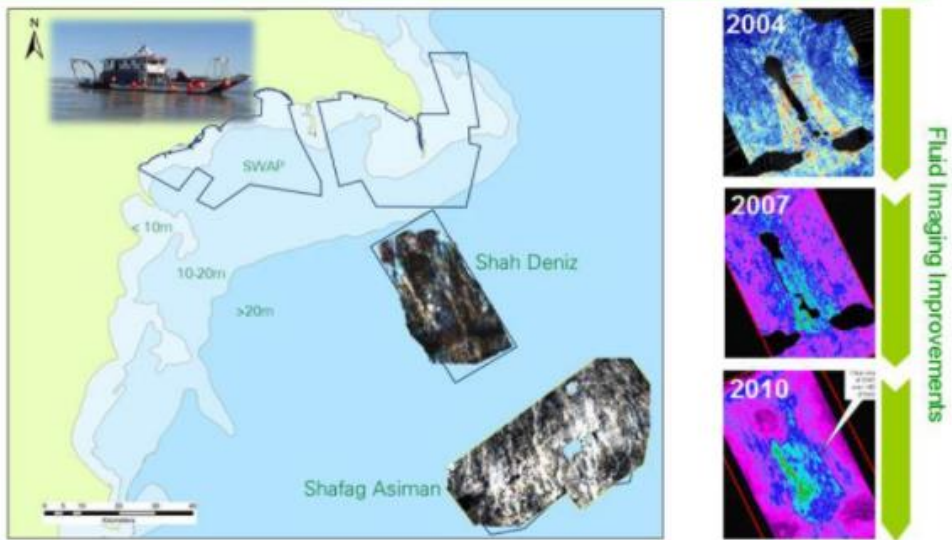
Along with the significant resources the region has to offer, there is an evolving export infrastructure that will make it possible to commercialize these large volumes and open new markets

The Southern Gas Corridor project is a great example of this in action. It's a collaboration between seven national governments, 11 different companies and 11 different gas buyers - and it will create a completely new route to supply Europe with gas.

By 2017 it will start to bring 16 billion cubic metres of gas each year from the Shah Deniz field in the Azerbaijani Caspian Sea to European markets, delivering to Georgia and Turkey along the way.

It is a part of securing energy security for the EU and other nations, as well as increasing the supply of the cleanest fossil fuel into the energy mix and making an affordable energy resource available to many more people.

### In focus: Caspian exploration



Exploration is vital to understanding and developing the available resources in a region like the Caspian. BP currently has two exploration Production Sharing Agreements, or PSAs, in the region. One of these is in deep water targeting a giant offshore structure called Shafag Asiman.

This structure is of similar scale to Shah Deniz and our recently acquired 3D seismic survey suggests the possibility that similar reservoir systems extend from Shah Deniz to Shafag Asiman. You can see this in the map here, which shows two time slices, at the reservoir level in Shah Deniz and the equivalent level at Shafag Asiman.

We have calibrated the seismic image and we can see the presence of N-S orientated geometries which we know are the Shah Deniz reservoir systems.

As we move south, we can map a very similar orientation and geometry that we can correlate to the hydrocarbon bearing zones in Shah Deniz 2. This type of images gives us confidence regarding the presence of reservoirs at Shafag Asiman.

So we will be able to transfer our drilling learnings and technologies, such as managed pressure drilling, directly from Shah Deniz to Shafag Asiman.

BP's second PSA is in very shallow water along the Caspian coast. Historically, shallow water transition zones are less explored than either the onshore or offshore due to the difficulty and expense of acquiring seismic data in these areas.

So this brings me to my next point - how the unlocking of energy resources like these also often involves technological improvements or even breakthroughs.

To overcome the challenges related to our second PSA, we are applying Instantaneous Simultaneous Source Seismic technology, which will allow us to dramatically reduce the acquisition times and costs.

We began using this technology onshore and have been able to reduce the costs of onshore seismic down to the costs of marine seismic. In our South Caspian PSA we will be using this technology to acquire 1000 km<sup>2</sup> of seismic data using up to five simultaneous sources.

## Using technology to unlock new resources...



The shale revolution in the US has been another real example of how technological innovation and productivity can unlock vast resources that were previously seen as inaccessible or uneconomical.

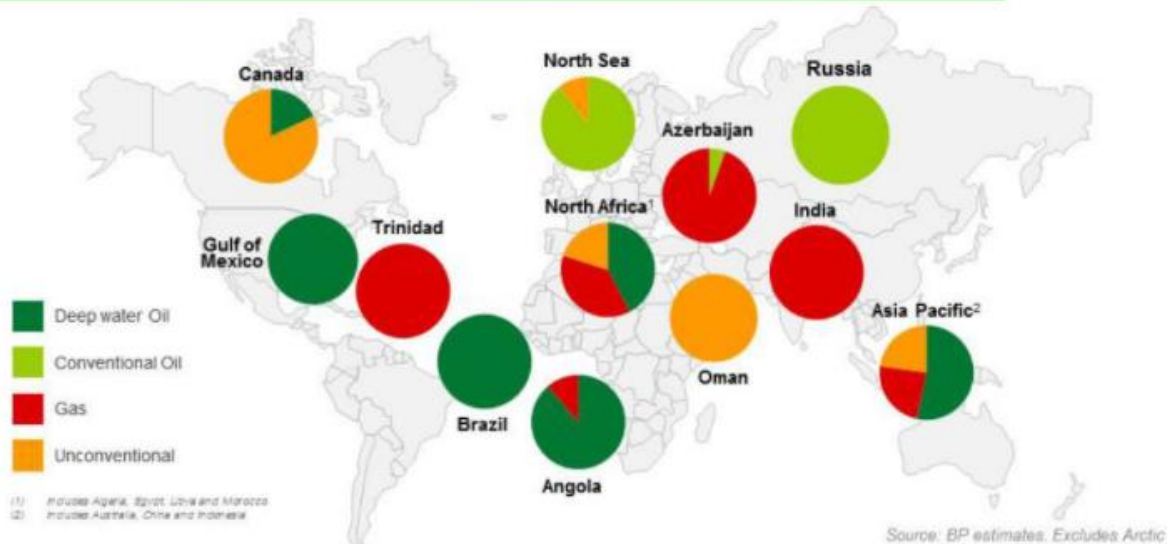
Indeed, it has been one of the most significant changes to resource opportunities over the past 10 years by ushering in the advent of production from shale and tight rock - more than doubling the total potentially accessible oil and gas in discovered reservoirs.

To demonstrate how technology plays a vital part in this, I want to share another example with you. The images on this slide are depositional environment maps, taken over a five year period, which show the distribution of reservoirs in a large tight gas field.

Through the application of advanced seismic imaging, wireline, static and dynamic data technology you can see how we have been able to dramatically increase the level of detail - which enables us to more accurately and efficiently develop the resource.

Unconventionals investment is now taking place in regions like the Middle East, for example the Khazzan project in Oman, the Neuquen basin in Argentina and China shale gas. International companies like BP are assisting in transferring the learnings from the US onshore industry to these other regions.

## A diverse exploration portfolio for the future....



So what are the implications of these forward trends to our industry? And - specifically - for those of us who are geoscientists and explorers?

As an explorer, I know that this is a dynamic business and certainly the current market environment does not make it easy for us.

However, just as during the past decade, we must continue to follow the rocks and look for the material plays for the next decade and beyond.

We will need to pursue new frontiers and identify new play opportunities to deliver the energy the world needs.

However, how we do exploration will need to adjust in response to the changing global energy environment.

In a low-commodity price world, we will also see an increased focus on commerciality and a need to drive costs down and improve efficiency to create value from exploration.

For the past 25 years, the exploration focus for major operators has been on deepwater, in places like Angola and the Gulf of Mexico. At the same time, as these regions have matured, we've seen the shale revolution in the US unlock vast onshore resources for significantly lower costs. Now

more than ever, there is a clear need for exploration opportunities in these types of basins that can bring returns in a period of low oil prices.

Does this mean the end of deepwater? No - but it does underline the advantages of a diversified portfolio across key themes like deepwater oil, conventional oil, gas and unconventional.

This map here shows the geographic spread of BP's exploration and appraisal portfolio, which demonstrates the growing importance of gas as well as the key role unconventional will play into the future.

So if we come back to the question posed by this session: The future of global energy: oil or gas? It should be clear from looking at this map that the answer is: both. There may of course be some who say 'neither' should have a role, but as I hope I've shown, the world's energy mix will need to incorporate a significant proportion of both oil and gas for decades to come if we are to produce the energy that we all need.

Looking at the energy mix, BP's portfolio is already around half natural gas and is heading towards more gas with some very big projects - in Egypt's Nile Delta, in Khazzan in Oman, and Shah Deniz 2 in Azerbaijan, combined with the southern corridor pipeline to Europe. We could be 60% gas by the end of the decade.

And as an industry we should all be clear on our part in the transition to a lower-carbon economy. More gas will help with that as will increasing the efficiency of our activities and products.

So although we are facing a very challenging and volatile time at present - we must not lose sight of the longer term, and the role we will all continue to play for decades to come.

Thank you.