Technology: fuelling the future of energy

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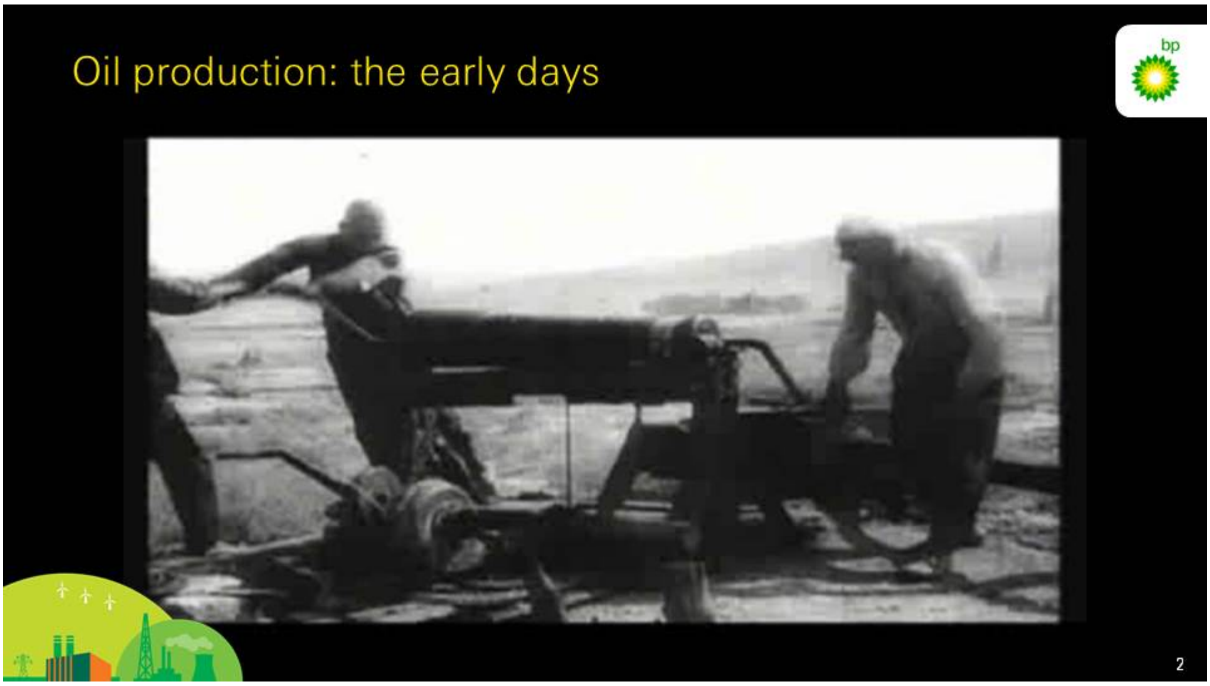
Good evening everyone, thank you all very much for joining me.

Today, I am going to talk about technology and its role in fuelling the future of the energy industry.

Given this is the 'blue skies' stage my job here is to look forward – but to put the future in context, I am going to start by taking a look back to see how far technology has come in the industry.

Let's take a look at this short video clip and please watch closely to see what comes out of this early well.



That was genuine footage of production operations in Baku in Azerbaijan in the early 1900s. As you can see, oil exploration was a high risk business at the time – and not for the faint-hearted, or for those without very deep pockets. That continues to be the case today, although the industry's management of exploration risks has come a very long way.

My personal history in the industry doesn't quite go back that far – but I have seen a lot of changes over the past 30 odd years both in the upstream, where I started as a young exploration geologist, and in the downstream refining and marketing end of the business, where I focus more today.

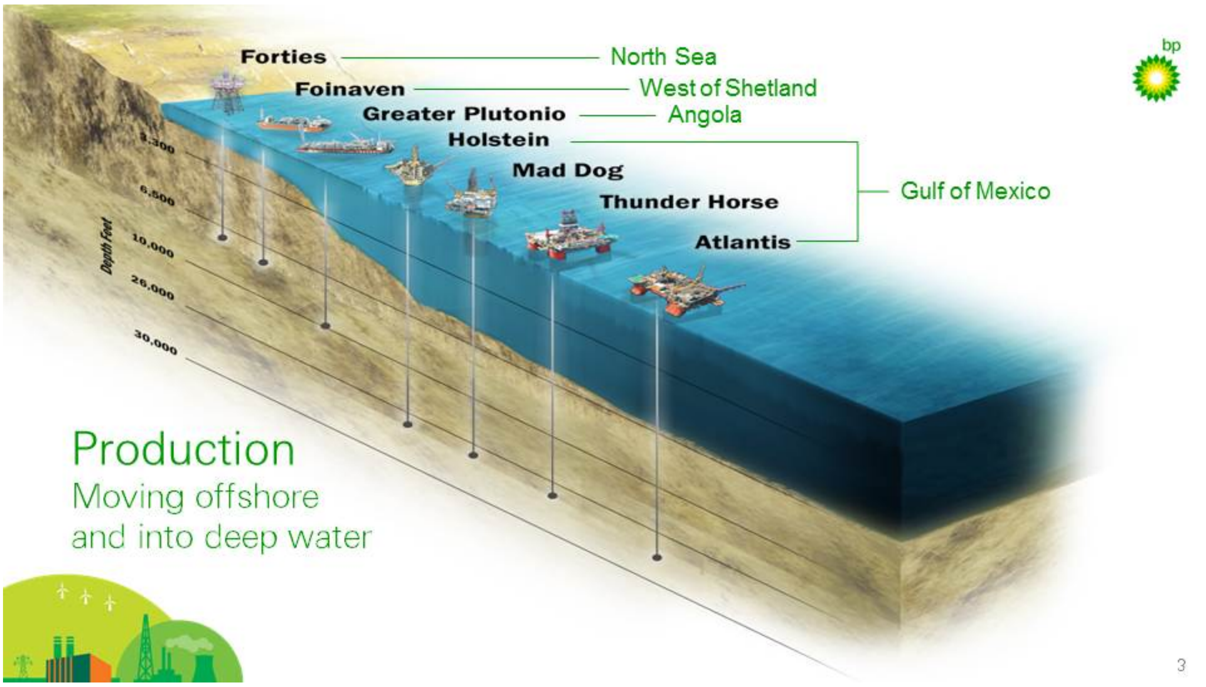
Constant advances in technology have transformed the energy industry – and they continue to do so at an increasingly rapid pace. Today, we have a huge range of sophisticated tools and techniques at our disposal.

The industry is a very different place – and so are the main issues we face. In the early 1980s – at the time I joined BP – security of supply was the big concern of the day. This was the era of the Iran-Iraq war, the Iranian Revolution…and the oil embargoes of the early 1970s were still fresh in the memory.

It was also a time when 'peak oil' was a big theme. The accepted wisdom back then was that global production of oil would reach a maximum within a few decades and then decline due to depleted resources. Today, the challenges are very different.

Over the past few decades demand for oil and gas has grown relentlessly, and to supply this demand, oil companies have had to set their eyes on more challenging frontiers.

Technology has taken the industry from onshore to deeper and deeper water offshore.



In 1970 BP discovered the giant Forties field 110 miles off the East Coast of Scotland in water depths of around 400 feet – very deep water at the time – and a real frontier technology breakthrough.

But since then the industry has developed the technology to work in deeper and deeper water – in the Gulf of Mexico, offshore West Africa and other deep water basins, drilling to depths further below the ground than the summit of Mount Everest is above it.

More recently the technologies of horizontal drilling and fracking have enabled the shale revolution in the US, and the unlocking of vast resources once thought inaccessible.

So today, oil and gas reserves are higher than ever.

And the 'peak oil' theory has well and truly peaked.

And the main concern today is of a very different nature – and that is sustainability.

In Paris last year, at the UN Climate Change Conference – COP21 – an historic agreement was reached. 195 countries adopted the most ambitious global deal ever, with a target of holding the temperature rise on pre-industrial times to well below 2 degrees.

The debate today is not about securing enough energy – it is about how we manage the transition to a more sustainable, lower carbon economy, while continuing to meet the world's growing demand for energy.

So this evening I am going to talk about how technology is helping with that transition to a lower carbon future.

But first, let's start with a look at the challenge ahead.

This slide is taken from BP's Energy Outlook – which is our Economics Team's assessment of most likely future energy patterns, based on current and expected trends in supply, demand, policy and technology.

So what are the challenges?

They are summed up neatly in this image…and in these charts.

Firstly, the world's population is growing. Anyone over 50 has already seen global population double in their lifetime – and it is set to increase from more than 7 billion people today to around 9 billion by 2035.

Secondly, the world's economy is growing. Global GDP has been increasing by an average of about 3.5% a year since 1970 and that's expected to continue up to 2035. Yet, we should not lose sight of the fact that over a billion people still don't have access to electricity.

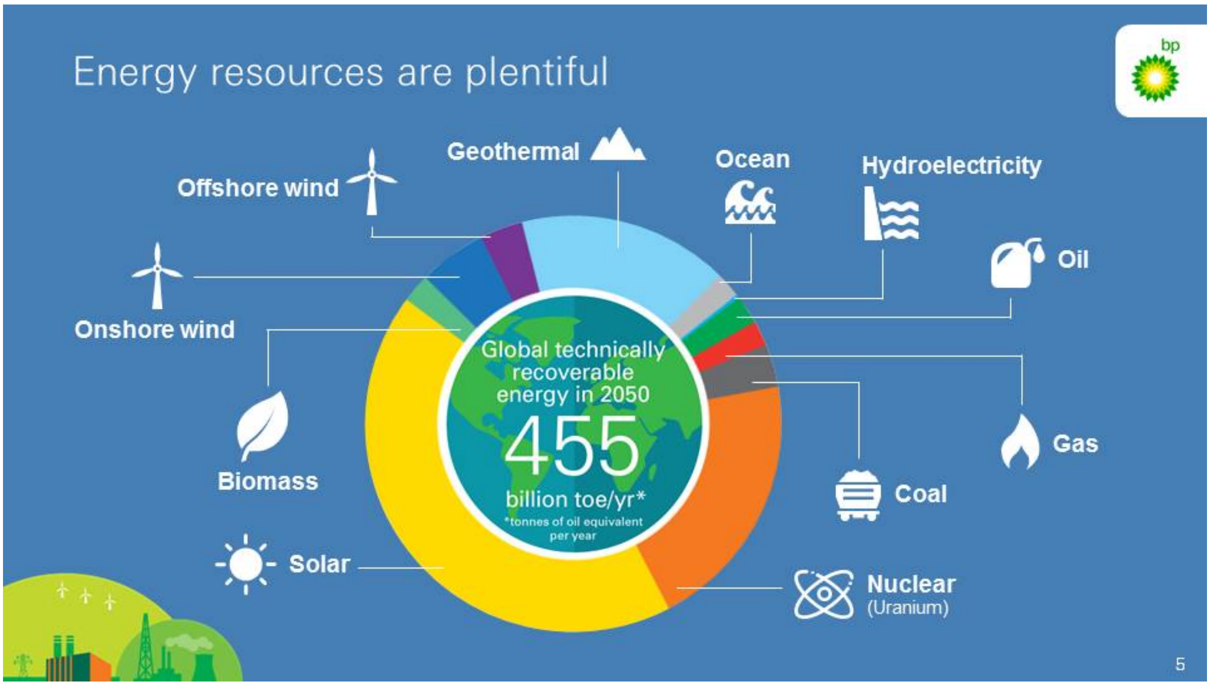
And thirdly, energy consumption is growing. In the last two decades energy demand grew by about 50% - and in the next two decades we expect a further 34% growth.

Technically that's a slowdown, but it won't feel like one – because 34% by 2035 means adding roughly one more US and one more China to today's energy consumption.

Meeting that demand raises two major challenges.

The first is sufficiency – is there enough energy to meet demand?

And the second is about sustainability – can energy demand be met without an unacceptable impact on the planet's ecosystem?



Let me expand briefly on these.

The sufficiency challenge is whether there is enough energy to meet this demand – bearing in mind that the world is over 80% reliant on fossil fuels for energy today?

The answer is a very straightforward 'yes'.

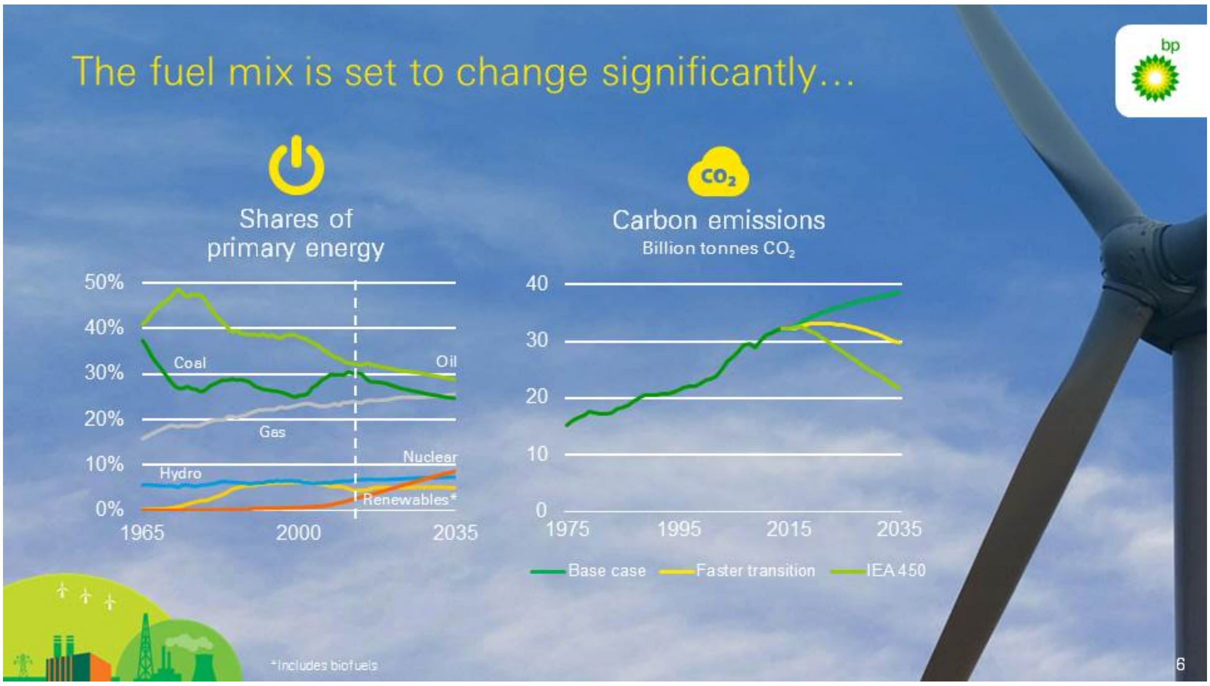
This diagram from BP's Technology Outlook shows that the world has abundant technically recoverable energy resources to meet global energy demand through to 2050.

And to put that theoretical 455 billion figure in perspective, it is 35 times greater than last year's total global consumption of energy of around 13 billion tonnes of oil equivalent and about 20 times the expected annual demand in 2050.

When I joined the industry proven resources of oil, for example, stood at just over 700 billion barrels. They now stand at 1.7 trillion barrels and we have used about a trillion barrels in between.

Advances in science, engineering and technology have kept on unlocking vast new sources of energy.

So our Technology Outlook shows that the resources really are plentiful.



The challenge ahead then, is meeting global aspirations for a more prosperous future while minimising the consequences for the planet.

These charts – in effect – summarise the scale of the challenge ahead to transition to a lower carbon global economy.

The one on the right is a series of projections on carbon emissions.

The dark green path at the top is from the BP Energy Outlook 2035 – our economists' 'base case' projection – the most likely path for emissions based on current assumptions.

The middle yellow curve is also from the BP Energy Outlook – and is an estimate for the path of emissions on a faster transition than in our 'base case'. This involves renewables growing at nearly 9% a year – rather than 6.6% in the base case.

The lower lighter green curve is the International Energy Agency's 450ppm scenario – the path that will contain the global temperature rise to 2^{o}C compared with pre-industrial times.

The chart on the left, which is BP's base case, illustrates how global energy demand has been met and is most likely to be met in the future by the different options in the energy mix.

Even growing at the faster transition rate, renewables would only reach a 15% share by 2035, compared to the 8% share shown here in the base case chart.

So, while the growth and development of renewables will be an important part of the future energy mix, there are many more aspects to securing the transition to a lower carbon economy, notably including greater efficiency and using more gas and less coal.

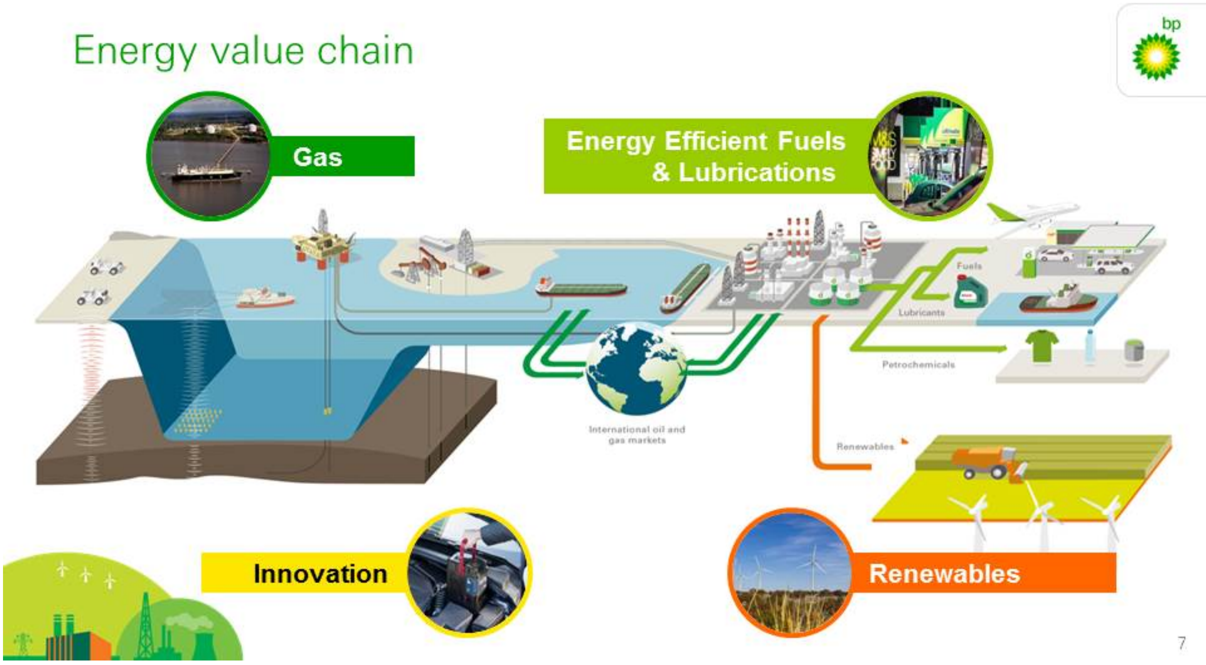
We all have a part to play in this, including governments who will need to go even further on policy than the pledges made so far in connection with the Paris Agreement.

BP supports this transition to a lower carbon future. We are a member of the Oil and Gas Climate Initiative – the OGCI – which was founded following discussions at the Davos World Economic Forum Annual Meeting in 2014, and currently chaired by our CEO Bob Dudley.

The OGCI brings together 10 national and international oil and gas companies, representing over a fifth of the world's global oil and gas production. Their aim is to catalyze practical action on climate change, in areas such as the role of natural gas, the role of carbon reduction instruments and tools, and also on longer-term energy solutions.

The OGCI is a body whose members share best practice, drive innovation and engage with stakeholders on this transition to a lower carbon economy.

I am now going to look at just a few examples of how science, engineering and technology are contributing towards a more sustainable future.



These are the areas I will focus on today:

- **Renewables**,
- The important role of **gas** in the future
- The role of **fuels and lubricants** that can boost **energy efficiency**
- and of course
- R&D to support **innovation**

I'll start with Renewables.

BP has had a long history in renewables, dating back to the 1970s and the development of solar PV technology.

In 1990s BP was one of the first major oil and gas companies to call for action on climate change.

As part of this endeavour we established the Carbon Mitigation Initiative in 2000 – a partnership with Princeton University to understand climate change science and scalable mitigation technologies, and we continue this important research with them today'.

In 2005 we created a new business, Alternative Energy, in 2005, with an investment of over $8bn.

Today we have chosen to focus our renewable investments on wind and on biofuels, and BP has the largest operated renewables businesses amongst our industry peers.

BP Wind Energy has interests in 16 wind farms and 1.6 GW capacity, across the USA, generating enough energy to power the homes in a city the size of Dallas – or Birmingham here in the UK.

And in Brazil, we operate three large sugar cane ethanol mills. We estimate that around 700,000 tonnes of CO_2 were avoided last year as a result of the ethanol produced. That's equal to somewhere in the region of 300,000 fewer European cars on the road for a year.

However, as I mentioned earlier, however fast renewables will grow, the current data indicates that there will be a continuing need for oil and gas to meet the world's energy needs for some decades to come.

Under the International Energy Agency's '450ppm scenario' – consistent with keeping the temperature rise to 2°C – oil and gas are forecast to make up 50% of the total energy mix in 2030 and 44% in 2040.

So how can that be?

As a lower carbon form of energy, natural gas can bring immediate carbon savings in the near term and will be a key and growing component of the future energy mix.

The OGCI has estimated that about 10% of energy-related greenhouse gas emissions could be avoided by the single act of switching the world's coal-fired power stations to state-of-the-art gas-fired plants.

In BP we are adjusting our portfolio towards more gas, from a 50/50 split currently towards about 60% gas as new natural gas projects come online around the globe.

These include major projects we are developing in Oman, in the Nile Delta in Egypt and one of the biggest energy projects in the world at the moment which is creating a brand new gas supply route for Europe – the Southern Gas Corridor, which will bring gas from beneath the Caspian Sea across Azerbaijan, Georgia, Turkey, Greece and Albania and into southern Italy.

The sheer scale, the leading edge engineering and technological achievement of the Southern Gas Corridor project is impressive.

It is actually two linked major projects.

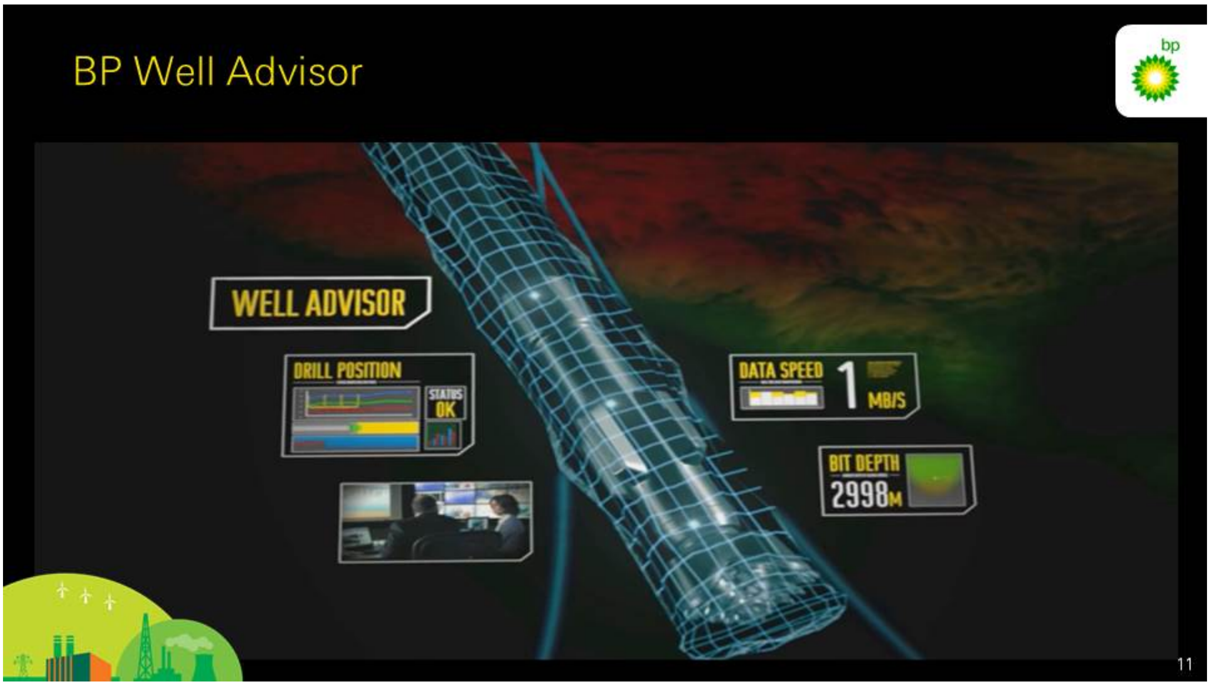
One is a new stage in the development of a gas field the size of Manhattan Island beneath the Caspian Sea, with 33 trillion cubic feet (tcf) of gas initially in place, but with additional reservoirs that could increase in-place volumes to 50tcf.

The second is the building of the southern gas corridor – a new 3,500km pipeline system that will provide 16 billion cubic meters of natural gas a year to Azerbaijan, Georgia, Turkey and on to Europe – linking Caspian gas to Europe for the very first time, creating a brand new supply of energy for Europe.

It's a $45 billion project that BP is leading, and which involves a partnership of 7 national governments, 11 different companies and 11 different gas buyers.

As I hope you can see from the images, this is leading-edge engineering on a massive scale.

And underpinning this great project are numerous examples of how cutting edge science and technology are transforming the industry and making it more operationally efficient.



We are going to take a look now at how we are deploying digital technology to transform the way we drill around the world, including the wells that will access the gas in the Shah Deniz field.

BP Well Adviser is a technology that collects real time 'down-hole' data – in other words from wells that are being drilled or producing. It then combines real-time data with predictive capability from an ever-increasing amount of historic data from hundreds of wells around the world.

Over the past two decades we have progressed from drilling that was guided only by limited analogue data, to drilling with the benefit of gigabytes of digital data, being generated every second from sensors in the well bore.

BP's Well Advisor technology takes that data, relating to pressures, depths, direction and many other variables, applies predictive analytics, and presents it on simple dashboard consoles for drilling operators.

Let's watch the video and see how this technology works…

[video]

We use Well Advisor to monitor key areas during the well drilling process – such as cementing, monitoring blowout preventers and running casing to name just a few.

Previously, a major cause of delays has been so-called ‘stuck casings’ – when the well casing gets snagged and stuck on its journey down the well and has to be freed for the operations to continue.

One of the big advantages of well advisor is that drillers can see exactly what is happening, second-by-second, in terms of the position of the casing; and can therefore prevent it getting stuck.

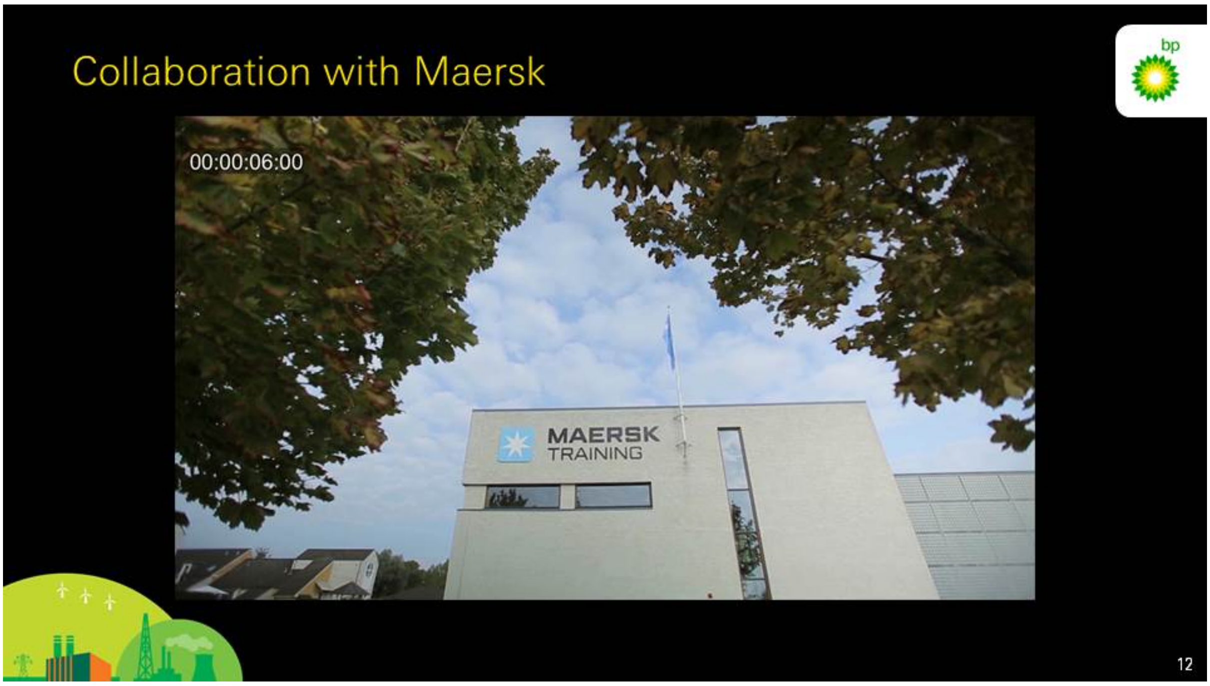
We now have this Well Advisor system live on 30 drilling rigs around the world and we have installed over 1,000km of casings without an incident. Monitoring casing alone with Well Advisor has saved more than $200m in delays and wastage over the past three years and allowed our operations to be much more efficient.

Next, I have a different but equally powerful example of how we are deploying digital technology to improve efficiency – one based on the use of virtual reality.

For this we collaborated with Maersk to train drilling crews in a state-of-the-art drilling simulator – like a flight simulator but looking down from the drill floor into the subsurface.

In the simulator we can recreate the specific conditions of the drilling operation – the same rocks, temperatures and pressures – even the same physical impact of the ocean currents on the rig.

We have used this technology to train our drilling crews heading out to Egypt to drill offshore in the Nile Delta.



Let's listen for a moment to David Lobedell from our Global Wells Organisation explaining the benefits.

[video]

After training in the simulator the drilling team from BP and Maersk went out and drilled a series of nine wells in the West Nile Delta.

They did so without any significant operational safety issues.

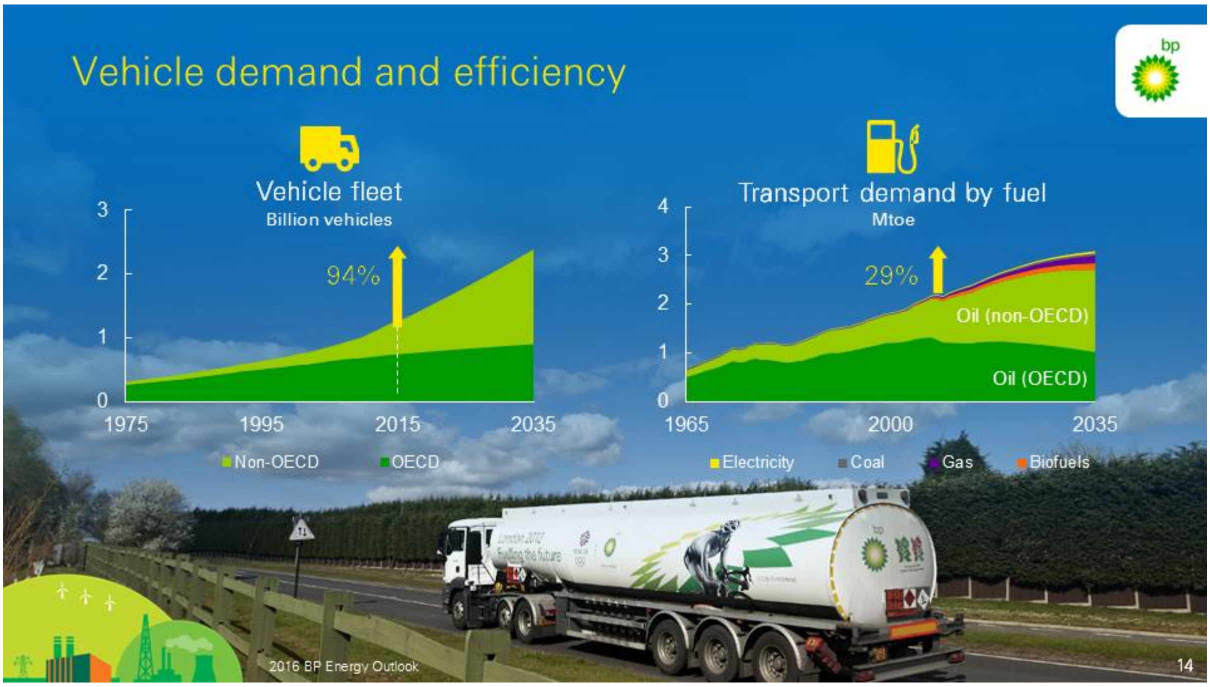
And they did it 40% under budget and much more energy efficiently by completing 114 days ahead of schedule.

That is a great example of the impact that digital technology is having in making our operations more efficient.

We are also installing similar VR simulators into all our refineries around the world

The ultimate aim is the creation of a 'digital mirror' for all of our physical assets – so that we can test, adapt and optimize our activities in the virtual world before we do so in the real world.

Optimising our operations in this way means we can use less energy, save time, save costs and also reduce carbon emissions.



I have been talking mainly about upstream technology so far. But I'm now going to move downstream – where technology is also moving very fast.

And I want to share a few examples now of where we are making significant efficiency gains.

The International Energy Agency estimates that no less than half of the reductions in carbon emissions that are needed by 2030 will come from energy efficiency.

These charts illustrate the gains that are being made in the automotive space.

On the left you can see that the global vehicle fleet is forecast to double over the next two decades – from around 1.2 billion today to 2.4 billion by 2035.

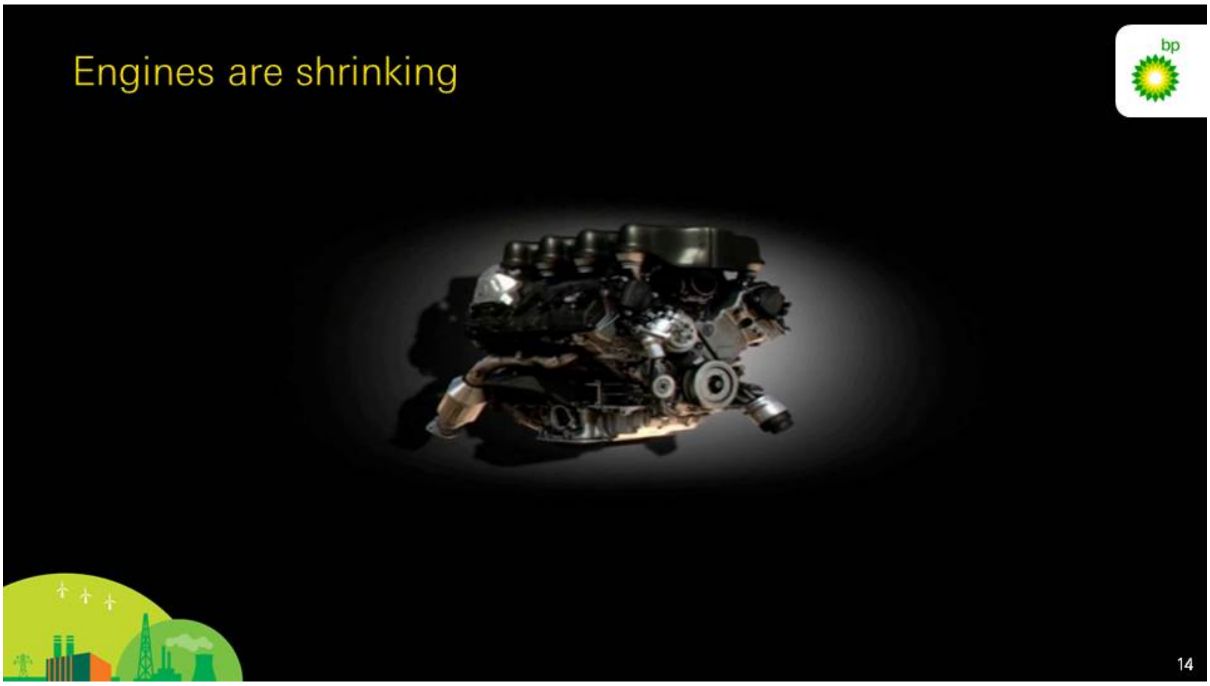
But over the same time period – shown on the right – we expect fuel demand to rise by less than a third due to more efficient vehicles.

This is a result of increasing use of electric vehicles and hybridisation, improved powertrains, and a significant contribution from advanced fuels and lubricants.

So, despite the increase in vehicles, total carbon emissions from transport remain constant as a percentage of the total of energy-related emissions to 2035.

That last point is important as we still expect liquid fuels – including biofuels – to continue as the major source of transport fuel – at least for the next 30 years.

In technological terms it's a very important relationship between auto manufacturers and the producers of fuels and lubricants and our scientists and engineers have been working in partnerships for many years to optimise engine performance.



One of the key developments in terms of improving fuel efficiency has been the dramatic shrinkage in engine size – generating the same levels of performance at the same time as burning less fuel.

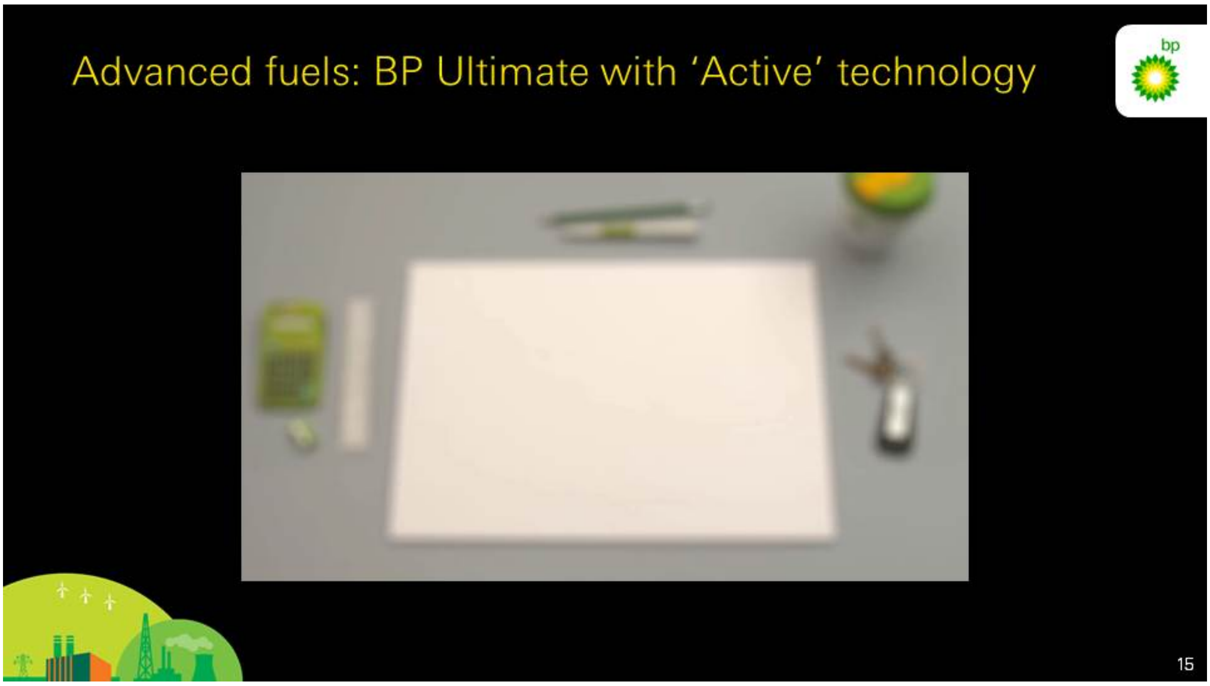
As you see with the example of the 8-cylinder engine in the video, this can be reduced in size to a 4-cylinder, halving the number of pistons and reducing the amount of friction in the engine. Today we can achieve 10% higher output and 40% better fuel economy with this 4-cylinder in-line engine compared to an 8-cylinder engine of ten years ago.

So now you can have an engine like the Ford Fox – otherwise known as the Ecoboost. The 1-litre version has an engine block no bigger than a sheet of A4 paper – and it can generate the same performance with greater fuel economy than the bigger 1.6-litre engine it has replaced in older Ford models.

The consequence of this downsizing is much higher pressures and temperatures in the smaller engine, which require advanced fuels and lubricants to optimise performance.

We have several hundred scientists, engineers and technologists in BP developing a new generation of fuels and lubricants. They work in partnership with auto manufacturers, with chemical additive companies, academic researchers and with specialist testing houses to develop new fuel-efficient products, which in turn help reduce greenhouse gas emissions..

Let me briefly share three examples.



The first is a new range of advanced fuels, which we call BP Ultimate with ACTIVE technology.

This has been a five-year development targeting in particular the effect that dirt build up can have on the fuel injectors in use in modern direct injection engines.

These injectors have tip-holes that are often just the width of a human hair, so any combustion residue that builds up can affect the even distribution of fuel, cause the fuel to burn inefficiently and contribute to more dirt build up and so on.

Our new Ultimate fuels are formulated to actively clean engines. The ACTIVE molecules are designed to attach themselves to dirt particles and drag them away, and also attach themselves to the engine surfaces to prevent any new build up.

We have a video that illustrates this…

[video]

We've calculated that those miles could help reduce CO_2 equivalent emissions on a journey by up to 4%, as you use less fuel to travel the same distance.

My second example is a new lubricant – Castrol Edge with Titanium fluid strength technology.

Again this is an example of a new additive and as the name suggests, a new additive is titanium.

The titanium is added to the lubricant and it changes the way the oil behaves under extreme pressures. And you've already heard that pressures in engines are increasing as engines are getting smaller, and more fuel efficient.

When the titanium-containing molecule comes under pressure in the engine, it momentarily causes the oil to form a cushioning pad between the points of contact, and this reduces friction as well as protecting the engine. And reduced engine friction means more fuel economy. This is special enough, but when this pressure is relieved, the oil converts back to its usual liquid state and continues its flow around the engine.

Castrol Edge is our best and strongest range of motor oils with Titanium Fluid Strength Technology.

The third example is a new technology that we believe is going to be revolutionary in terms of engine maintenance.

It is a new technology called Nexcel that will radically alter the oil change process for the first time in decades, leading to improvements in fuel efficiency, improved environmental impact – and saving a lot of time.

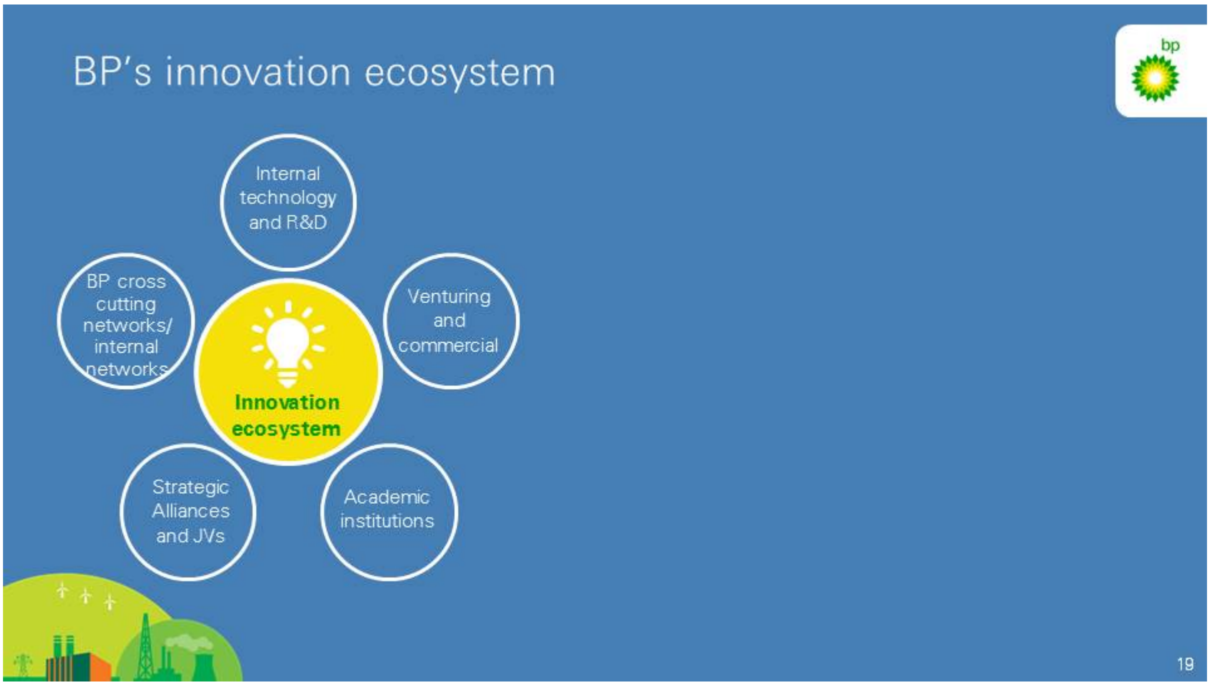
Let's watch the video ….

[video]

In terms of how it works, this connects us back to what I was talking about earlier with digitisation. At the heart of the oil cell are sensors that monitor the oil level and oil quality, ensuring that the exact quantity and quality of lubricant is in the engine at the right time. This has the benefit of improving the efficiency of the engine with enhanced thermal management, leading to improved fuel efficiency, and lower GHG emissions.

So it's safer, quicker, cleaner, there is no spillage and the old oil is returned and recycled, so it's more sustainable as well. At the moment Aston Martin is using the technology in its super car the Vulcan – which is a track car – but we are confident that this is going to roll out to the mass market and be on road cars in the future.

That's a taster of the fuels and lubricants available to vehicles on the road today – and in the near future in the case of Nexcel.

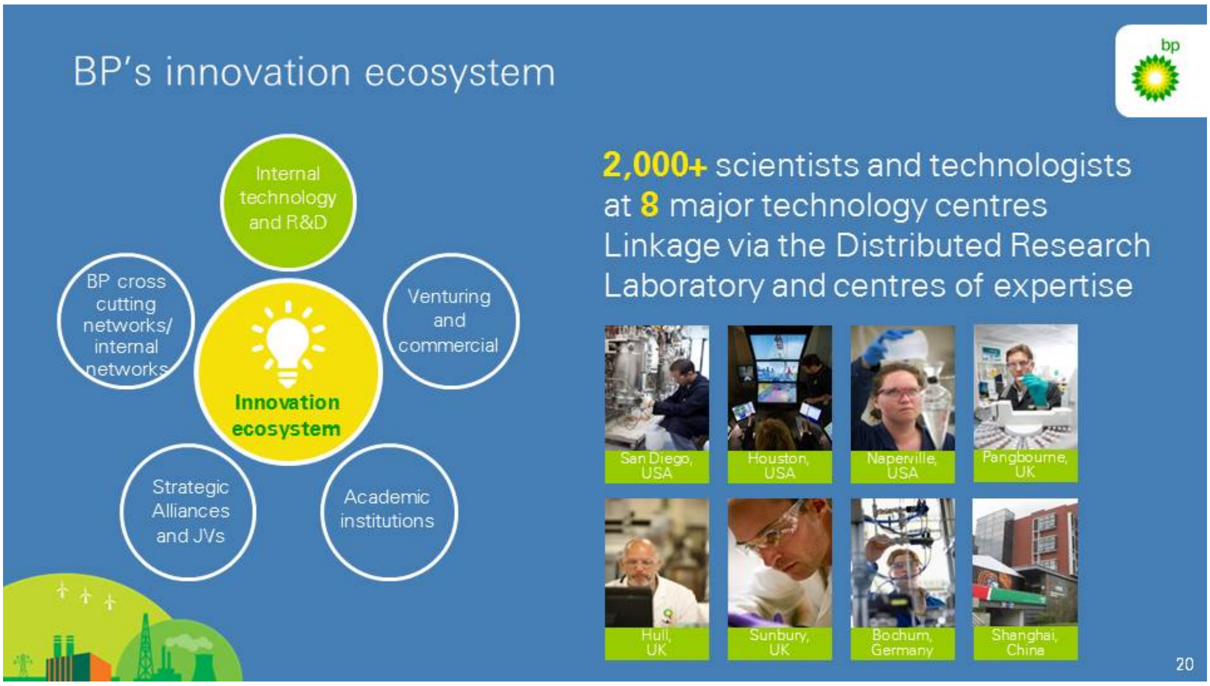


So as you can see, technology is driving change in the oil and gas sector with innovation across the value chain. And technology is coming from many sectors and more countries than ever before as we assimilate innovation from the aeronautics industry, mining, pharmaceuticals, automotive and elsewhere.

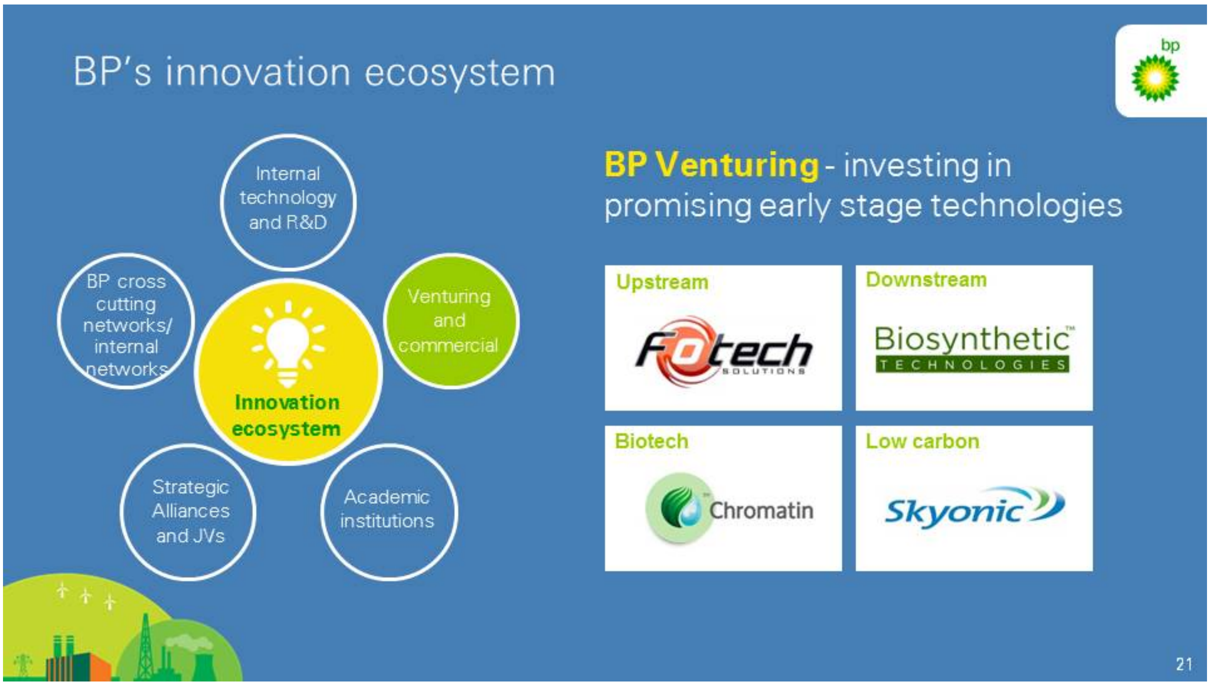
Today, it is far beyond the resources of any one company or organization, regardless of size, to excel and innovate in so many different disciplines. Today it is as much of a skill to choose the right partners as it is to do the leading edge research yourself.

As a result, R&D models have moved from big, in-house corporate laboratories to co-operation with academia, and to a diversity of collaborative partnerships.

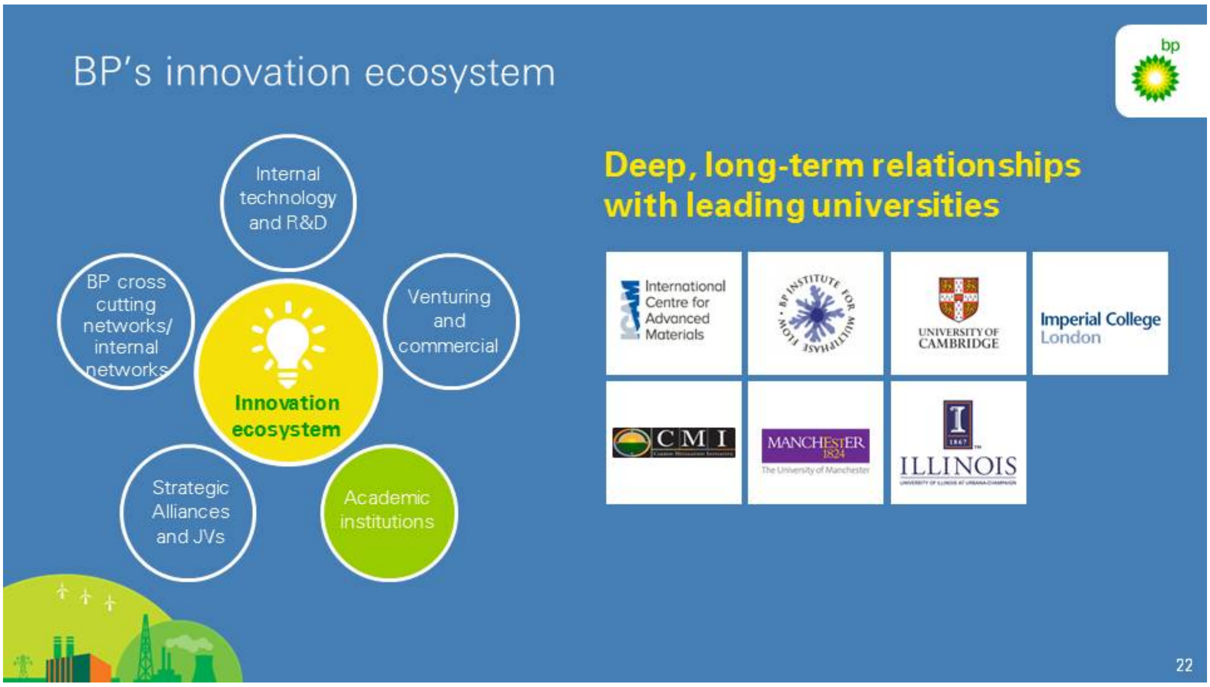
In BP we have what we call an Innovation Ecosystem – one that works to create a bigger brain through collaborations, partnerships and networking.



We directly employ more than 2,000 scientists and technologists – many of whom are based at one of eight major BP technology centres around the world – in the UK, US, Germany and China – and in smaller technology centres that serve local needs.



And we also have a global venturing business which includes several investments in technology start-ups around the world – partnering with high-growth, game-changing technology businesses where we look to help accelerate cutting-edge innovations across the entire energy spectrum.



Today we invest in research in 22 of the UK's leading universities and also have long-standing, deeply strategic research relationships with several leading universities in the UK and the US.

The whole ecosystem is focused on driving business performance and a more sustainable future through world-class research and business relationships.

I'd like to draw my talk to a close by focussing on one particular part of our ecosystem – the BP International Centre for Advanced Materials, or ICAM, which we established in 2012 as a $100 million, 10-year commitment to fundamental research in materials science.

The ICAM has its hub at the other end of the East Lancs Road, in Manchester. It is truly world class in capability and in its facilities. In fact,

ICAM's director, Professor Phil Withers has just been appointed Regius Professor of Materials in the Queen's 90th birthday celebrations – a well-deserved recognition.

We set ICAM up on a hub and spoke model with four university partners – Imperial College, Cambridge and Urbana-Champaign Illinois as the spokes, with the hub at Manchester University.

We will have 40 programmes running at ICAM conducting research in protection (including corrosion), materials, surface interaction and separation that we believe could be transformative – not just for oil and gas but for many other sectors as well.

What you are seeing on the screen now is one of the first innovations to emerge from our partnership with ICAM, and with a funding contribution from the Engineering and Physical Sciences Research Council – and it is a great example for me to finish with this afternoon.

This unassuming object in the picture is a nanofilm – an ultra-thin, super strong membrane that is able to perform separations that are super-fast and highly selective.

This prototype membrane is unique in that it's only 8-10 nanometers thick – a stack of 10,000 of these membranes would be no thicker than a human hair – and this 'thinness' makes it very permeable and very efficient.

It might be thin but it is also incredibly strong and can withstand pressures of around 50 bar – that is about the same as the pressures we find 500m below the ocean's surface.

This membrane can also be crumpled – like this piece of paper. The crumpled membrane is even more spectacular in performance as it can separate substances 400 times faster than a conventional membrane.

This real scientific breakthrough could slash energy consumption in industry compared with conventional, heat- related separation methods, such as distillation and evaporation – techniques we use in the oil and gas industry.

It could revolutionize filtration processes such as desalination – removing salt from sea water – both to provide drinking water and for more cost and energy efficient industrial uses such as enhanced oil recovery offshore.

It has significant benefits in the pharmaceutical and other industries, as well as in medicine, such as filtering the blood of kidney patients reliant on dialysis.

The uses of this incredibly strong but delicate looking membrane are in their infancy.

What is clear today is that the impact of this new BP-ICAM technology on energy efficiency, on reducing carbon emissions and on the environment could be hugely significant.

For me it demonstrates that the UK remains firmly at the forefront of science and innovation – and who knows what other technologies like this nanofilm will emerge right here on our doorstep that may change all our lives for the future?

Thank you for listening.


Dr Angela Strank
Head of Downstream Technology
and Chief Scientist, BP
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