

# BIEE conference: Innovation and disruption: the energy sector in transition

First plenary session: Sources of innovation and disruption

## Technology and innovation - fuelling the future

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**Speaker:** Angela Strank, head of technology, Downstream, and BP chief scientist

**Date:** Wednesday 21 September 2016

**Venue:** St John's College, Oxford



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

I'd like to thank the British Institute of Energy Economics for inviting me here today. BP has enjoyed a long and fruitful relationship with the BIEE as a corporate member.

I'm the head of downstream technology for BP - which includes our refining, fuels, lubricants and petrochemicals businesses.

I'm also BP's chief scientist, and responsible for the health of science across the company.

Another way of looking at that is to say I'm responsible - with others - for fostering innovation in the business, and also for our ability to understand the opportunities and disruptions from technology in the world today.

I think we have a really interesting morning ahead of us, and what I'd like to do with my remarks is set the scene.

- I'll start with the current context for energy, based on BP's Energy Outlook - which forecasts the direction of the energy sector over the next two decades.
- I'll then share some examples of how BP is responding to these future trends.
- And I'll finish by looking at how we anticipate, and harness emerging sources of innovation and disruption in technology.

So let's start with a look at the current context.



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

So what are the challenges?

Firstly, the world's population is growing. If you are over 50, then you've already seen global population double in your lifetime - and it's set to increase from over 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 shouldn't 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 it to grow by about a third.

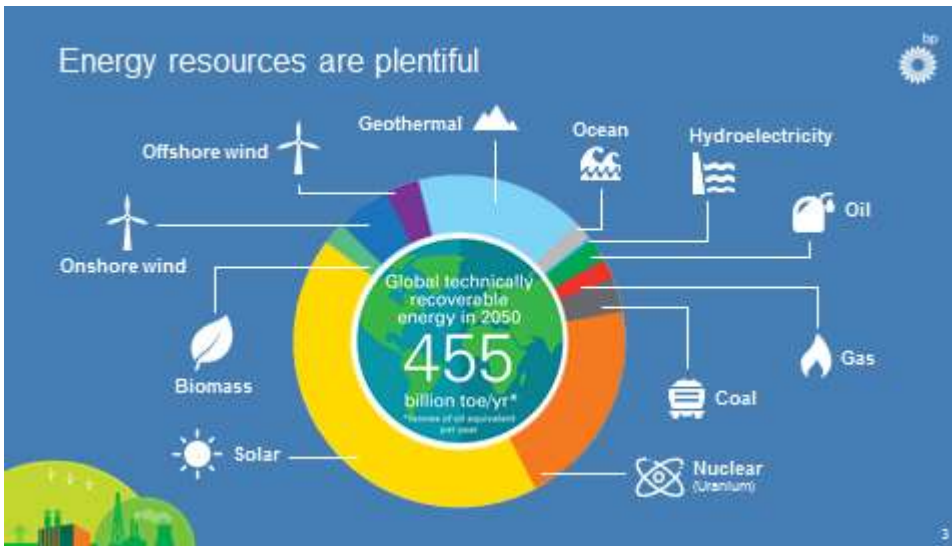
Technically that's a slowdown, but it won't feel like one - because it's like adding roughly two more USAs to today's energy consumption - or 23 three UKs.

Meeting that demand raises two major challenges.

The first is sufficiency - is there enough energy to meet that demand?

And the second is about sustainability - can the 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?

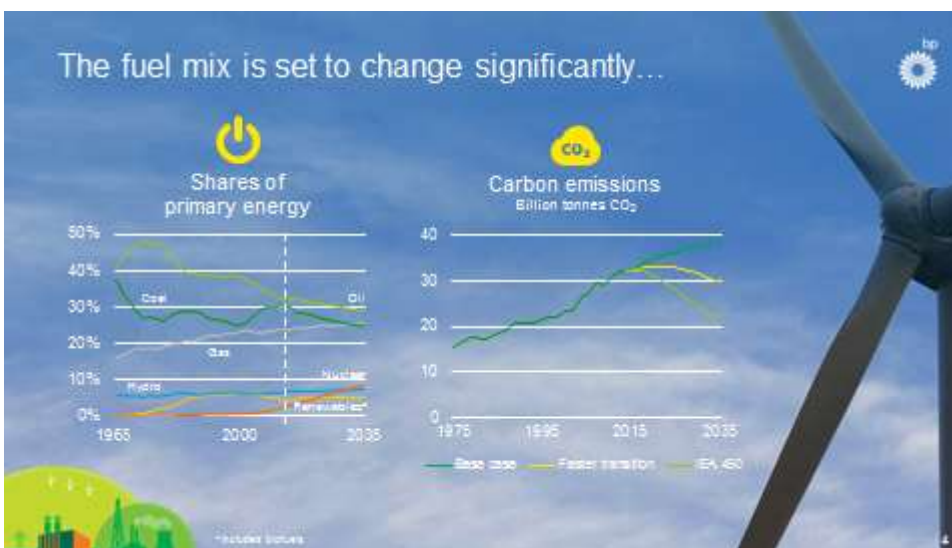
The answer is a very straightforward 'yes'.

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

When I joined the industry, over 30 years ago, proven resources of oil, for example, stood at just over 700 billion barrels. They now stand at 1.7 trillion barrels, and the world has used about a trillion barrels in between.

Advances in science, engineering and technology have continued to unlock vast new sources of energy - like the shale revolution in the US. So resources really are plentiful.

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



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

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

The middle yellow curve (also from the Energy Outlook) - is an estimate for emissions in a faster transition 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 - a path consistent with limiting global temperature rise to 2°C compared with pre-industrial times.

The chart on the left, 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 only reach 15% share by 2035, compared to a 9% share in the base case.

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 energy efficiency and using more gas and less coal.

### **So how do we respond to this challenge?**

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 COP 21 Agreement.

BP supports this transition to a lower carbon future. We're very proud of being the first oil and gas major to publically call for action on climate change, back in 1997, and we've been active on a number of fronts ever since.



We have a long history in renewables dating back to the 1970s with BP Solar and the development of solar PV technology.

Today, we operate two material renewables businesses - a US onshore wind business and a biofuels business in Brazil where we operate three ethanol mills.

And earlier this year we made a breakthrough with biojet by becoming the first supplier to deliver biojet through an airport's normal supply system.

I'll turn now to our core activities of oil and gas where BP is responding with a shift in its portfolio towards more natural gas than oil - recognizing the lower carbon advantages of gas. For example, about 10% of energy-related GHG emissions could be avoided by the single act of switching the world's coal fired power stations to gas.



Our switch to gas includes one of the biggest energy projects in the world - called 'the Southern Gas Corridor'.



With our partners, this project will create a brand new gas supply route for Europe - bringing gas from a 33 tcf field beneath the Caspian Sea across Azerbaijan, Georgia, Turkey, Greece and Albania and into southern Italy through a newly constructed 3,500km pipeline system at a total cost of \$45bn.

This is leading-edge engineering and innovation on a massive scale.

But, as I've said we all have a part to play in this transition, and this brings me on to talk about the Oil and Gas Climate Initiative, the OGCI.

## Oil and gas climate initiative



"Today you see companies who provide a tenth of the world's energy united in supporting an effective global climate change agreement, united behind the shared ambition to limit the rise in temperature to two degrees and united in our commitment to be a part of the solution as we provide energy for the future."

Bob Dudley, BP Chief Executive



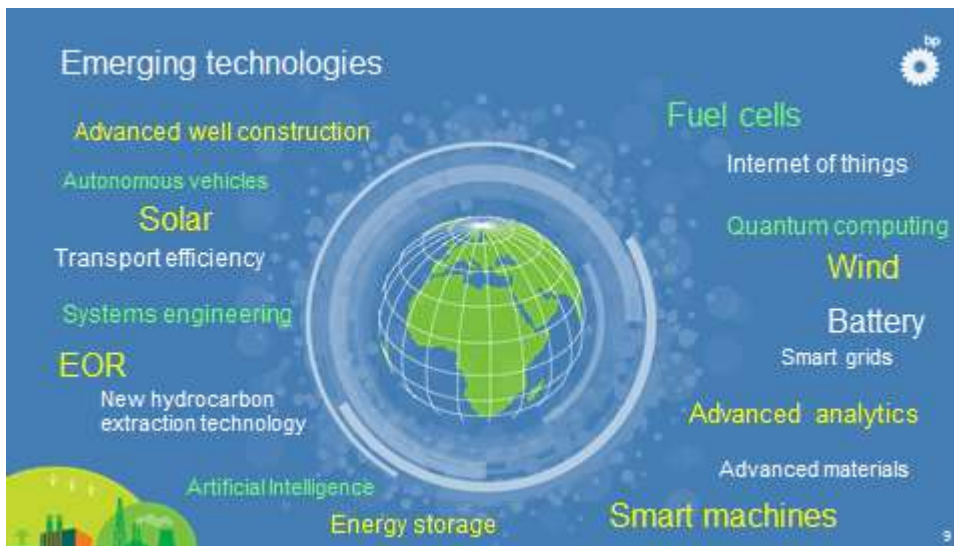
For those who may not be familiar with it, the Oil and Gas Climate Initiative is an innovative industry partnership. It was set up in 2014 via the World Economic Forum in Davos. The intent is to make significant impact on carbon emissions in our industry through collaboration and deep expertise. It now includes 10 major oil and gas companies, which collectively represent more than 20% of the world's oil and gas production, and more than 10% of the world's energy supply. The OGCI is focusing on three main topics:

- Firstly, defining a low emissions roadmap of technology pathways to 2040
- Next, the role of natural gas - and the management of methane emissions, and finally
- The role of carbon capture and storage - through burial of the CO<sub>2</sub> in the subsurface and through the use of CO<sub>2</sub> in products for the marketplace.

This collaborative industry effort, led by the 10 company chief executives, will be a powerful source of innovation and progress towards a lower carbon future.

### **Responding to change**

So let me move on now to some of sources of innovation in technology that are already having an efficiency impact on our businesses.



New technology is progressing quickly, and from more and different directions than ever before. This slide shows just some of them, from advanced materials and fuel cells, to artificial intelligence and quantum computing.

There's far too many to talk to today but I'll mention just a few.



Digital technology and data analytics have an increasingly important role in many aspects of our operations. In the US, BP has about 28,000 miles of pipelines and hundreds of tanks and vessels. Often the pipelines are in 'hard to reach' places to inspect; many operate at high pressures and temperatures, e.g. in refineries. Today, we are using drones, robots, remote sensing and data analytics to inspect these facilities for corrosion and also for environmental monitoring, improving both maintenance efficiency and safety.



I'll now want to spend some time on the transport sector where the pace of innovation and change in mobility has been, and continues to be significant. What is clear is that this change is likely to be the most significant transformation in the transport sector since the development of the internal combustion engine.

New technologies such as electric and autonomous vehicles are beginning to change the landscape, and digital technology is creating new customer offers, such as ride-sharing and car-pooling. New mobility players and partnerships with new and traditional companies are emerging.



The International Energy Agency estimates that half of the reduction in carbon emissions needed by 2030 will come from energy efficiency.

On the left you can see that the global vehicle fleet is forecast to double over the next two decades. But, as you can see 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 new and improved powertrains, as well as a significant contribution from advanced fuels and lubricants.

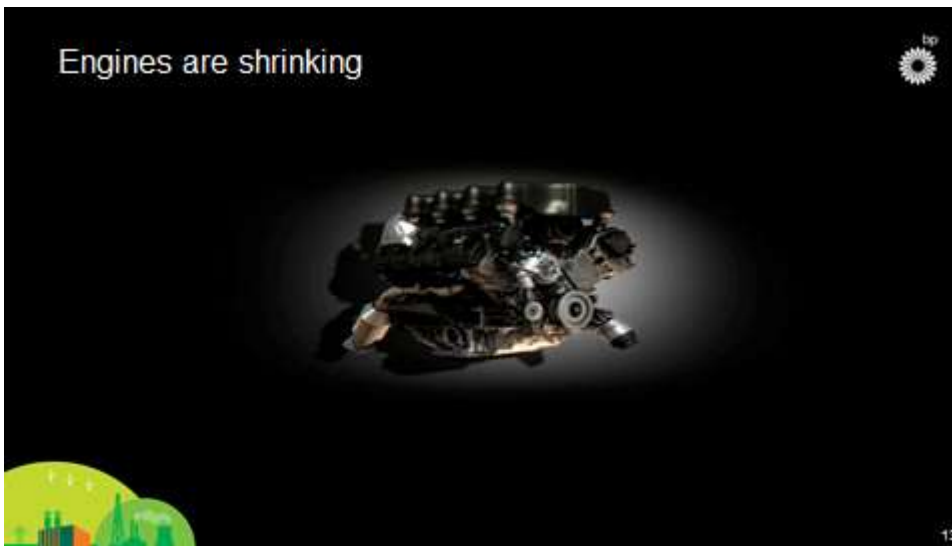


So, despite the increase in vehicles, carbon emissions from transport will remain constant as a percentage of the total of energy emissions to 2035.

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

There's considerable innovation going on to improve energy efficiency in transport.

Let's take a look at some examples.



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

This 8-cylinder engine, can be reduced in size to a 4-cylinder, reducing the amount of friction in the engine. Today it is possible to achieve 40% better fuel economy with a 4-cylinder in-line engine compared to an 8-cylinder engine of 10 years ago.

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

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 programme, targeting in particular, the effect that build-up of dirt can have on the fuel injectors in use in modern direct injection engines.

The ACTIVE molecules attach themselves to dirt and drag it away from the engine. They also attach themselves to the metal surfaces of clean engines, forming a protective layer, stopping more dirt binding to the metal.

And BP Ultimate could give fuel efficiency of up to 21 more miles per tank.



My second example is a new lubricant - Castrol Edge with Titanium Fluid Strength technology.

The new titanium formulation in Edge changes the way the oil behaves in these new smaller engines.

When the Titanium molecules come under pressure in the engine, they cause the oil to form a strong, cushioning pad between the metal points of contact, and this reduces friction as well as protecting the engine... and reduced engine friction means more fuel economy.

In industry standard testing the Edge range achieves significant fuel economy benefits - up to 4% for the latest, best performing oils.



The third example is a new technology called Nexcel that could be revolutionary in terms of car maintenance.

Nexcel turns a conventional 30-minute oil change into a 90-second operation, essentially involving lifting a box of oil out from under the bonnet and putting a new box in. The box, or oil cell, includes sensors that monitor the oil level and oil quality, ensuring that the exact quantity of lubricant is in the engine at the right time. This improves engine efficiency and 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.

### **Anticipating and managing future disruption**

That's just a taster of innovation already changing the industry and making it more efficient. But it's beyond the resources of any one company or organization, regardless of size, to excel and innovate in so many different science and engineering disciplines.

Today it's as much of a skill to choose the right partners, as it is to do the leading-edge research yourself.

Nowadays, our model is much more external with a rich diversity of collaborative technology partnerships.



We call it our Innovation Ecosystem - one that works to create a 'bigger brain' through collaborations, partnerships and networking.

# BP's innovation ecosystem

Internal technology and R&D

BP cross cutting networks/ internal networks

Innovation ecosystem

Venturing and commercial

Academic institutions

Strategic Alliances and JVs

**Deep, long-term relationships with leading universities**

International Centre for Advanced Materials	UNIVERSITY OF CAMBRIDGE	Imperial College London
CMI	MANCHESTER	ILLINOIS

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Those relationships include partnerships with leading academic institutions - including a number here in Oxford, collaborating across the social and physical sciences.

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**2,000+ scientists and technologists at 8 major technology centres**

Red Oak, USA	Houston, USA	Research, USA	Perthshire, UK
UK, UK	Edinburgh, UK	8 South, Germany	Orange, China

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We also maintain extensive in-house expertise and directly employ more than 2,000 scientists - based in eight major BP technology centres around the world.



And we have a global venturing business which makes investments in technology start-ups - where we look to accelerate cutting-edge innovations across the entire energy spectrum.

Take Peloton for instance. Peloton's innovative system uses radar and vehicle-to-vehicle communications to enable pairs of trucks to 'couple' - or in other words, to drive closer together to reduce drag and so improve fuel efficiency - and do so safely.

## Conclusion

To sum up, technology and innovation are progressing rapidly, providing a wealth of opportunities and new business models.

As business leaders we need to move fast, and flexibly, to leverage the opportunities as they arise.

And these opportunities can take many different forms.

Take this water bottle, for example.

It's one of billions produced around the world every year. The US alone used around 50 billion last year. Some are made partly from recycled plastic - the more the better. But many are not.

For a petrochemicals business, that's an opportunity to improve the sustainability of new production - something we look at all the time.



Last year BP opened a new purified terephthalic acid (or PTA) plant, which uses our latest PTA technology. PTA is one of the feedstock chemicals used to make these bottles, as well as hundreds of other everyday items - clothes, paint and food packaging.

The latest PTA technology reduces solid waste from the new plant by 95% compared with conventional technology; it also reduces water discharge by 75%, and lowers greenhouse gas emissions by 65%.

We have used elements of this technology to produce a new brand of low carbon PTA, which we're calling PTAir.

Independent analysis of the production lifecycle shows the carbon footprint to be nearly 40% lower than the average for other European PTA manufacturers.

That's an innovation we are proud of - it's good for the industry, for our customers and for the environment. And I'm anticipating that many more innovations such as this will follow in the months and years ahead.

Thank you for listening.