**International Petroleum Week 2014**

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**Session title:** Strategic role of technological advances in unlocking available and affordable oil and gas supplies

**Script:**

1. *Introduction*

I am a civil engineer by degree and have spent most of my career in BP's Upstream business

Over the past 15 years I have led multi-billion dollar developments in Trinidad (gas) and the deep water Gulf of Mexico (largely oil) before taking on my current role as BP's Head of Technology.

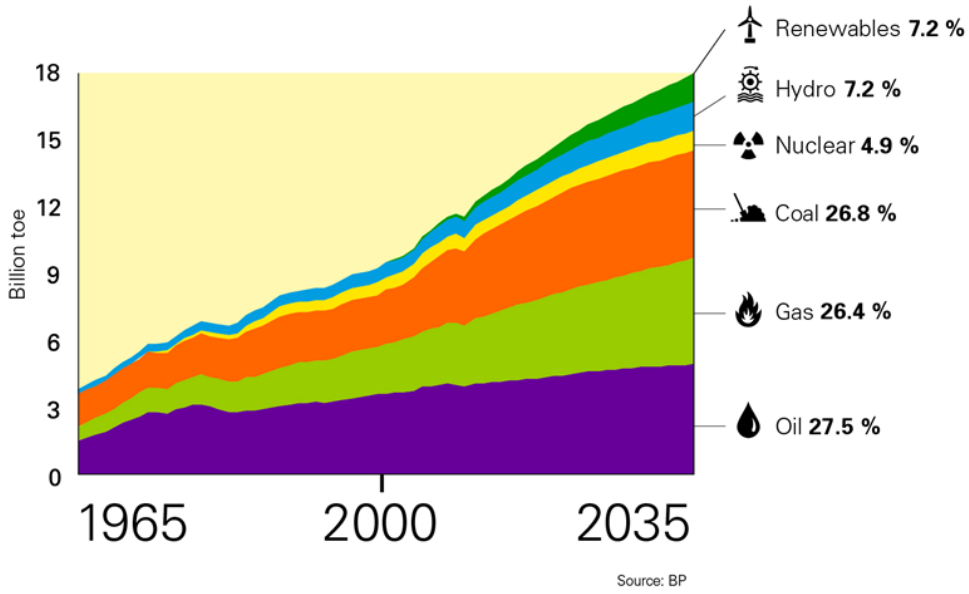
I'll start with a broad overview of the outlook for oil and gas, then look at how technology can contribute towards meeting the major challenges facing the industry, and finally touch on the importance of regional differences.

# The outlook for oil and gas

*2. The outlook for oil and gas*

World energy demand is growing (driven by population and income growth).

# Energy Outlook 2035 insights
## Consumption by fuel

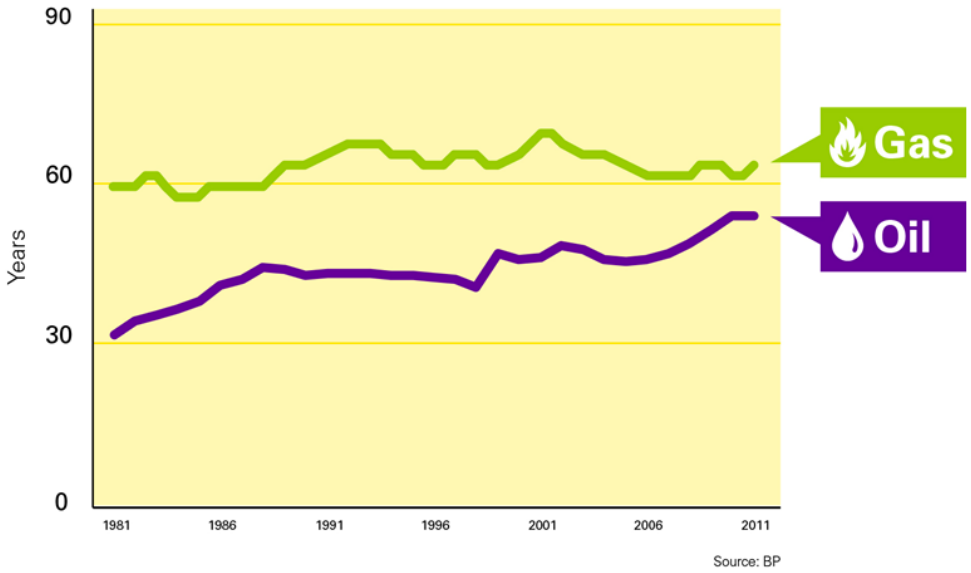



BP's Energy Outlook 2035 projects that demand will grow by around 1.5% per annum or 41% between 2012 and 2035.

Oil, gas and coal are expected to converge in terms of market shares at around 27% each by 2035, with renewables, nuclear and hydro collectively growing to nearly 20% of the total.

Doubts that there is sufficient oil and gas to meet this demand growth – the so-called peak oil theory - are receding.

# Track record
## Reserves-to-production (R/P) ratios




This chart shows global R/P ratios for oil and gas over the past 30 years taken from the BP Statistical Review – the industry has a remarkable track record of replacing reserves enabled by price and technology.

Unconventionals have significantly changed the picture over the past decade, increasing by 50% - from around 30trboe to 45trboe - the hydrocarbons in place which can potentially be exploited economically, although there is a high level of uncertainty associated with the global potential of shales (especially shale oil), due to above ground factors such as mineral rights, policy and public opinion. Nevertheless, US technology developments are being transferred globally and there is great potential for learning and rapid innovation due to the modular nature of the process.

The question is: how long can the industry carry on doing this?

# Challenges and the role of technology

*3. Challenges and the role of technology*

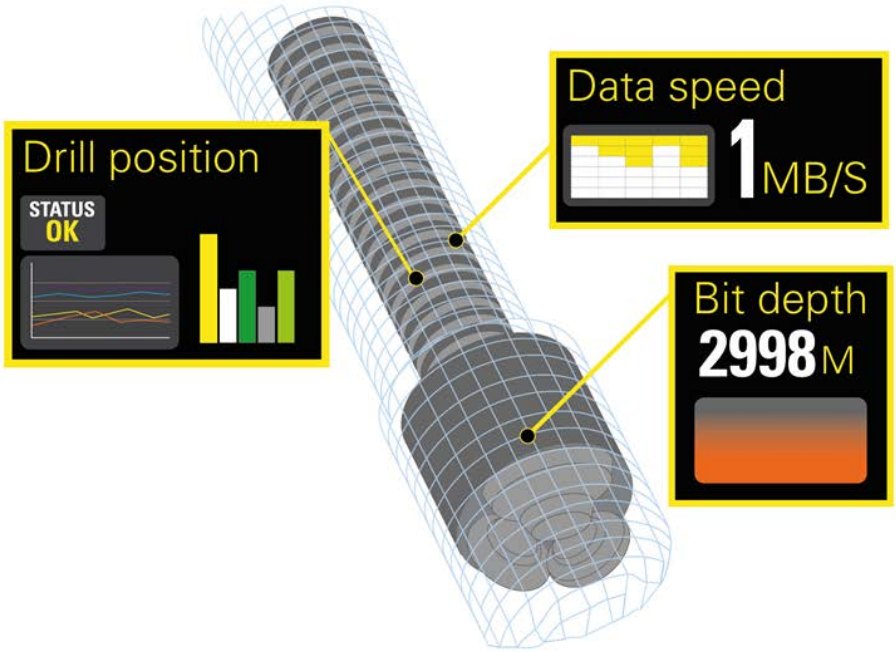
The technology challenges for the oil and gas industry seem reasonably clear - producing hydrocarbons safely; accessing new resources economically; using energy more efficiently; and creating a more sustainable energy future.


The most basic challenge, which is fundamental to maintaining the energy industry's licence to operate, is finding and producing the resources we need **safely**. This underpins everything we do.

Managing operating risk is increasing in complexity, as the industry operates, for example, in more remote locations, deeper water, with more sophisticated operating systems, and external threats – cyber, terror and even extreme weather conditions.

On the positive side of digital technologies, however, advances are making a big difference to the identification and prevention of potential risks.

## Safety and reliability
BP Well Advisor



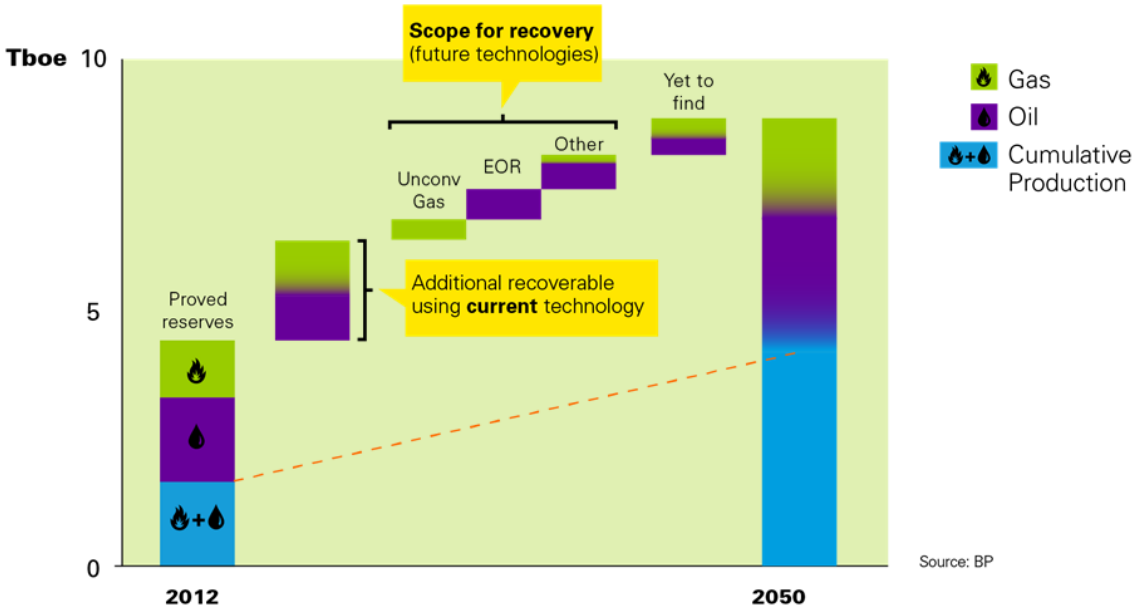

The BP Well Advisor programme is a good example: a suite of technologies that enable operators to integrate real-time data, from all sources of measurement associated with well operations, with predictive tools. It then organizes the information in a standardized way on single dashboard-like screens so that the rig crew and onshore engineers can monitor operations and make more intelligent decisions in real time.

The next major challenge is securing **access to resources**.

# Access to resources

Demand has driven the industry to operate at new frontiers, from the Arctic to deepwater to unconventionals. Each poses unique technical and practical challenges, such as temperature, depth, pressure, remoteness, ice, geological formation, and the local environment.

# Access to resources
## New oil and gas resources




This chart, based on BP analysis of O&G resource potential, indicates that technology could enable any reasonable forecast of global demand to be met at least through to 2050 at today's prices.

We estimate that ~1.6 Tboe of oil and gas has been produced to date, with a further 2.9 Tboe of recognised recoverable resources available today.

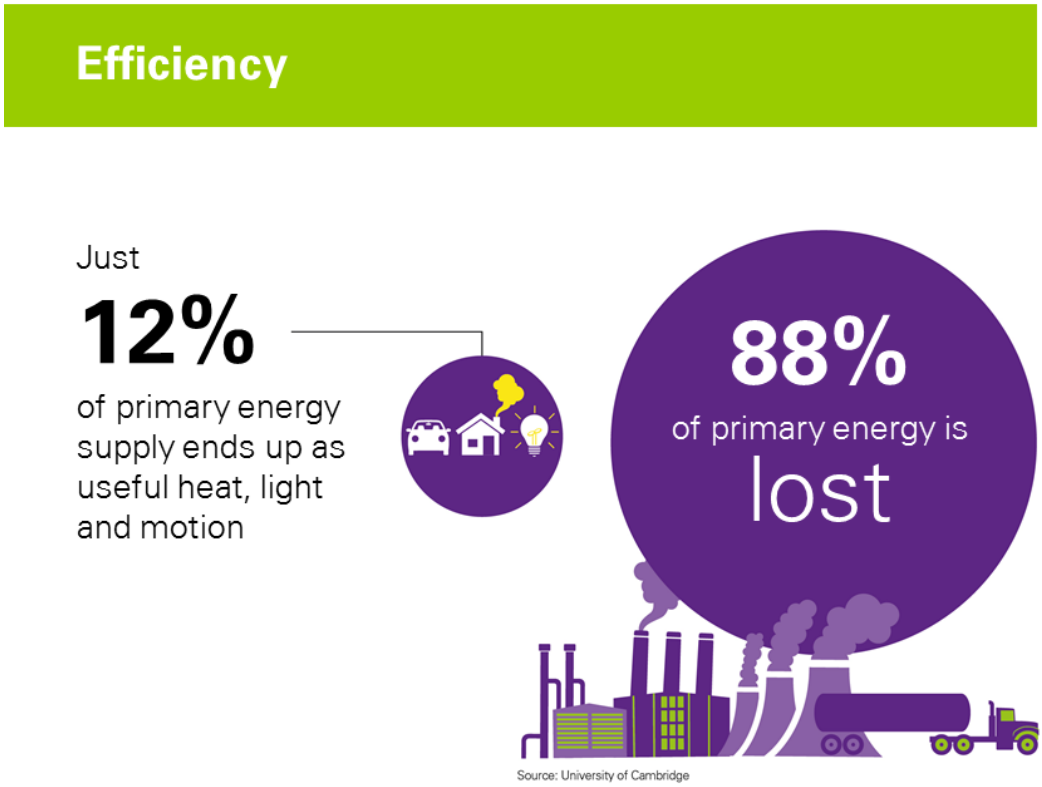
We believe that the application of best available technologies **today** can increase the remaining recoverable resource base by almost a factor of two.

On top of that, improvements in recovery factors, particularly in relation to unconventional gas and conventional oil, coupled with exploration, have the potential to add the same again.

We have probably reached a point globally when the potential for enhanced recovery from known hydrocarbon resources exceeds the potential from new discoveries (such as from arctic or ultra-deepwater).

Technology advances will not only sustain supply but are also likely to change the merit order of resources for development.

From an environmental point of view, this may sound more like a bad news, as opposed to a good news story. Continued high reliance on fossil fuels, and the consequent impact on carbon emissions, is very likely to contribute to climate change.




The third big and complex challenge for society and the industry is therefore increasing **energy efficiency**.

There are significant opportunities to improve the efficiency of the world's energy systems.

Research at Cambridge University indicates that around 12% of primary energy supply ends up in useful motion, heat and light.

The rest, 88%, is lost, largely as low grade heat, in the supply, conversion, distribution and consumption of energy. Not all of these losses can be captured, even theoretically, but they still present the single largest opportunity to reduce our energy footprint, together with demand side management.

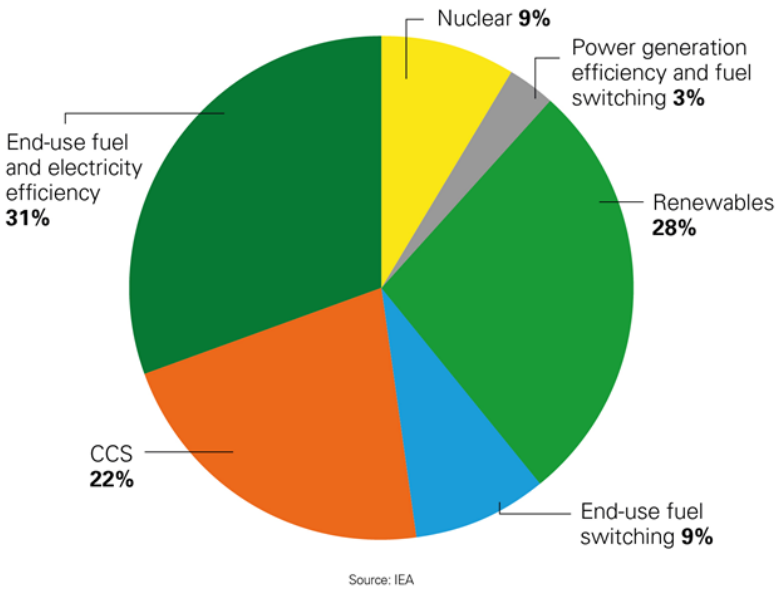
For our industry, which tends to produce undifferentiated commodity products, efficiency is a key source of competitive advantage. Matching that with a commitment to improve environmental performance can result in significant benefits all round. For example, BP and its partners in China are building the next generation of PTA plant at Zhuhai. Compared with

conventional PTA technologies, we expect the new plant to achieve 75% lower water discharge, 65% lower greenhouse gas emissions, and 95% lower solid waste.

The fourth challenge is **sustainability**, and in particular the transition to a low carbon economy.

## Sustainability

Technologies required to limit temperature rise to 2°C




The transition in the world's energy systems will occur slowly. The sector is characterized by a large installed asset base and infrastructure, built for the long term, and the timeline from new technology innovation to widespread adoption can usually be measured in decades. Occasionally disruptive technologies can make more rapid in-roads, particularly within regions, as we have seen with shale in the US. However note that this was not a new technology, it was a new application of an old technology (which BP heritage company, Amoco, invented in 1947). And it is 10 years since this new application began.

Renewable energy tends to be more expensive absent a price on carbon, because it is less concentrated than fossil fuels and often intermittent, hence requiring storage. Of course there are some notable exceptions - biofuels in Brazil, hydro in Norway, geothermal in Iceland, etc.

While renewables are the fastest growing source of energy, renewable sources are starting from a low base. Today, the world's renewables - wind, solar, biofuels, wave, tidal and geothermal power - account for just 2.4% of total consumption, excluding hydro - and BP's Energy Outlook suggests that by 2035 this proportion may have grown to 7%.

If we look at what the International Energy Agency suggests are the technologies required to hold the world's temperature rise to $2^0$ C by 2050, in addition to renewables, two stand out - first is the high proportion attributed to energy efficiency in the downstream. The second is the 22% ascribed to CCS. CCS is the only technology which can enable the continued wide-scale use of fossil fuels and limit atmospheric $CO_2$ emissions – but only if governments are prepared to fund multi-billion dollar demonstration projects; offer transitional support for early deployment to reduce costs; and society is ultimately prepared to pay a substantial price for carbon, in the region of say $100 a tonne $CO_2$ in the long term.

We therefore have to be realistic. Producing more low carbon energy is going to require new infrastructure, better technology and massive amounts of money, perhaps $1tr per annum on a global basis. And the big question remains 'who pays?'

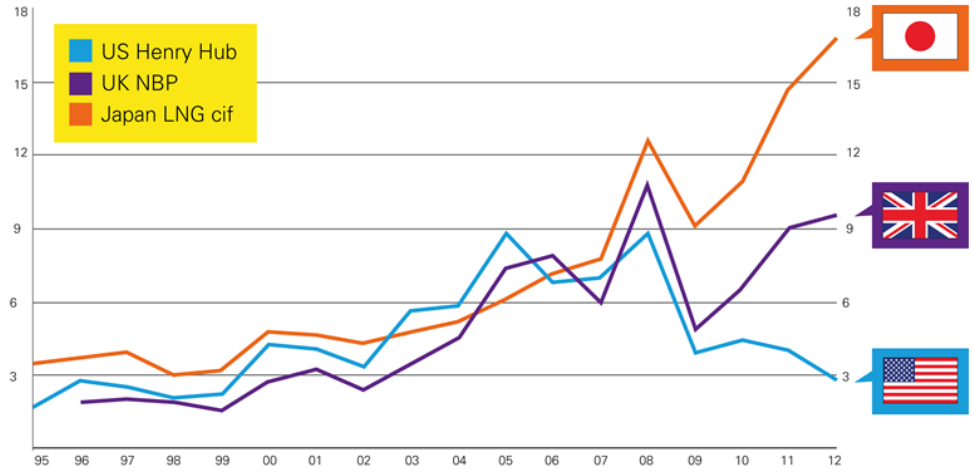
So the challenges are immense, and technology is one of the few levers available. Solutions will come both from within and outside our industry, for example in areas such as information, nano and bio-technologies.


4. *Regional differences:*

Finally, a few words on regional differences. Optimum solutions will vary significantly by region because many things differ both above and below ground.

Nations want supplies to be secure, affordable and sustainable - the so-called energy trilemma. Rarely do all of these circumstances exist anywhere.

# Regional differences
## Gas prices




Energy density also matters - oil is a globally traded commodity, whereas gas pricing is more regional, and electricity is priced by the second and location. You can see from the graphic the way in which gas prices have diverged in recent times, due to the US shale phenomenon. Even within the US, the disparity in gas prices can be huge, with local trading at over $100/mmbtu during the recent polar vortex.

Social pressures can make otherwise technically and economically rational technologies difficult to implement.

If any nation can solve the energy trilemma, then it is the USA given the huge scale of its natural resources, capital markets and innovation ecosystem.


# Conclusions

- Advances in technology can meet demand through to 2050
- Pace of learning will be a critical differentiator – faster for modular technologies
- Resource access and energy efficiency are achievable – sustainability a bigger challenge

5. *Concluding remarks*

*Even though the global potential of shales remains uncertain, the world is not running out of fossil fuels any time soon. It is very likely that advances in technology alone can enable rising demand to be supplied at least through to 2050, with enhanced oil recovery beginning to rival exploration in terms of ultimate potential.*

*However the pace of change differs between sub-sectors, and the pace of learning is an increasingly critical differentiator when aggregated over time. Faster experimentation is possible in more modular technologies, such as shale wells or solar PV modules.*

*Whereas the oil & gas industry can rise to the challenges of enhancing safety, unlocking new resources and increasing energy efficiency (particularly in consumption), the journey to a more sustainable energy system will not be as fast as some would like. This is partly because fossil fuels still have an extraordinary capacity to compete on the basis of price.*