Shifting trends in Upstream Technology

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Introduction

Good morning/afternoon ladies and gentleman.

As I stand here today, many happy memories come flooding back of the period from 1999 to 2001 that I was responsible for BP's gas business in Trinidad & Tobago – happy from both a business and personal perspective, raising a young family here at the same time as initiating the offshore developments for ALNG trains 2 & 3, and Atlas Methanol.

….So….it is a great pleasure to return to Trinidad & Tobago, as BP's head of technology.

The energy sector has played a vital role in Trinidad's economic development, and can be expected to do so for decades to come. But the current context is unusually challenging: with competition from shale developments in the US, the return of volatility to oil prices, concerns about climate change, and other geo-political tensions.

BP has played a major part in helping to build the world-class energy industry we see here today. Over some 50 years of local operations, we have become the country's largest hydrocarbon producer, accounting for about 55 per cent of the nation's oil and gas

production. Over that time, we have deployed new technologies, some developed by BP, that have increased hydrocarbon recovery and helped discover new resources.

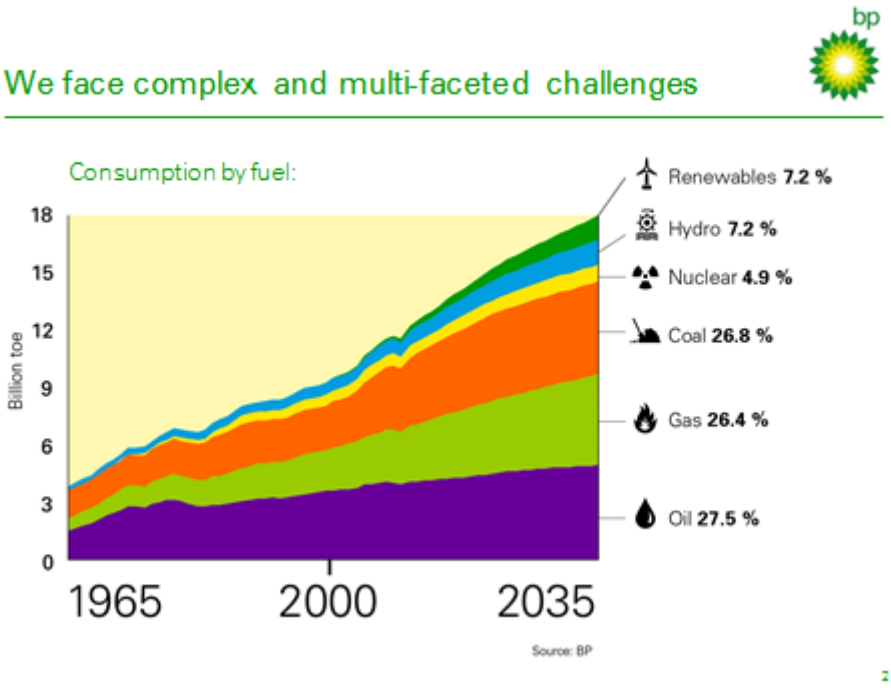
Over the next 15-20 minutes, I will first provide an overview of the global context for oil and gas affecting Trinidad and Tobago.

I will then consider the role that technology is playing in maximizing the efficiency of the industry here in the coming years, alongside improving safety and reliability.

This region has a number of specific challenges – such as subsurface and well complexity, ageing infrastructure, and decreasing pool sizes – and I will draw on a number of leading-edge technologies in the BP portfolio that we are deploying to overcome challenges in:

- Subsurface imaging
- Drilling and completions
- And ageing facilities

Industry context



Starting then with the global context: energy demand has grown by more than 50% over the past two decades, and growth in global population and rising living standards are continuing to drive demand.

By 2030, the global population is expected to be approximately 8.3 billion. That means about 1.3 billion more people in the world will need energy, in less than two decades from now. BP's 'Energy Outlook 2035' projects that global energy consumption will rise by 41% by 2035 - with 95% of that growth coming from rapidly growing emerging economies. Demand for gas, in particular, will rise quickly - at about twice the rate of demand for oil.

But the challenge is not only that more people want more energy. They want it to be affordable, secure and low-carbon.

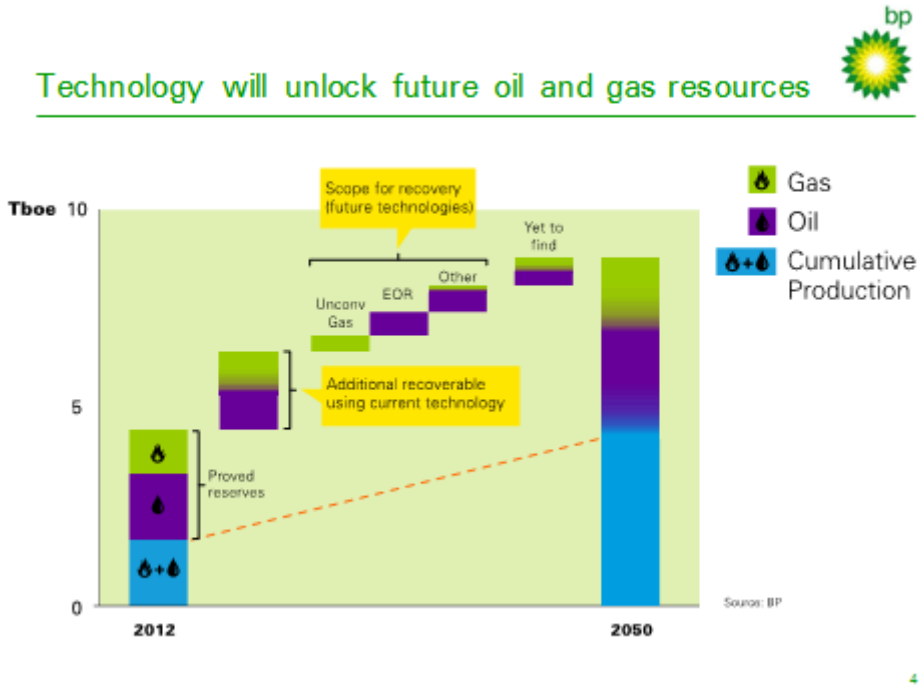
Addressing these complex and multi-faceted challenges is daunting. It is driving us to maximise the value of discovered resources - including those here in the Columbus basin. It is leading oil and gas companies worldwide to find and produce energy from increasingly difficult locations - deeper underground, at higher temperatures and pressures, and in sensitive new areas such as the Arctic or oil sands. It is spurring us to develop innovative technologies that can unlock renewable resources, as well as develop products and processes that are increasingly energy efficient. And of course, we need to do all this while continuing to enhance operational safely and reliability.

Technology has an important role to play in helping us address these challenges.

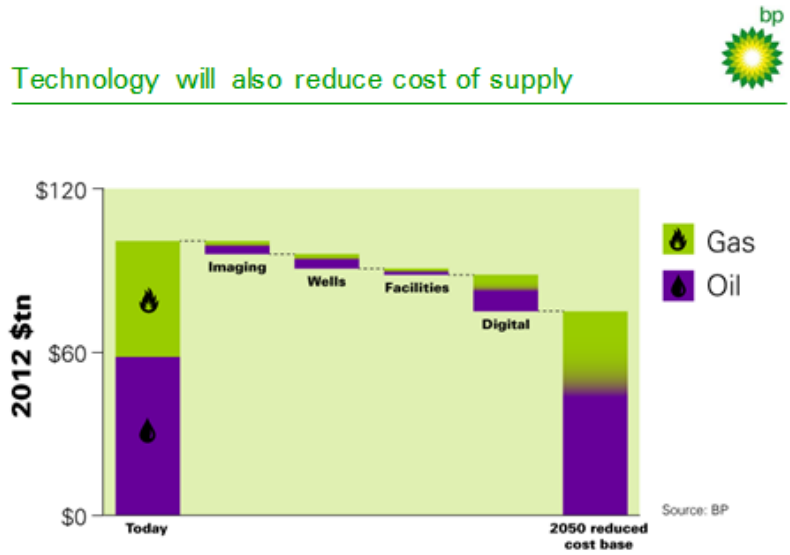
The long-term technology view

BP periodically analyses technology trends to identify opportunities and threats to its business. Our 'Long Term Technology View' (or LTTV) is an in-depth, industry-wide assessment of technology potential. Our latest view, in 2013, looked at the potential impact of technology on energy systems through to 2050 and focused on oil and gas resources. Summaries are available in paper form here at the conference, and also online.

The LTTV highlights how technology could affect the future availability of energy resources, how it will increase competition between resource classes and value chains, and how it will make energy consumption more efficient. It also highlights the importance of a number of cross-cutting themes, such as the ability to drive down the cost of modular technologies, and how natural regional differences play a major role in shaping technology choices



Our analysis shows that the world is not short of energy resources – there are abundant technically-accessible resources to meet global energy demand through to 2050, albeit at a range of costs. In terms of oil and gas, there are approximately 45 trillion barrels of originally in-place oil and gas equivalent discovered. This is mostly onshore, and 1.7 trillion boe have been produced to date. No major oil and gas technology breakthroughs are needed to meet projected medium term demand. Using the best available technologies today would significantly increase the world's recoverable reserves.



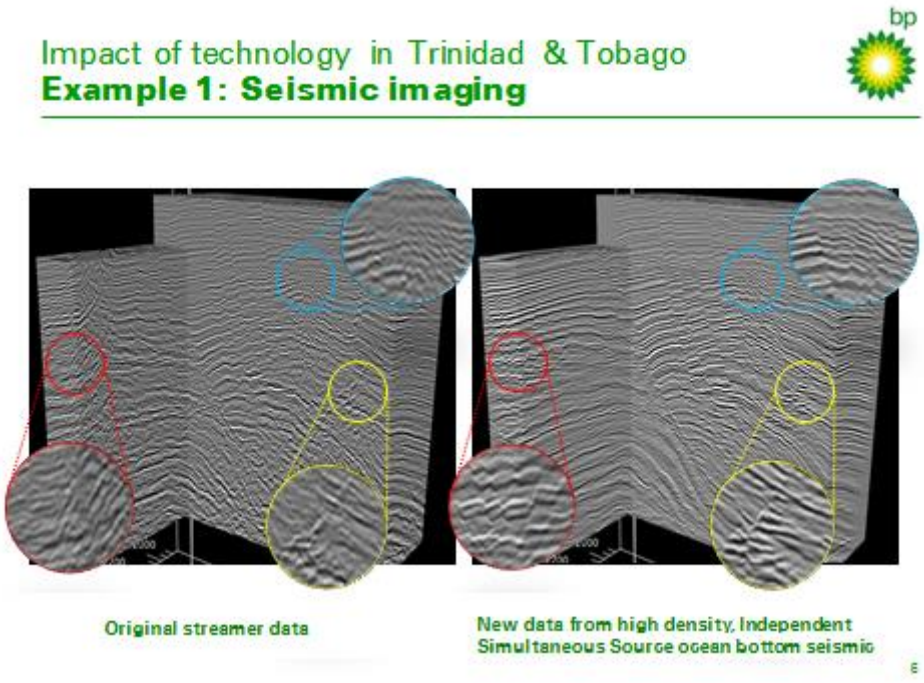
The key issue, therefore, is not really resource availability, but cost of supply. The LTTV estimates the potential cumulative contribution of subsurface imaging, drilling and completions, facilities and digital technologies in reducing today's cost of supply of oil and gas – this excludes any impacts of inflation, government restrictions or other 'above ground' factors. Of these digital technologies – by which we mean sensors, data analytics and advisory or automated systems, integrated into operating workflows – have perhaps the greatest potential to reduce the average cost of supply globally, whilst at the same time enhancing safety and reliability.

Future generations of these technologies can be expected to further enhance value.

How can technology help Trinidad and Tobago?

Let me illustrate the role technology has played, and is likely to continue playing, in maximising gas recovery from the Columbus basin, in those four main areas of imaging, drilling and completions, facilities and digital technologies.

BP is making use of experience gained from around the world in deploying technologies in all these areas here in Trinidad



BP is an industry leader in developing new seismic technologies and our Trinidad business has been one of our earliest adopters. Over the period 2011 to 2014, BP conducted the first commercial scale High Definition Ocean Bottom Seismic campaign – covering a total area of 1,000 km^2 and using five survey vessels – using BP's proprietary *Independent Simultaneous Source*® technology.

These tools improve our ability to capture higher quality images of the subsurface, and enable much faster data acquisition. This capability is of real value in the Columbus basin, which is characterised by multiple stacked gas-saturated sands which can distort sound waves.

The seismic survey carried out in Trinidad covered all bpTT's major gas fields and prospective acreage in the southern trend of the Columbus basin. Its aim was to sustain production at 400mboed.

By using ISS, the seismic survey could be completed far more quickly than conventionally acquired ocean bottom cable data. It also delivered improved frequency content, fault delineation, steep dip bed imaging and deeper signal penetration than vintage streamer seismic operations. Interpretation of the dataset delivered has not only added resources to existing fields but also helped to improve our understanding of new fields like Angelin.

This type of seismic data acquisition is specialised and expensive to secure, so we established a partnership with BP colleagues in the North Sea which enabled the crew to shuttle between TT in the winter and the North Sea in the summer - increasing production efficiency and delivering significant cost savings.

More recently, bpTT conducted BP's first offshore in-well seismic pilot, using fibre optics and acoustic sensing. This technology has the potential to offer 4D seismic images, generating snapshots of the reservoirs over time. 4D seismic facilitates more efficient reservoir management.

On the processing side, Trinidad has again been an early adopter of BP technologies, with huge steps forward in image resolution made from the use of Full Waveform Inversion and Compression Wave Processing, thereby revealing more detailed geological features.

As we look to the future, there are of course opportunities for further exploration in T&T. In addition we can expect to see greater use of new sources, 4D seismic imaging coupled with in-well fibre-optics, and the use of integration engines across a wider array of subsurface data, all enabled by ever-increasing computing power. This will yield better static and dynamic descriptions of complex reservoirs, such as those here, and hence better operational management of them, in areas such as drilling and completions, which is my next theme.

The productivity of wells in the Columbus basin is prolific, but as the basin matures, production will become increasingly hampered by the weakness of these unconsolidated sands, and the need to drill through depleted zones – hence the growing use of advanced sand control completions, supported by downhole sand management measurement and modelling. Water breakthrough generally increases sand production, requiring remediation to avoid production losses. BP software developed called ISIS (Integrated Surveillance Information System), deployed in bpTT, already provides alerts relating to well conditions, fluid rates and phases, reservoir pressures and sand monitoring. But there is more to be done.

We are planning this year to trial a new chemical sand consolidation technology in Trinidad, which will be the first in the basin. We have applied this technology with success in other sand-prone regions and believe it could deliver lower cost, lower risk interventions that will keep wells online for longer.

Historical analysis of industry drilling and completions performance indicates a very significant gap between today's results and the technical limit – in areas such as non-productive time and well failures; and hence production deferrals. This is particularly the case in sand prone reservoirs. Many of these losses are tractable through better use of real time data, although the technology for obtaining and analysing these data is still in its infancy – a theme I will return to later.

Success in this area would reduce effective reservoir development costs, and hence have the added benefit of unlocking more marginal pool sizes.

Our experience in operating fields in maturing basins like the North Sea and Alaska demonstrates the important role technology plays in protecting the value of investments and adding new reserves.

Subsea tieback technology plays a critical role in the North Sea, harvesting its resources by aggregating smaller pools to make developments economic - as in our recent Kinnoull field, tied into the re-developed Andrew platform. However, subsea systems are less accessible which makes integrity management more challenging, particularly in deep water, and the cost of intervention is higher and more time-consuming. This will no doubt remain an area of ongoing technology development.

In Alaska, technologies which support asset integrity are vital to protect and extend the life of our facilities: we use digital technologies, like pipeline inspection and corrosion monitoring, and deploy new types of production chemistry to inhibit corrosive species. For example, Permasense® technology,[i] developed by Imperial College in collaboration with BP, has already been deployed in Trinidad. It is a new wireless-enabled system that offers corrosion engineers, inspectors, planners and plant managers real time measurement of the wall thicknesses of critical oil and gas equipment - such as pipelines and risers – and hence the ability to intervene before integrity is threatened.

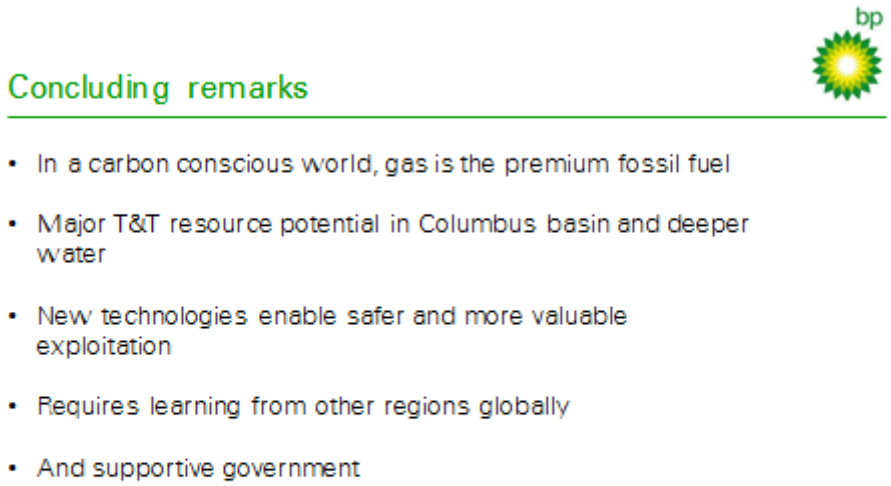
BP's technologies and expertise in managing maturing basins are already being transferred to Trinidad & Tobago. These capabilities will be of increasing value as we move into deepwater.

Most among you will already have noted that digital technologies are a recurrent theme in my talk, which I'd like to draw out now. Our industry has not been in the vanguard of these developments – whereas 90% operating efficiency would be a major step forward in some of BP's Upstream regions, that would not be the case in for example the automotive or aerospace sectors! Sure we need to contend with harsh and unpredictable environments, but the same principles apply, and the opportunity is large, in the billions of dollars per annum for a company of BP's scale. It is frankly quite difficult to imagine what will be possible in the 2020s with for example access to Exaflop computer power at an affordable cost.

BP has arguably set the pace in developing the 'digital oilfield' through our *Field of the Future*® technology programme, which began almost 15 years ago. At the programme's outset, digital was shorthand for connectivity and collaboration. We invested heavily in fibre communications technology and established Advanced Collaborative Environments, monitoring centres based onshore, which enable our experts to see relevant information from platforms in real time and talk to operators offshore, no matter what the conditions. We also invested in the software and hardware needed to monitor operational integrity and carry out reservoir surveillance.

Over the past five years, the digital oilfield has become a reality. Sensors are now all-pervasive. In our operations in bpTT, we have sensors downhole, in our facilities and across our topsides, although we have yet to realise the full value inherent in the data we are obtaining. One of our more recent developments is the Casing Running Console, as part of our Well Advisor portfolio of tools, deployed here in 2013. It uses sensors on the drill string to detect friction as the well is completed, and has been 100% successful globally in avoiding stuck pipe in more than 300 runs of 640km of tubulars, monitored live to date. The estimated saving to date is $200 million through reduced non-productive time.

Given the size of the prize, we have now established a digital centre of expertise in BP's Upstream Technology, with deep capability in systems integration, data analytics and automation, to deliver step-change improvements in safety, cost, operational efficiency and resource recovery.



In conclusion:

BP is privileged to have been a major actor in the development of Trinidad & Tobago's oil and gas industry, contributing broadly to the nation's socio-economic development.

The Columbus basin is maturing, which is introducing new challenges, some of which we have already experienced elsewhere. Beyond this, the deepwater in Trinidad & Tobago holds exciting promise.

Technologies developed and transferred here have enhanced the safety and reliability of today's operations, and added reserves. The ability to leverage global technology developments can be expected to contribute to safer and more valuable exploitation of the nation's remaining resources – particularly in the areas of seismic imaging, sand completions, facilities integrity management, and the broader application of digital technologies. We aim to continue bringing our global experience and expertise to bear here, in these areas.

In a carbon conscious world, natural gas is the premium fossil fuel. This puts T&T in a good position, as a producer in a world where gas is the strongest growing fossil fuel. Continued investment in technology, in the context of a long-term plan for the energy sector, will help to sustain T&T's strong position for many years ahead.

Thank you.