WOC 1.1 :
Technology – Driving Global Gas Growth
(Setting the context)

By:

Strategic Research

Corporate Strategic Planning

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PART 1

RISING ENERGY DEMAND NEEDS TIMELY INNOVATION

Rising population will result in increasing demand for energy particularly in Non-OECD countries …

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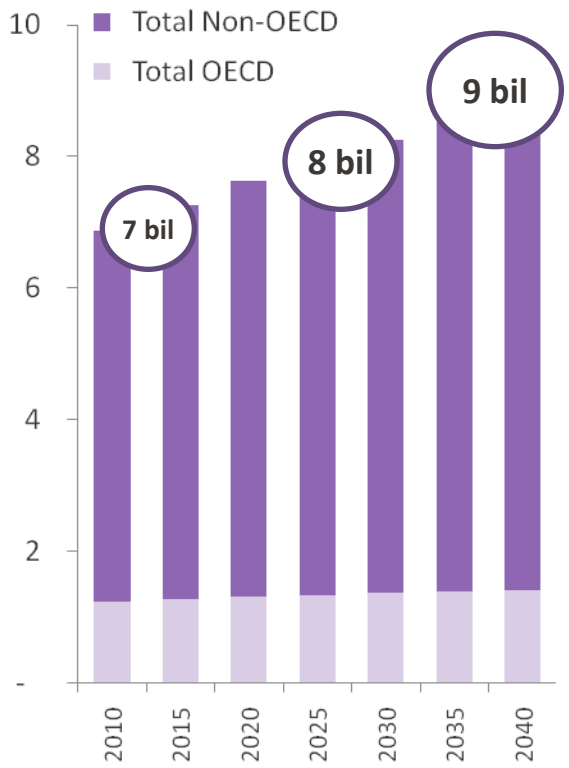
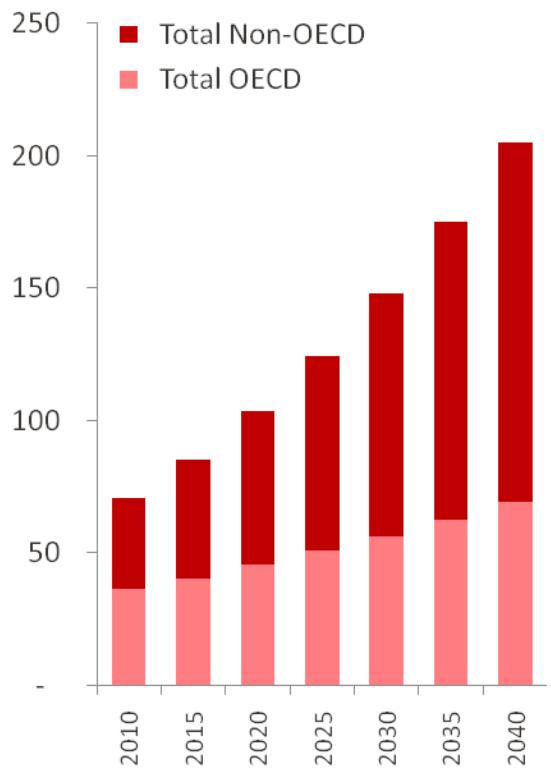
Population (billion)



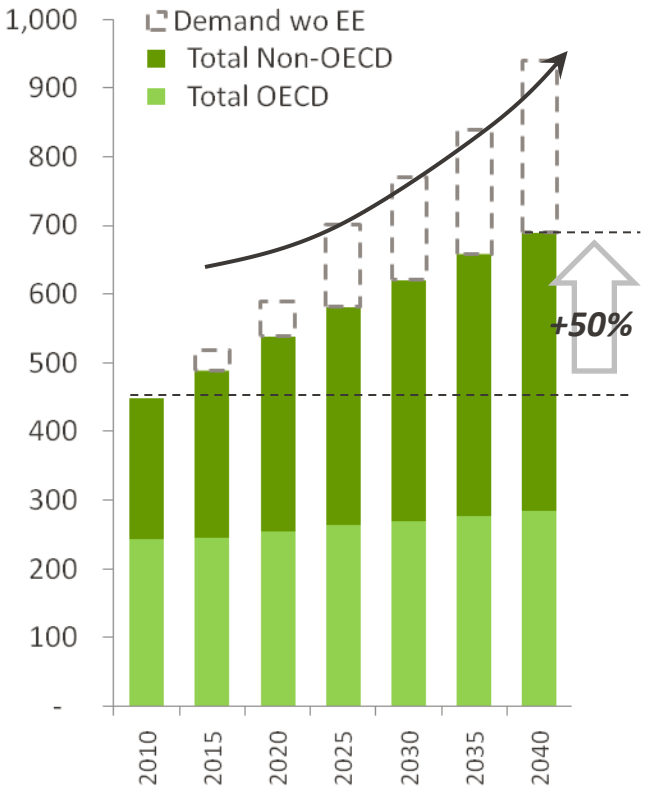
- By 2030, the world population reaches 8bil, and will swell further to 9bil by 2040

GDP (Trillion 2011$)



- Emerging economies with burgeoning **middle class** will drive global growth

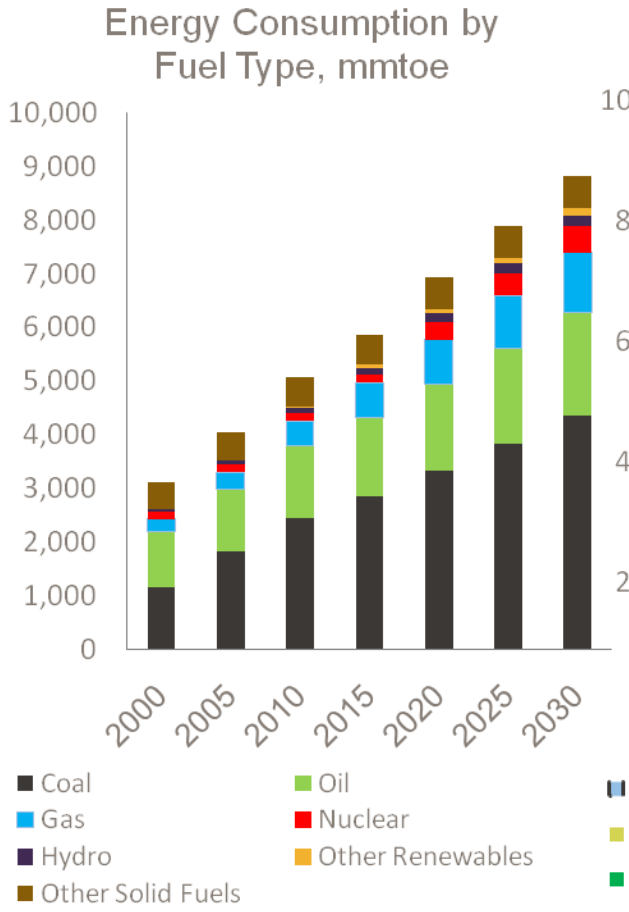
Energy (QBTU)

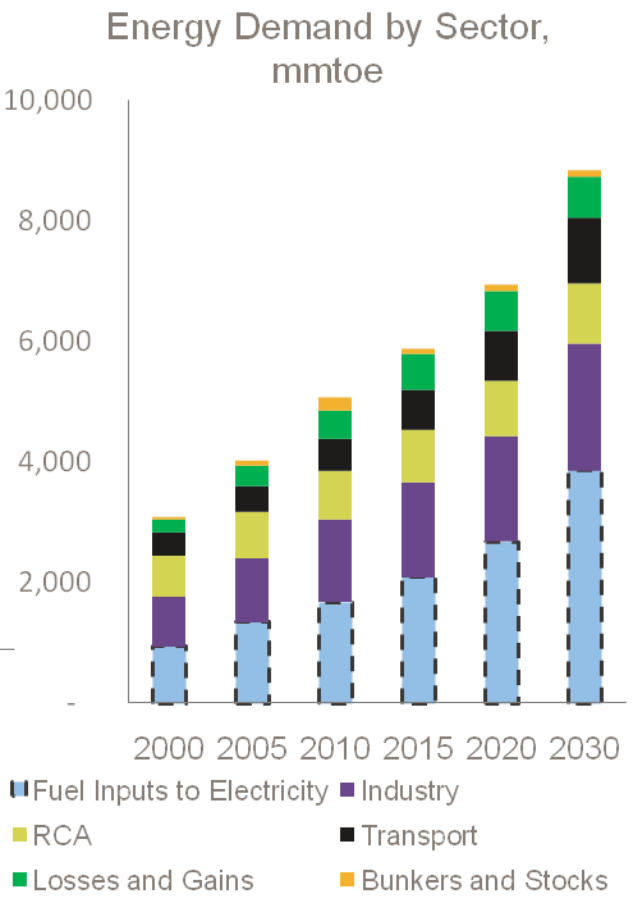


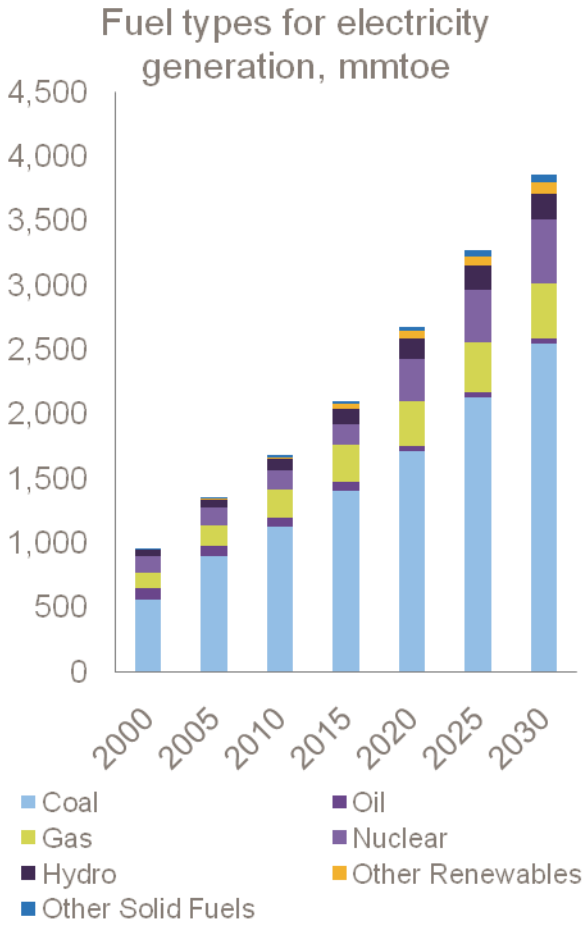
- With gains in efficiency +50% more energy will be needed

Source: PETRONAS Analysis, IEO 2013

… and fossil fuels will remain dominant, accounting for some 80% of the energy mix







- 80% energy source comes from fossil fuel. Gas will be the fastest growing at 2.3%
- Energy is largely used for electricity generation
- Coal and gas take up around ~65% and 12% respectively for electricity generation mix

Source: PETRONAS Analysis, Wood Mackenzie

Advancement and breakthroughs in technology will unlock and deliver various sources of energy to global markets in safe, reliable and sustainable manner …

- Technology **opens up access** to and **expand new sources of energy supply**
- Energy technology evolution and revolution hastened adoption of **sustainability driven** business model

Energy Security

- Resource depletion makes it imperative to explore for **new sources** in **new areas** such as **unconventionals** or exploring **new frontiers**

Energy Affordability

- Technology advancement facilitates in **bringing down cost and enhance project economics**

Climate change mitigation

- Technology will remain a key enabler to **mitigate future rise in emissions**

Source: PETRONAS World in 2030 & Megatrends

…. however, governments globally need to seriously tackle rising emissions that come from fossil fuels

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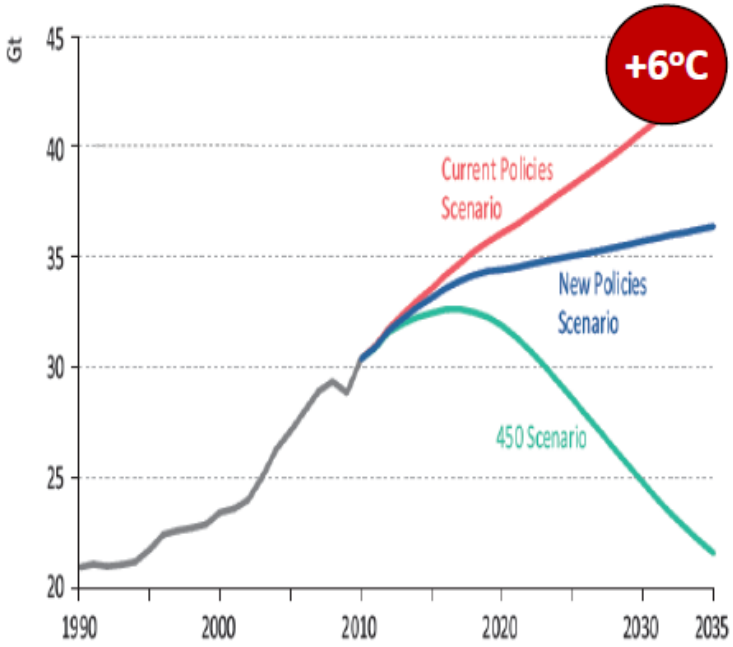
World CO_2 equivalent emissions by scenario



Implications of different policy scenarios

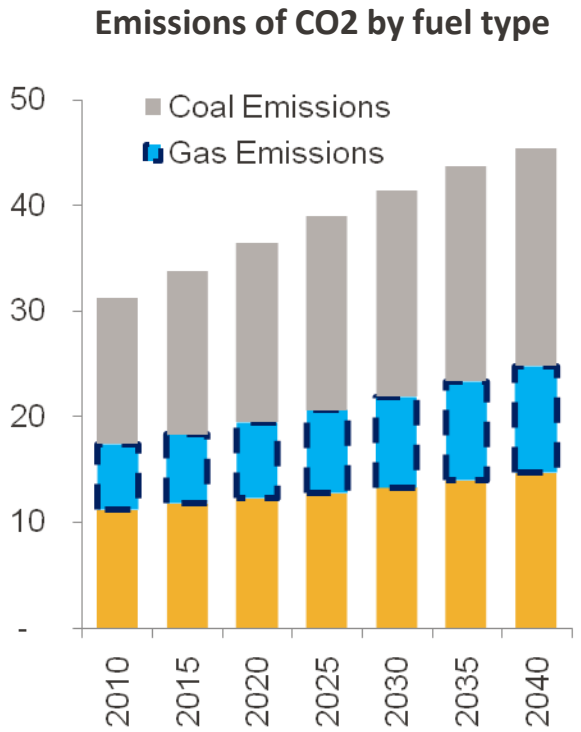
Scenarios	Temperature increase / *Atmospheric CO_2e concentration* *	Effects
Current Policy Scenario	~ 6°C	Sea level increase by **3 metres**, more floods faced by **millions**, **vast** number of human diseases, **40%** risk of species extinction, water & food scarcity
	1000 ppm	
New Policy Scenario	~3.5°C	Sea level increase of **2 metres**, increasing floods faced by **almost a million people**, **substantial** increase of human diseases, **35%** risk of species extinction, water & food scarcity
	650 ppm	
450 Scenario	2°C	Sea level increase of **1 metre**, increasing floods faced by **a few hundred thousands** of people, some risk of human diseases, **30%** risk of species extinction
	450 ppm	

*in 2035

- Evolution in technology will continue to play the central role in curbing CO2 emissions. Technology is expected to lead to innovation that are more energy efficient creation, or harness the alternative uses in CO2.

Source: WEO, PETRONAS Analysis

Gas is fast becoming a fuel of choice due to environmental and safety concerns



- Would protests and government policy (triggered by safety concerns) result in nuclear becoming the "fuel of last resort" for climate change?

- Gas and renewables are complementary resources for power generation

- Natural Gas is the cleanest among hydrocarbon fuels, averaging around 20% of total hydrocarbon fuel emissions worldwide

Source: PETRONAS Analysis

PART 2

GLOBAL GAS MARKET OUTLOOK

Global Gas Demand will be fastest growing in non-OECD market, however the largest market will still be the OECD – both driven by power and industrial sectors

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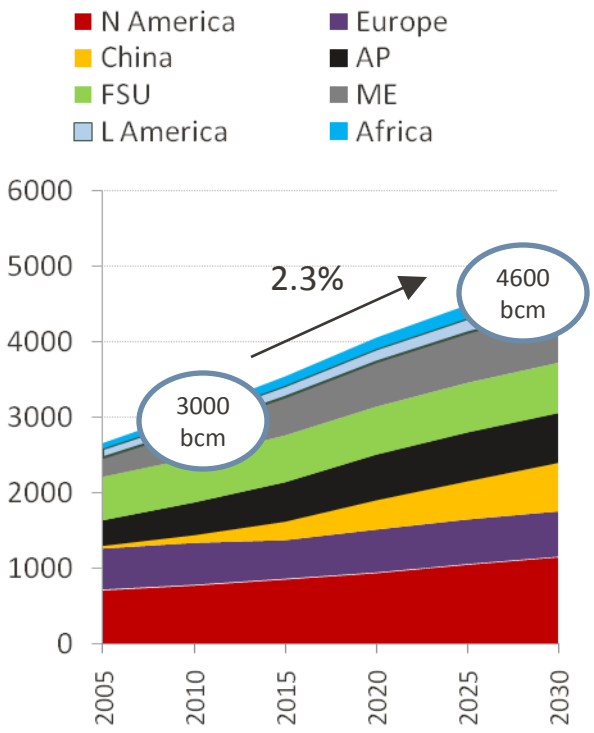
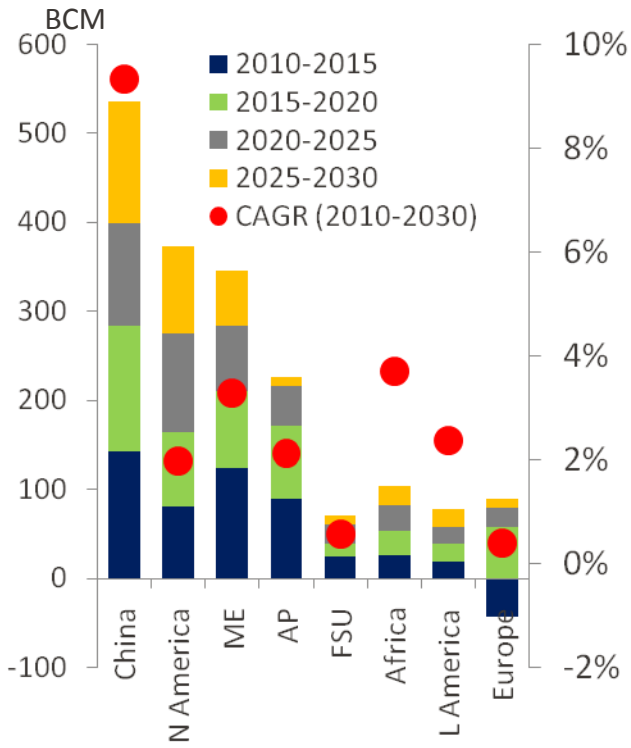
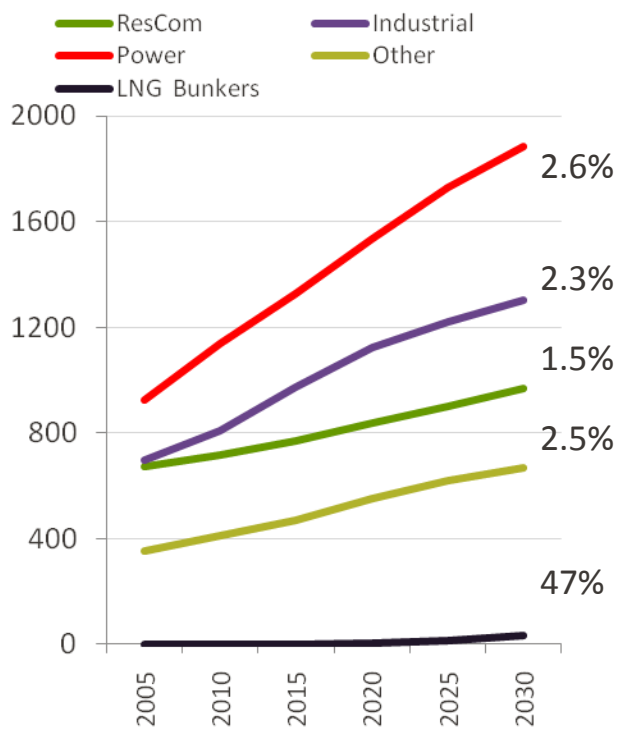
Global gas demand



Incremental gas demand



Sectoral gas demand



- Non OECD gas demand grows faster than the OECD. Non OECD market will account for ¾ of the growth
- Bulk of the growth will come from power and industrial sectors, whereby both sectors accounts for 40% of the growth
- Gas replaces coal in the OECD power generation and industry, which non OECD demand is strong enough to accommodate growth of gas and coal in both sectors

Source: PETRONAS Analysis, Wood Mackenzie,

LNG trade is growing in importance evidenced by its increase penetration in LNG trade – and will continue to be dominated by Asia Pacific market

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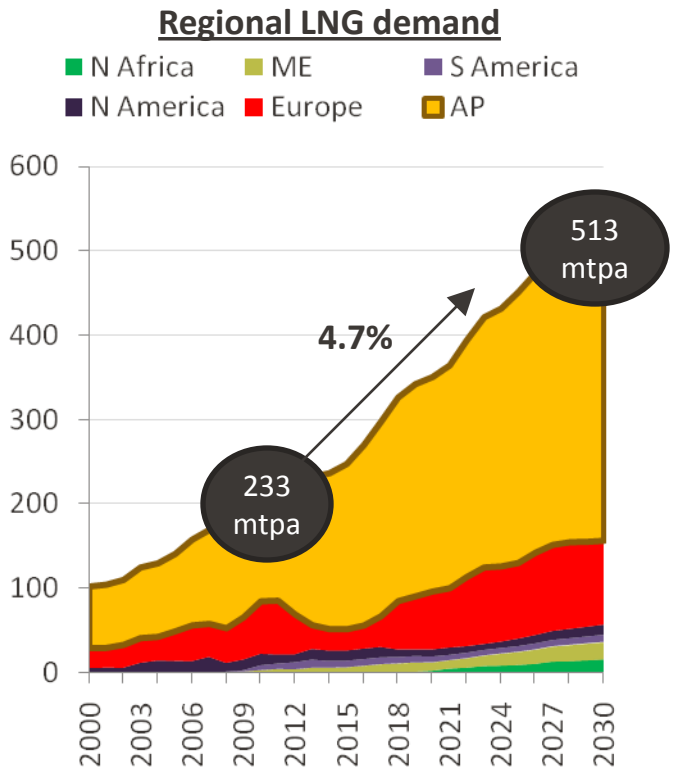
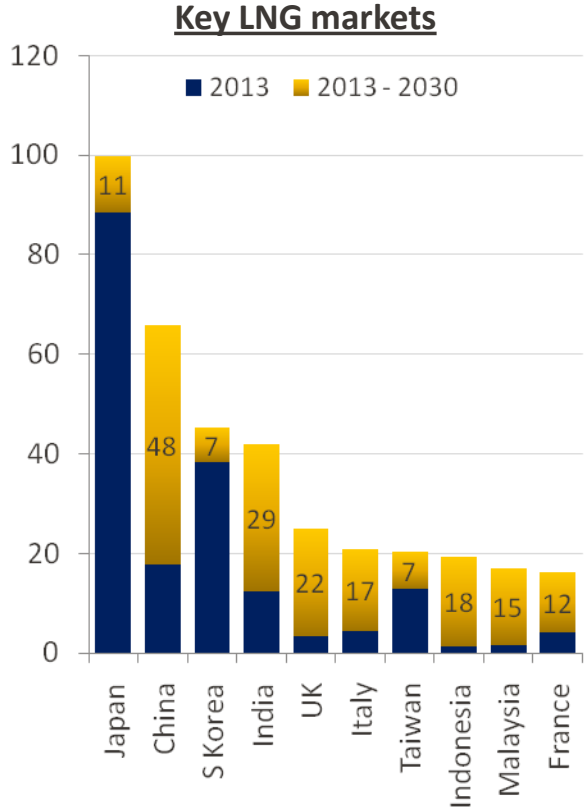
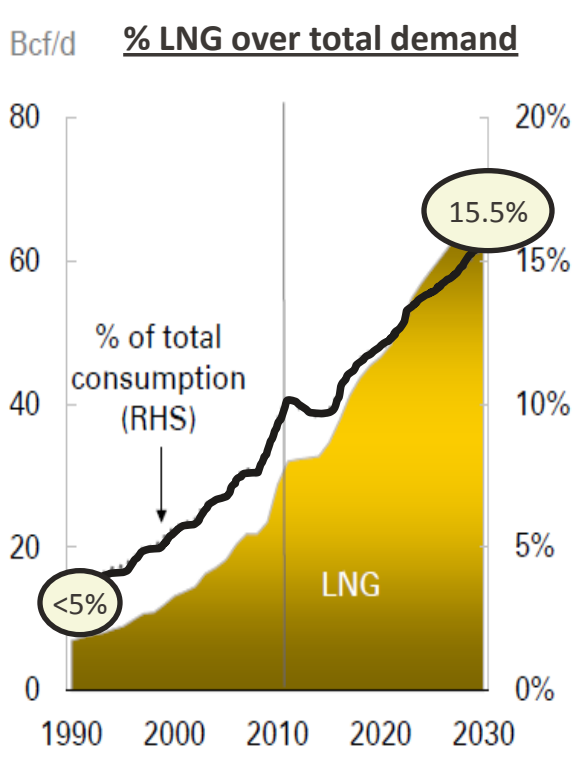






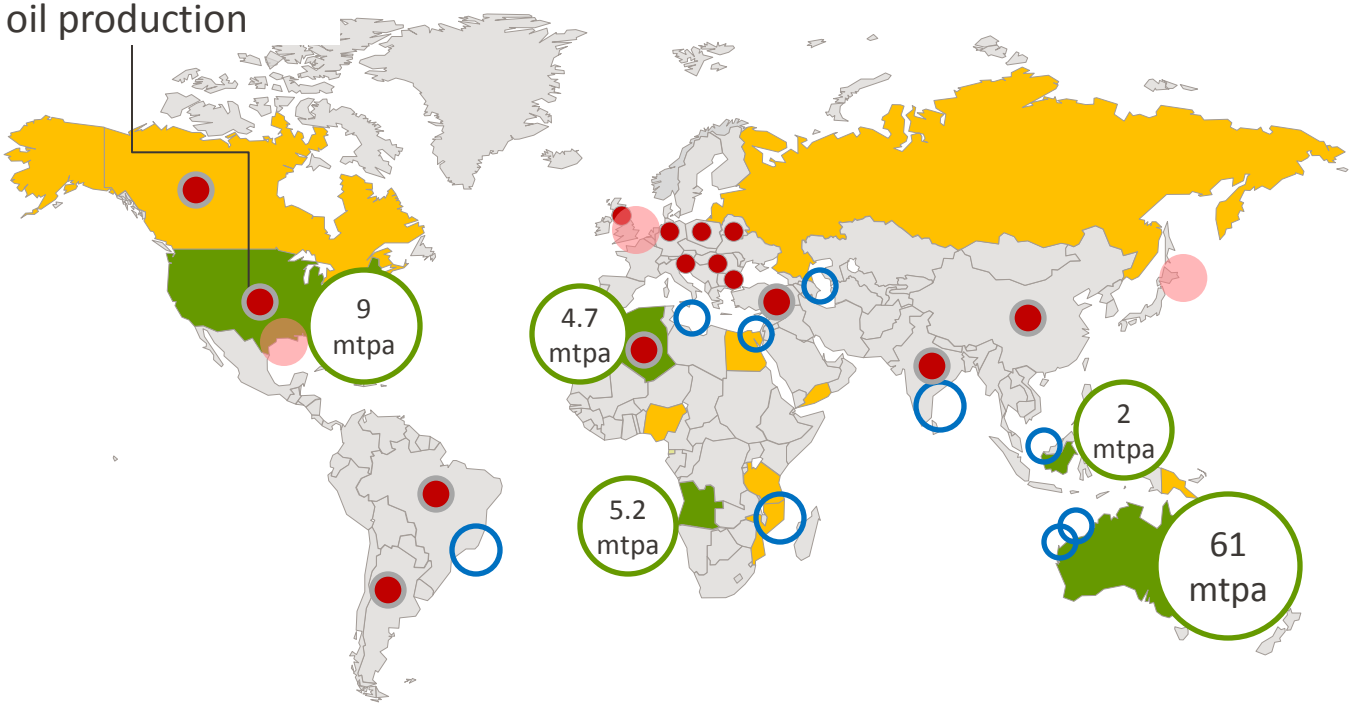
- LNG trade is growing 2x faster than gas consumption. LNG trade will see its share in total gas consumption arising to 15.5% by 2030
- Asia Pacific continue dominate. Largest LNG demand growth will be from China. However Japan will continue to be the largest market
- Resource rich regions such Middle East and Africa will also be importing LNG

Source: PETRONAS Analysis, Wood Mackenzie, BP energy outlook

There are ample gas discoveries and gas projects that will satisfy energy /gas demand

- Increasing shale gas production
- Associated gas from tight oil production

15 # of shale gas producing countries by 2020



Up to **82%** Gas discoveries in deepwater

91 mtpa LNG capacity under construction

208 mtpa Planned LNG capacity

Source: PETRONAS

Investments will be influenced by levels of oil and gas prices for sustainability of the projects

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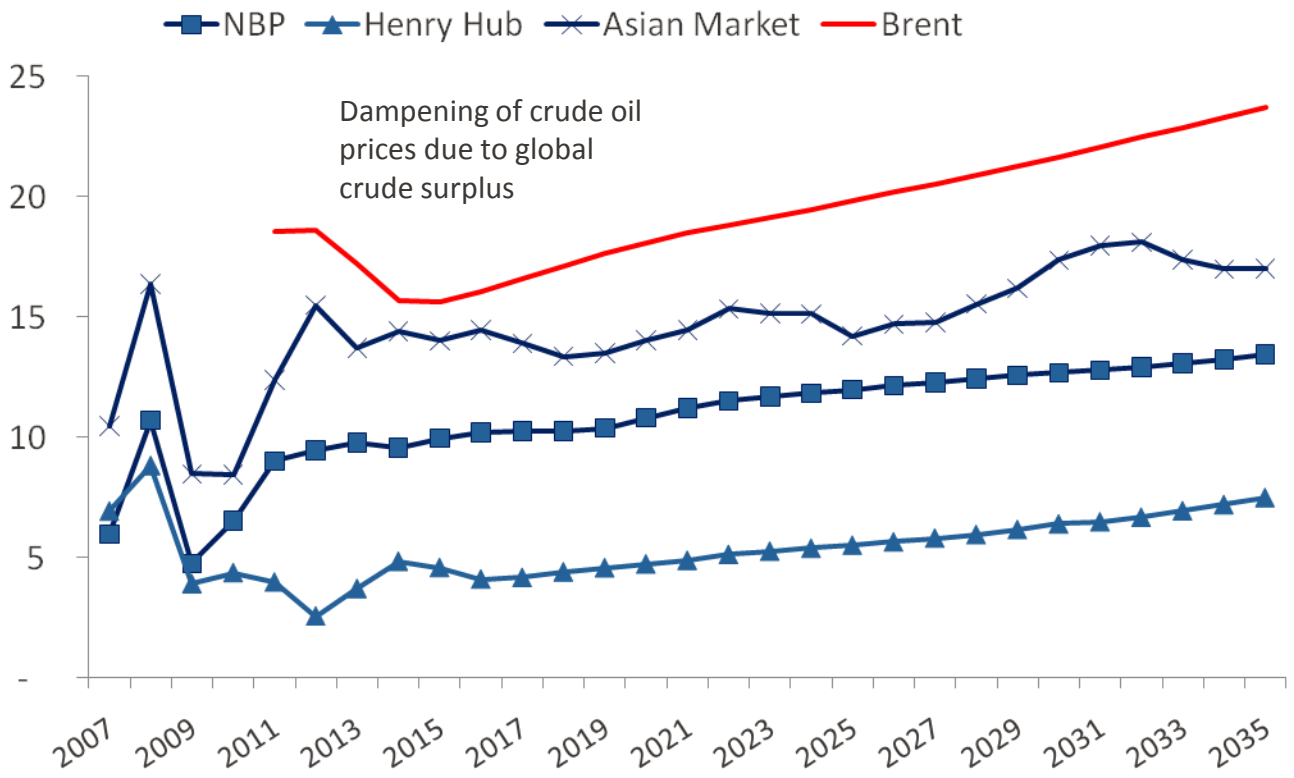
Natural Gas & Oil prices

US$/mmbtu



- Elevated oil prices will encourage development of capital intensive projects

- Regionalised gas prices
- Shale boom in the US has resulted in the abundance of gas supply that has led to sharp decline of Henry Hub price

Source: PETRONAS Analysis, IHS

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PART 3

ROLE OF TECHNOLOGY IN E&P AND GAS VALUE CHAIN

Technology has given the industry a new lease of life for resources with reserves life exceeding 200 years – the "Peak Oil (&Gas)" theory is no longer valid

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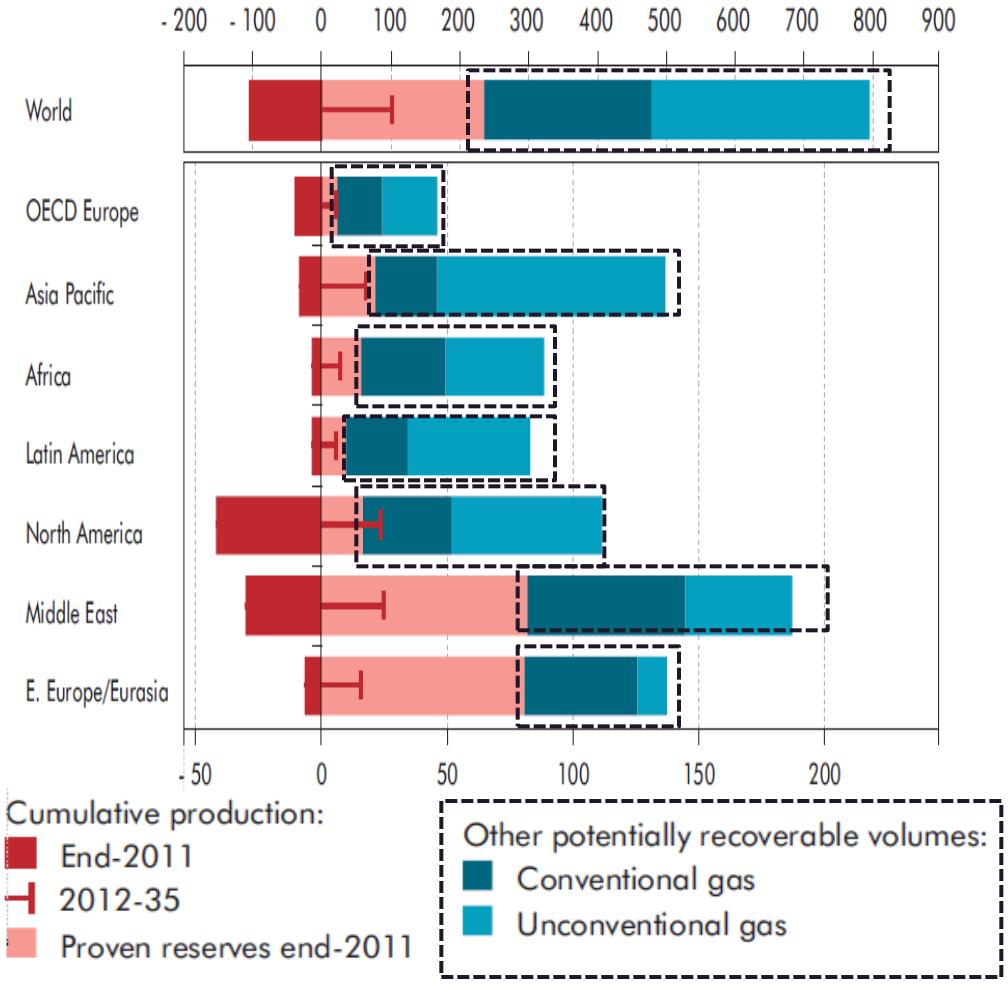
Ultimately recoverable resources of gas by region (tcm)



- **Disparities** in resource location reflects the differences in proximity of reserves to markets and investment requirements.
- **Increasing reserves** in recent years through appraisal and development, in addition to large gas discoveries
- **Unconventional gas** is becoming more **significant** component of gas supply

	Proved	Recoverable
Gas reserves live	56 years	240 years

Source: PETRONAS Analysis, IEA

Meeting the supply challenge will require a shift up the technology curve

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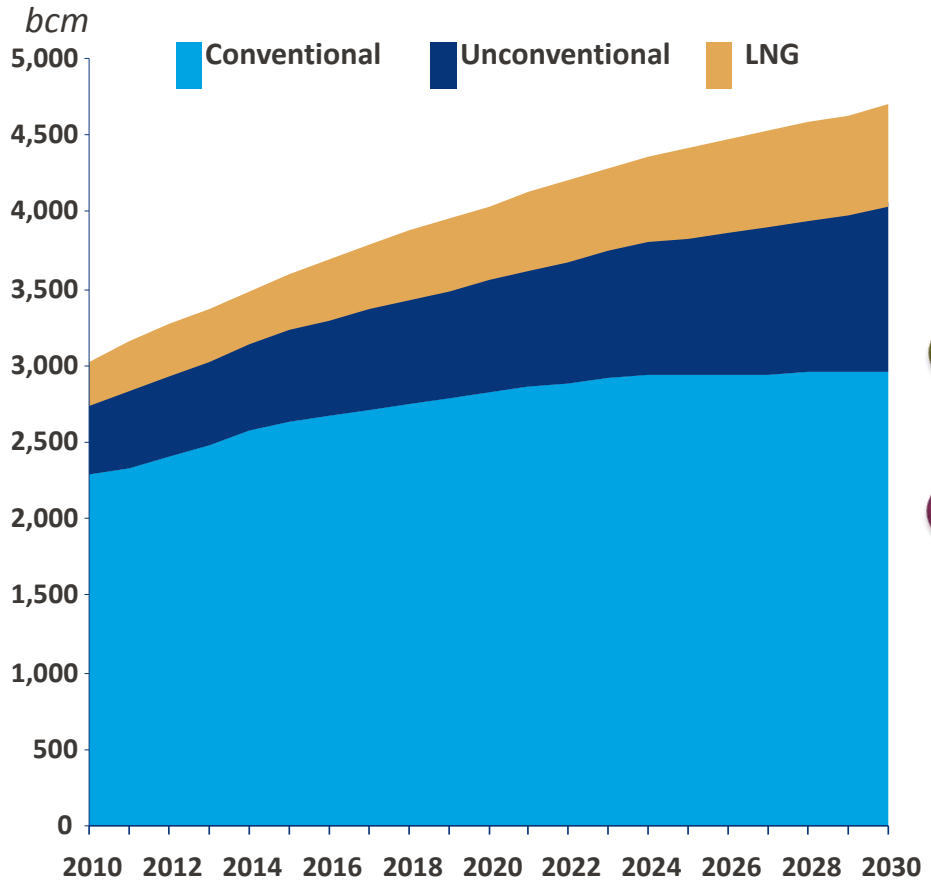
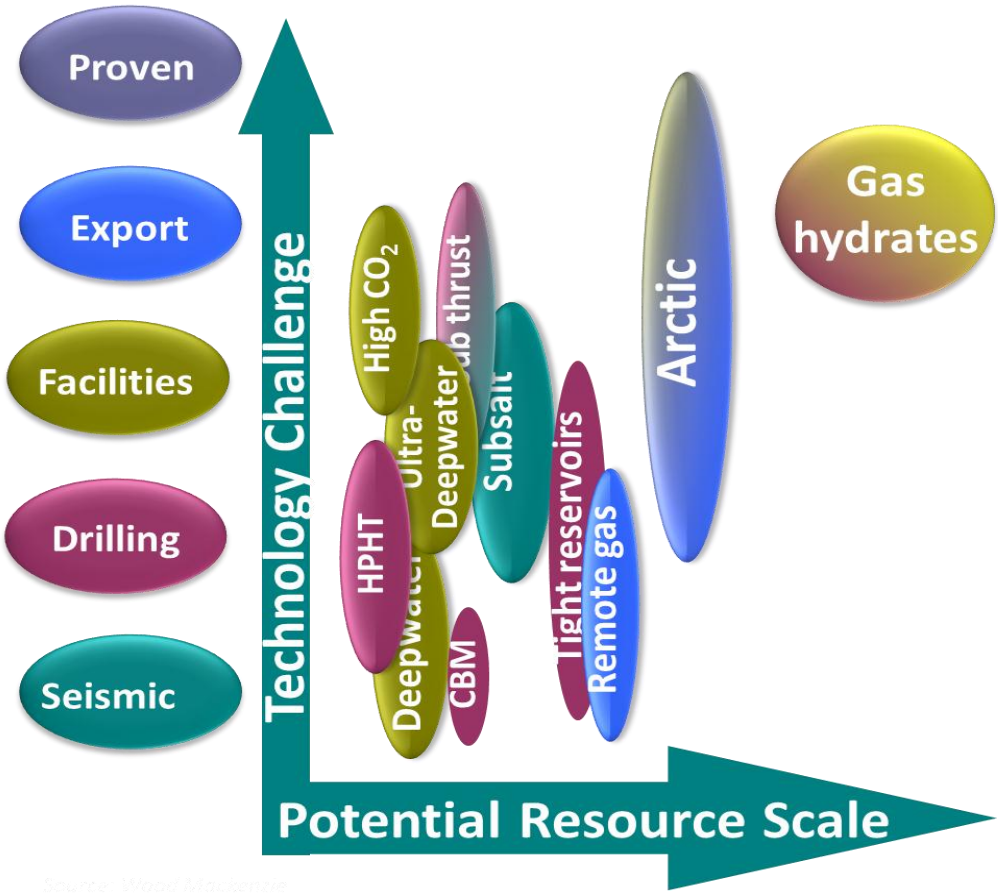
Global gas supply and demand 2010-2030

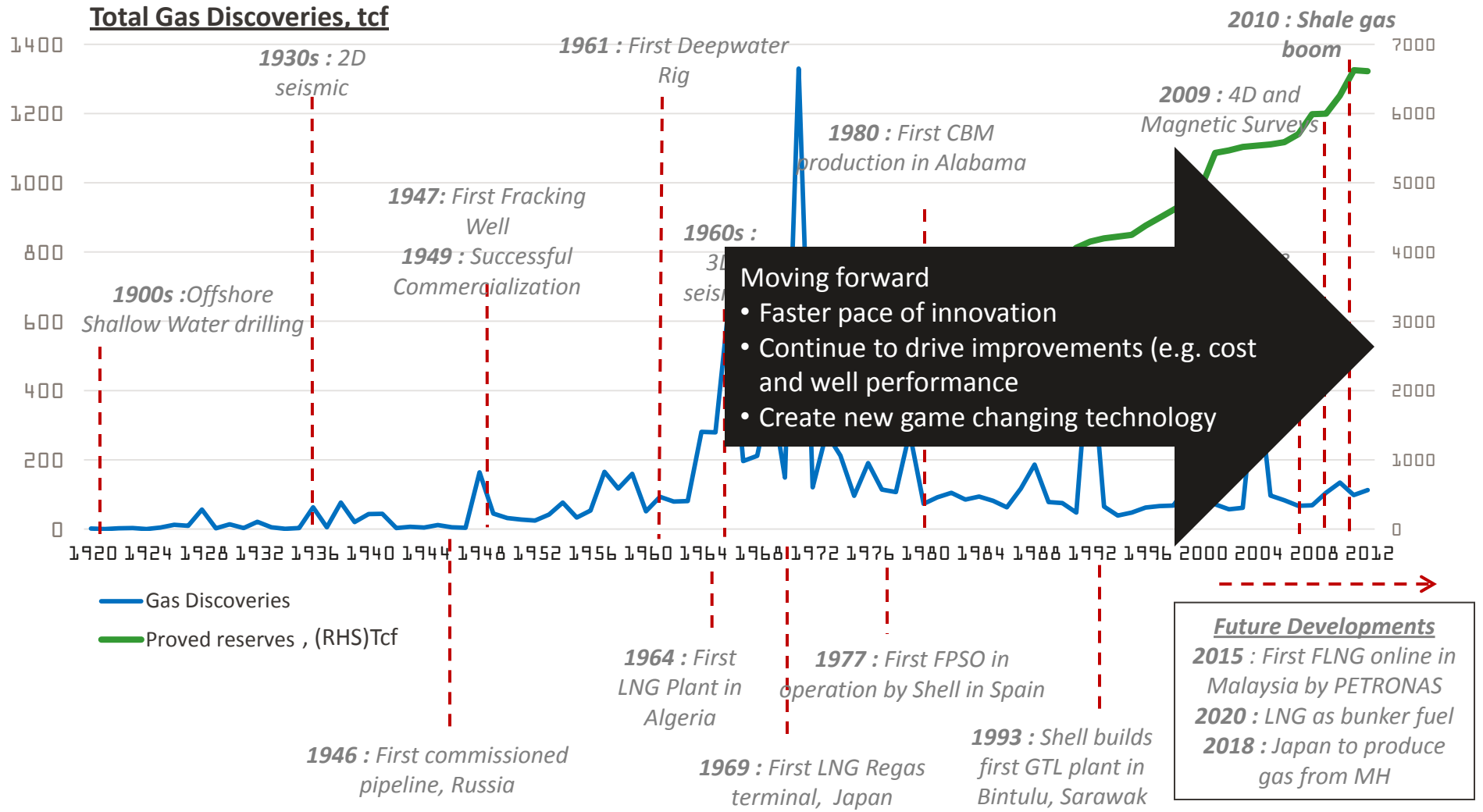


Technological challenges and play types



Source: Wood Mackenzie

Technology, increasing global demand and elevated oil prices have lead to the push for gas extraction technologies for better gas recoveries



Source: PETRONAS Analysis, IHS Energy, Signposts

Oil and Gas majors invest significantly in R&D to explore for new types of hydrocarbon resources and enhancement of oil and gas recovery

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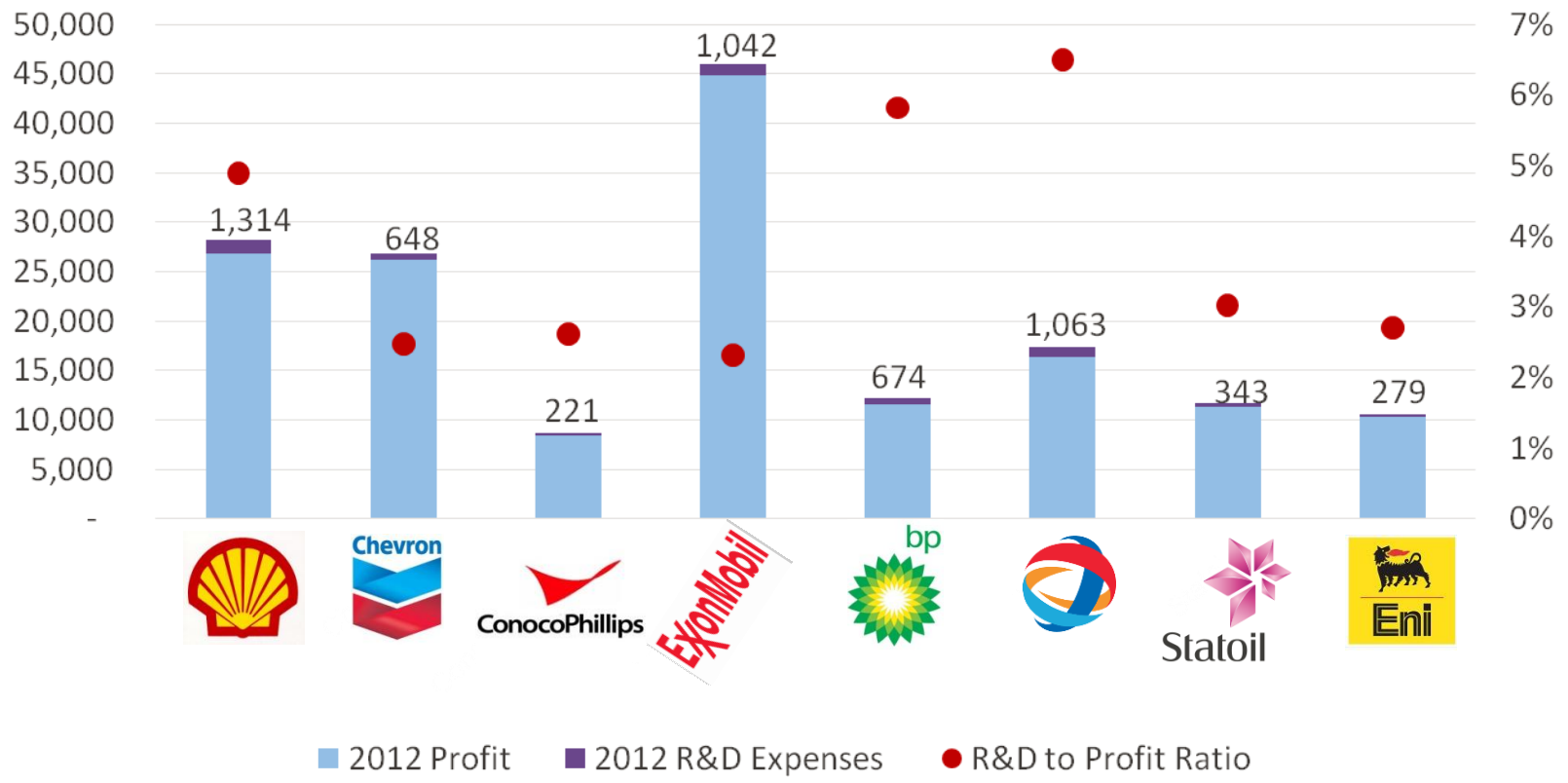
IOCs have the edge

US$Million / %



Source: PETRONAS Analysis, Company Annual Reports

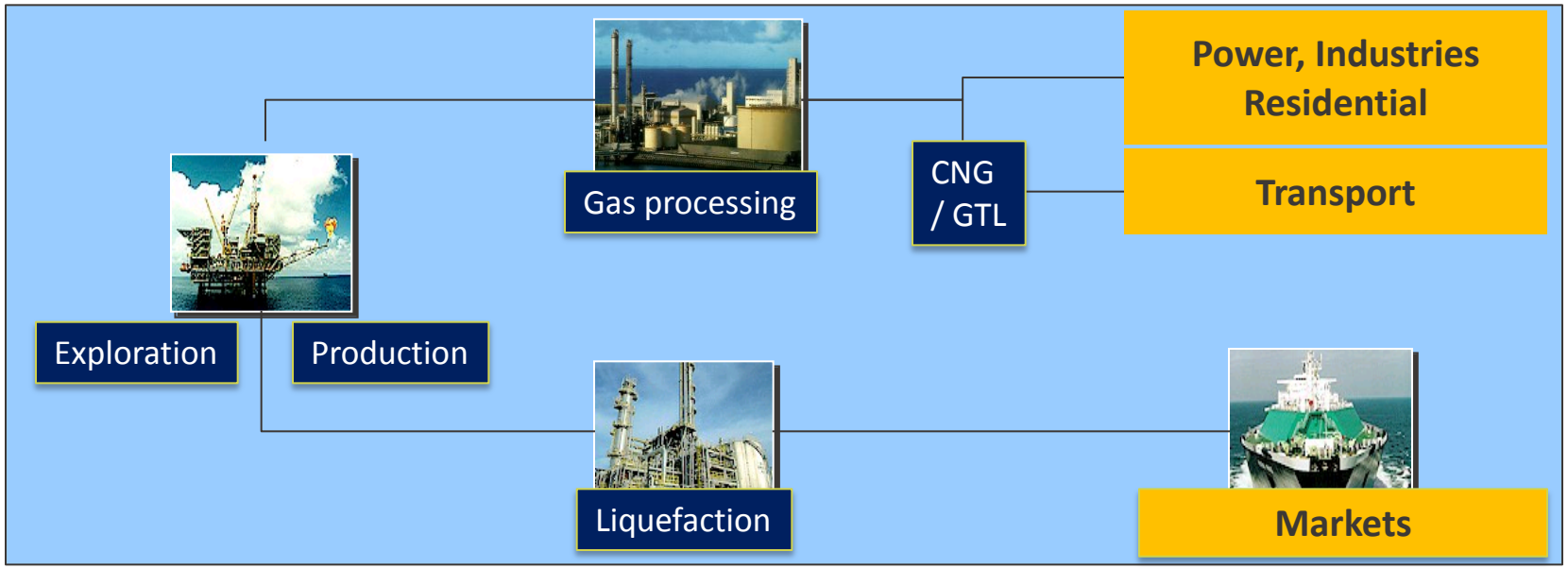
Conclusion: Role of technology in the E&P/gas value chain

- **Cost competitiveness**
- **Sustainability**
- **Operational excellence**

Role of technology

- Exploration of new (& more difficult) resource type
- Adds recoverability
- Improve success rate
- Add to resource base

- Provide monetisation routes through new demand segments
- Monetising stranded gas



Influencing factors

Oil & Gas prices
Gas market devt.
Pace of demand growth

Source: PETRONAS

END