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Technology & business drivers for the upstream oil & gas industry in Australia: implications for working with Africa

10.03.2015

Curtin University main campus, WA

Presenter’s background

- Geoscientist - former executive with Esso, Exxon and Woodside
- Roles included head of Global Studies for Exxon, and Executive Vice President Exploration for Woodside
- Executive Director, Strategic Engagement, Curtin Business School
- Managing Director, Norris Strategic Investments P/L
- Chair, Earth Science Western Australia
- Chair, Curtin Graduate School of Business
- Non-Executive Director, Central Petroleum Ltd

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Curtin University's interests in Africa

- History of working with Africa:
  especially in minerals area through WASM (Western Australia School of Mines)
- Keen to assist in the development of the region via education and research
- Strong in oil and gas:
  - Largest university in Western Australia (>60,000 students)
  - Largest Engineering School in WA
  - Largest Business School in WA
  - Australia's only MBA in Oil & Gas
  - Strong links to Australian industries

Engineering building 215, main campus, WA

Curtin Graduate School of Business, Perth, WA

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Global considerations for Africa

- Global energy demand remains high
- Continued dominant role of oil and gas
- Global energy mix evolves
- Transformational role of “unconventionals” – including the current oil price collapse and flow-on to gas pricing

Very strong competition in the marketplace

- **Cost will need to come down**
- **Quality opportunities will remain in demand**
- **Only best opportunities will be funded**
- **Technology and outstanding talent will be critical to success**

North Rankin A and B production platforms, WA.
Image: Woodside

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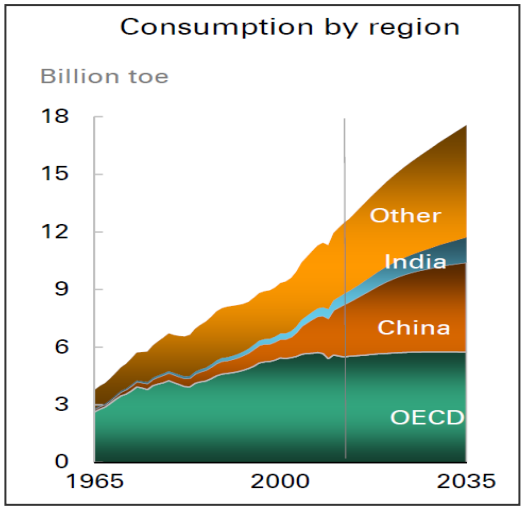
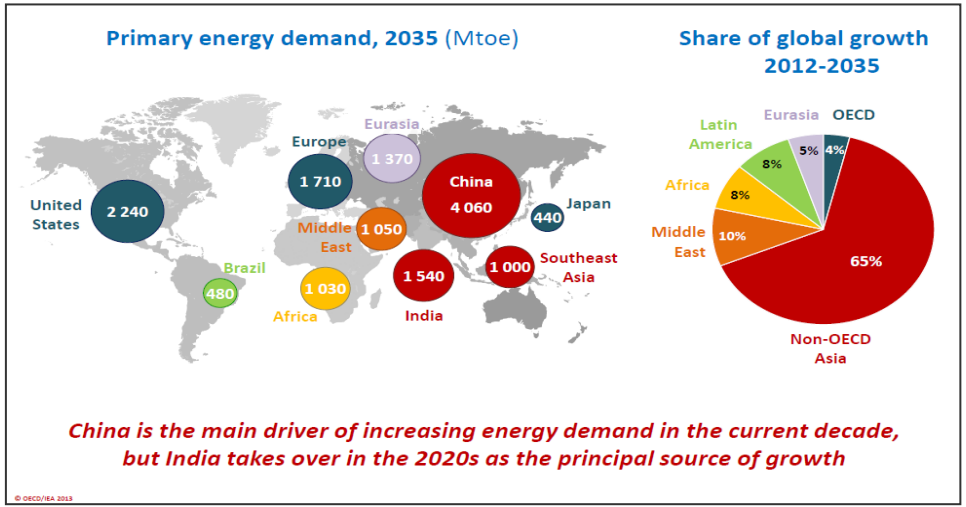
Global energy demand driven by SE Asia

Oil is globally traded, although US light crude from shale gas has reduced their need for Nigeria crude
Gas is increasingly being moved globally as LNG
For gas, Africa is well placed to pursue various growing markets



Global energy consumption vs time.
Source: BP Energy Outlook 2014



World energy demand and global energy growth versus time
Source: IEA World Energy Outlook 2013

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Oil price movements & impacts

- **Oil price fall attributed to a combination of events:**
  - US unconventional production adding > 1 MMbbl/day each year for the past 3 years
  - Softening demand from (a) weak economic conditions & (b) substitutions
  - OPEC failure to act as swing producer
- **Signs of a floor recently**
- **Uncertainty about timing and magnitude of recovery:**
  - OPEC response critical (next meeting June)
  - Continued growth in consumption
  - Uneconomic stripper wells first to stop
  - Uneconomic shale oil next
  - Reduction in exploration
  - Slowdown in marginal new developments

Brent crude oil prices: 10 years (top) and 3 months) bottom

Source: www.nasdaq.com

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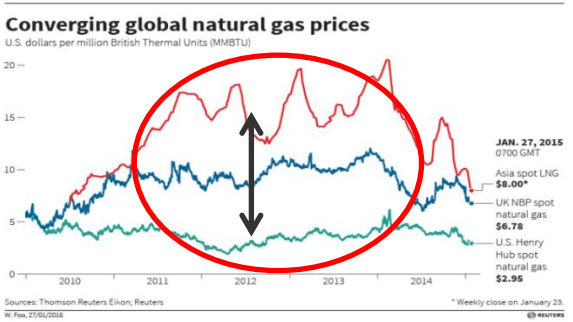
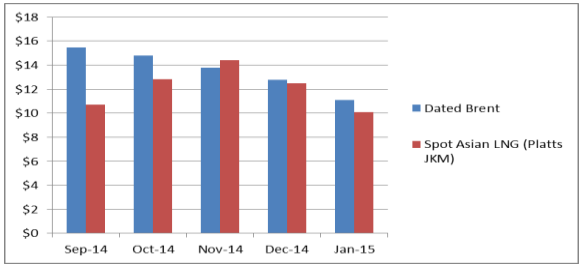
Gas price movements & impacts

- **Asian spot LNG prices have been falling due to trends that favours buyers:**
  - Mild temperatures, high inventories, soft economies
  - Growing production (PNG LNG; now QCLNG)
  - Indirect linkage to Brent crude prices
- **Most Asian LNG is sold under long term, oil-price-linked contracts:**
  - e.g. 14.5-15% slope to crude on a lagged '3-0-1' pricing formula (ie 3 mth averaging, 0 month countback, 1 mth being priced).
  - With time, if oil stays around $50 vs $100, Asian Contract LNG prices will fall from around $15/Mmbtu to as little as $7.50/Mmbtu, depending on the shape of the S curve and the contract price floor.
- **Arbitrage opportunities for US LNG into Asia are diminishing, given:**
  - Falling Asian LNG spot prices
  - Falling oil prices and assuming $6.50 cost of liquifaction, shipping and re-gasification.



Global spot gas prices, 2010-2014

Source: http://blogs/platts.com/2015/01/15/crude-price-lng/



5 month price trend of Asian spot LNG and Japan/Korea contracted LNG

Data Source: http://blogs.platts.com/2015/01/15/crude-price-lng/

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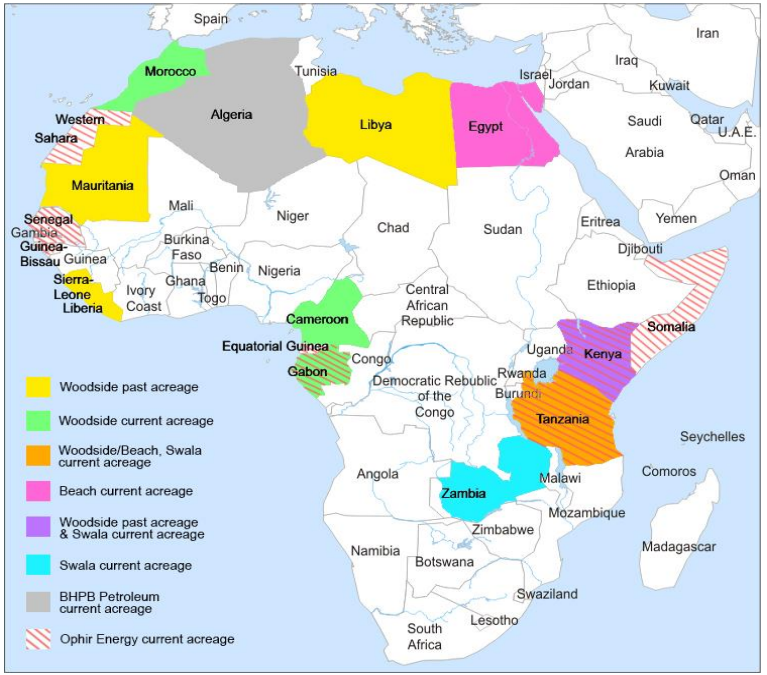
“Australian” oil & gas operators in Africa

- Solid history of working in Africa
- Woodside took lead role over ~2 decades from the late 1980s, & has recently re-engaged
- Other major player is Ophir: registered on London SX but with a major technical office in Perth



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Major oil and gas operators, contractors and research institutions in Perth

Major Operating Companies	Major Contractors	Major Research Institutions
Woodside	Schlumberger	Curtin University
Chevron	Clough	UWA
Shell	Worley Parsons	CSIRO
TOTAL	Chiyoda	Monash University
ConnocoPhillips	Thiess	Edith Cowan University
ENI	Transfield	Notra Dame University
BP	Aust Marine Complex	
BHPB	CB&I	
Inpex	KBR	
Murphy	GE Oil & Gas	
Hess	Weatherford	
Santos	Saipem	
	Subsea7	
	Wood Kenny	
	Fugro	
	Jacobs/SKM	
	Fluor	
	FMC Technologies	
	Baker Hughes	
	Oceaneering	
	Techniq	
	DNV GL	

Source: Wood Mackenzie, *in* AAPG Explorer Jan 2014

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Africa: 2014 key discoveries

Offshore Senegal
Cairn/COP/FAR
Sangomar Deep block
Fan-1 & SNE-1
Cretaceous deep water fans

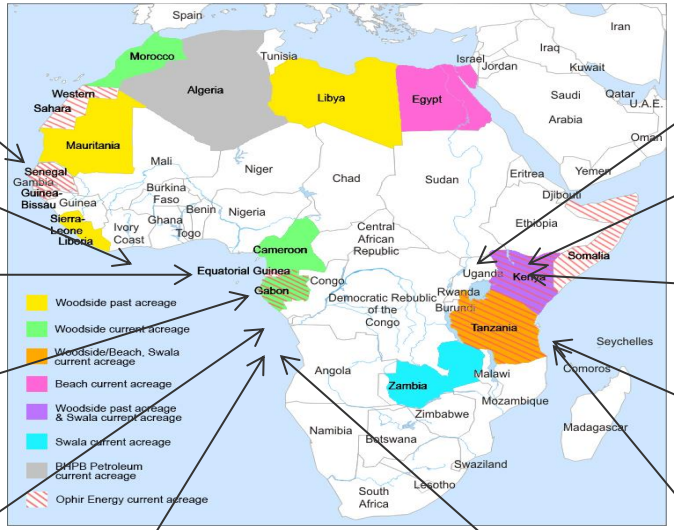
Offshore Ivory Coast
Cairn/COP/FAR
Sangomar Deep block
Fan-1 & SNE-1
Cretaceous deep water fans

Offshore Equatorial Guinea
Ophir
R Blocl (3.4 Tcf EUR)
Silenus East-1 (400 Bcf)
Cretaceous deep water fans

Offshore Gabon
ENI
Block D4
NyonieDeep-1
500 MMBOE
Cretaceous pre-salt

Offshore Congo
ENI
Marine XII block
Nene Marine-3
1.2 BBO, 30 Bcm IP
Minsala Marine-1
1 BBOE IP
Lower Cretaceous pre-salt

NB: ENI: 4 BBOIP in their Gabon/Congo permits



Offshore Angola
Cobalt, BP, Sonangol
Block 20/11 (Kwanza Basin)
Orca-1
400-700 MMbbl
Cretaceous pre-salt

Offshore Angola
ENI
Block 15/06
Ochigufu-1 (300 MMbbl IP &10th discovery in block)
L Miocene & Oligocene sands

NB: Uganda (3.5 BBOE). MOU signed with Tullow, TOTAL, CNOOC for oil development

Onshore Kenya
Africa Oil/Tullow
Block 10BB
Amosing-1
Ewoi-1
Ngamia-2
Tertiary rift play

Onshore Kenya
Tullow
Ekosowan-1
South Lochichar Basin
Tertiary rift play

Offshore Tanzania
BG/Ophir
Block 4
Kamba-1 (1.03 Tcf)
Cretaceous & Paleocene deep water fans

Offshore Tanzania
Statoil/ExxonMobil/
Production Tanzania
Block 2 (20 Tcf GIP)
Zafarani-2
Piri-1 (2-3 Tcf)
Cretaceous deep water fans

Sources: Woodmac, company reports

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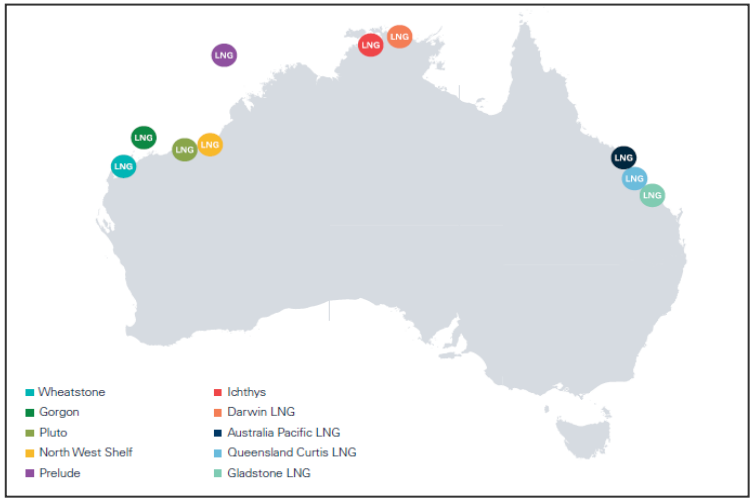
Lessons from Australia's gas industry

In Australia, over the last 50 years, exploration has uncovered world-scale gas resources.

These resources have allowed the growth of both domestic and LNG export markets.

Australia's LNG operators and contractors have an abundance of experience



Location of existing and under-construction LNG projects in Australia

PROJECT	TRAINS	PRODUCTION CAPACITY (mtpa)	CAPEX (A$B)	START DATE
A. Operating				
North West Shelf	5	16.3	60*	1989
Darwin LNG	1	3.7	1.6**	2005
Pluto	1	4.3	15.3	2012
	7	**24.3**	**66.8**	
B. Committed / Under Construction				
Qld Curtis LNG	2	8.5	20.4	2014
Gladstone LNG	2	7.8	18.5	2015
Aust Pacific LNG	2	9	24.7	2015
Gorgon	3	15	54	2015
Ichthys	2	8.4	34	2016
Wheatstone	2	8.9	29	2016
Prelude FLNG	1	3.5	13	2017
	14	**61.1**	**193.6**	

* In 2012 dollars

** In 2006 dollars

Capacity of existing & under-construction LNG trains in Australia
The first QCLNG train is now in Operation

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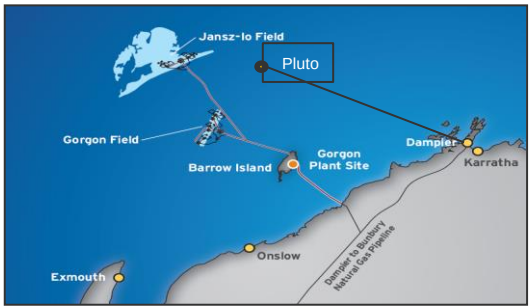
WA's experience: the last decade (1: LNG)

- 2005: Pluto discovery (~5 tcf)
  - Woodside 100%
  - FID 2007, On production 2013
  - One train, 4.3 mtpa, $15B
- 2009: Gorgon FID (~37 tcf)
  - Chevron/Shell/Exxon 50%/25%/25%
  - Discovered in 1981 (Gorgon) and 2000 (Jansz-Io)
  - FID 2009, RFSU 2015+
  - Three trains, 15.6 mtpa, 100 TJ/d, $54B

Gorgon LNG construction on Barrow Island, WA. Image: Chevron

Pluto LNG plant, Burrup Peninsula, Karratha, WA
Image: Woodside



Location of Pluto, Gorgon & Jansz-Io discoveries
Image: Chevron

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WA's experience: the last decade (2: LNG)

- 2004: Wheatstone discovery (~8 tcf)
  - Chevron 64.14% Operated JV
  - FID 2011, On production 2016
  - Two trains, 8.9 mtpa, 200 TJ/d, $29B
- Browse Basin: Ichthys / Prelude
  - Ichthys LNG development
    - Inpex/TOTAL
    - Discovered 2000, FID 2012
    - 2 trains, 8.4 mtpa and 100K BCPD $34B, RFSU 2016
  - Prelude FLNG development
    - Shell 100%
    - 1 train, 3.5 mtpa
    - ~$13B, RFSU 2017

Wheatstone LNG plant construction, Onslow, WA. Image: Chevron

Shell's Prelude FLNG vessel under construction. Image: Shell

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WA’s experience: the last decade (3:domgas)

- 2011: Devils Creek domestic gas production
  - Apache 55% (Op), Santos 45%
  - Development of Reindeer Gas Field, discovered in 1997
  - Design capacity 200 MMscf/d (delivering 100 MMscf/d)
  - FID 2009, Cost A$1.1B
- 2013: Macedon domestic gas production
  - BHPB 71.5% (Op), Apache 28.5%
  - Development of Macedon Gas Field, discovered in 1992
  - Design capacity 200 MMscf/d
  - FID 2011, Cost US$1.5B
- 2013: Red Gully domestic gas production
  - Empire Oil 76.39% (Op), ERM 23.61%
  - Development of Gingin West and Red Gully Gas Fields, discovered in 2009 & 2011
  - Design capacity 10 MMscf/d
  - FID 2011, Cost A$39M

Devil Creek domestic gas plant, Cape Preston, WA.
Photo courtesy Apache Corporation

Macedon domestic gas plant, Onslow, WA
Image: BHPB

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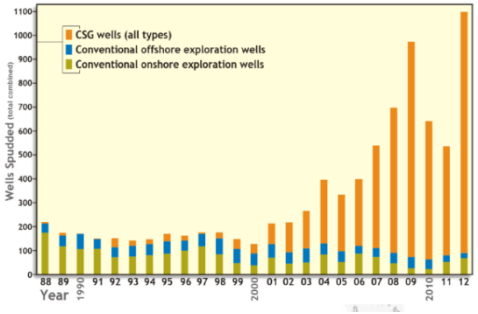
Eastern Australia today

- **World's first coal-seam-gas (CSG) to LNG**
- **3 projects, 6 trains LNG, A$70B investment**
- **Investment seen as very positive to Australia**
- **Has revitalised many struggling communities**
- **Stakeholder engagement critical**

Multi well production.
Image: Santos



Australian exploration wells vs time.
Image: APPEA Annual Report 2012-13

Well head production, gathering, stabilisation. Image: Santos

3 projects & 6 trains LNG, Gladstone, Qld.
Image: Santos

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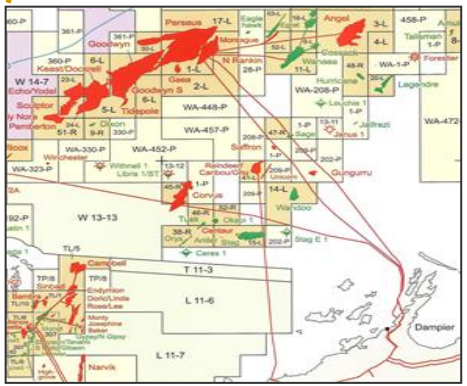
Origin of a gas industry in WA: the NW Shelf

- **Woodside-led JV makes multi-tcf gas discoveries:**
  - Scott Reef (1971) in Browse Basin
  - North Rankin (1971) and Goodwyn (1972) in Carnarvon Basin. Also smaller gas find at Angel (1972).
- **North Rankin and Goodwyn form basis of NW Shelf gas development**

Location of Woodside-operated acreage & gas discoveries in 1971-2
Image: Fifty years of Woodside's history. Woodside



2014 acreage map of NW Shelf area, showing discoveries & pipelines

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NW Shelf Venture LNG development

- **1971-2**: initial discoveries
- **1976**: JV adjusts: Woodside (operator), Shell, Chevron, BP, BHP
- **1980**: signing of domestic gas supply contract with state government
- **1984**: Japanese (MIMI) joins. JV forms 1/6th equal shares
- **1985**: LNG export sales agreement
- **1989**: First LNG shipment to Japan
- **2001**: Expansion to 4th train
- **2002**: 25 year contract to China to underpin Train 5 expansion
- **Today**: 5 trains, 16.3 mtpa, capex in 2012 A$ estimated at ~$60B

North West Shelf LNG plant at Karratha, WA
Image: Fifty years of Woodside's history. Woodside

Northwest Shelf LNG development on Burrup Peninsula, Karratha, WA
Image: Woodside Energy Ltd.

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Government policy matters

Strong support for E&P overall

- **Strong relationships with governments**
- **Government support at startup**
- **Strong government support** for exports
- **Exploration support** e.g. transparent awarding and granting of permits; Retention Lease policy
- **Clear and stable laws & legislation**
- **Transparent Regulator**
- **Reasonable fiscal terms**

Debate around domgas reservation

Curtin Business Outlook Series
The West Australian, November 2014

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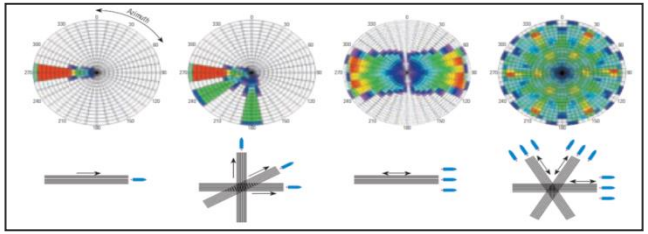
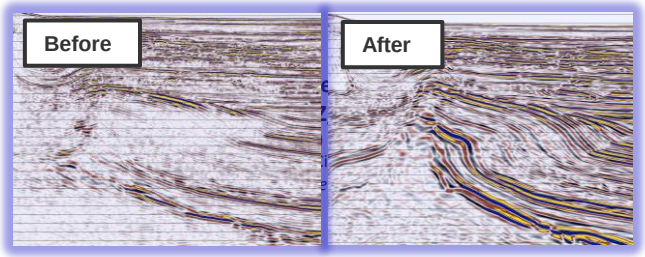
Technology matters: exploration & development seismic

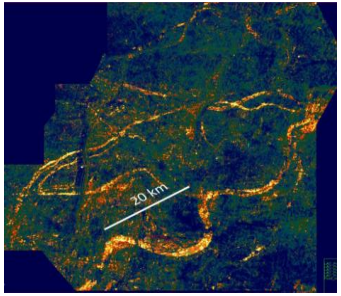


Acquisition techniques (standard, MAZ, WAZ, RAZ)
Image: Moore (2013) Beijing ITC, from "Shooting Seismic in Circles", Buia, et al. *Oilfield Review*, 2008

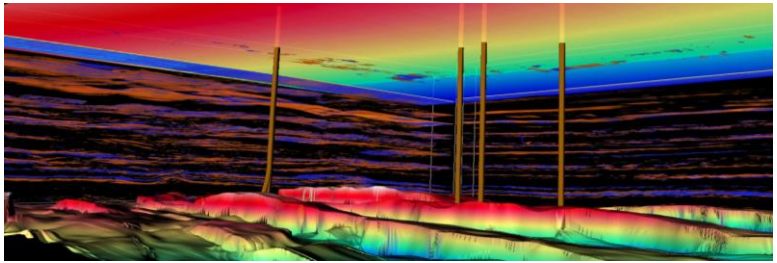


Acquisition & processing: standard vs RAZ
Image: Neptune Field, from Moore (2013) Beijing ITC

Best practice tools and people



Processing & display
Image: Carnarvon Basin 3D, from Moore (2013) Beijing ITC



3D visualisation
Image: From Moore (2013) Beijing ITC

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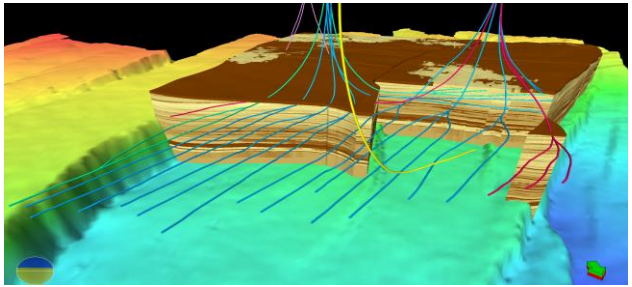
Technology matters: development engineering



Multilateral, long-reach drilling
Image: Vincent oil field, from Moore (2013) Beijing ITC

Transporting module to Pluto LNG site
Image: Woodside

Best practice capabilities

One of 7 FPSOs off the W & N coasts of Australia
Image: Woodside

Model of Prelude FLNG ship, with offloading tanker
Image: Shell

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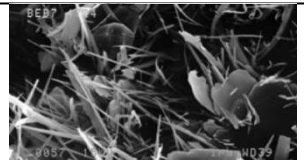
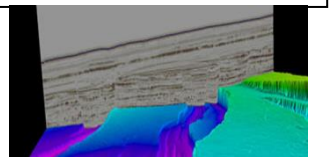
Research matters

Curtin University: petroleum fields of expertise

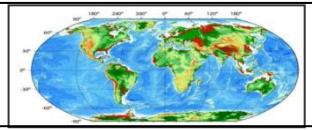
Petroleum Geology



Petroleum Geophysics



Spatial Sciences



Chemical Engineering

Petroleum Engineering

Business

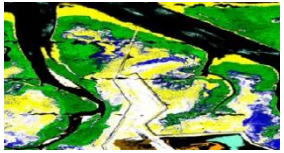
Petroleum Geochemistry

Corrosion Engineering

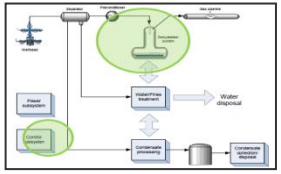
Marine Sciences

Lean Construction

Remote Sensing



Subsea Engineering



Supercomputing

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Research partnerships matter
e.g. WAERA

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Towards the future: the Internet of Everything

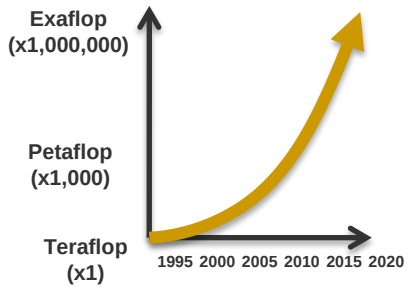
*'**The Internet of Everything (IoE)**, with over 50 Billion devices to be connected to the Internet by 2020, **will have five to 10 times the impact on society as the Internet itself'** Cisco*

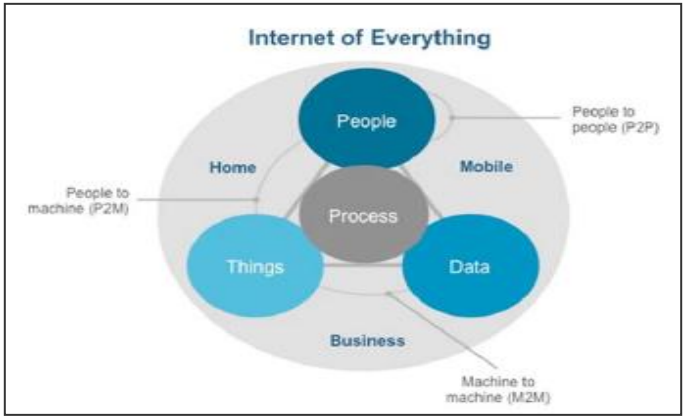
'Less than 2%, of what can be connected to the internet, is connected today' Cisco

Australia is an early adopter of high-technology:

- **#1 cloud adopter**
- **#1 sales revenue per capita (#8 total sales revenue)***

Google spent $3.2 billion to acquire smart thermostat and smoke detector company Nest in 2014





#Cisco – See CNET Article for Summary: http://www.cnet.com/news/how-much-is-the-internet-of-everything-worth-cisco-says-19-trillion/
*Cisco Global Outcomes by Revenue

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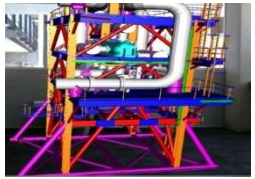
Data > information > knowledge > performance

Smart buildings

“Dumb” meters

Smart meters



Smart facilities

The ability to analyse:
Big data & data analytics
e.g. Pawsey Supercomputer

The ability to visualise:
e.g. Curtin University HIVE

Superior performance

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Some insights for Africa to consider

- There is a new reality with falling oil prices
  - Costs will have to decrease to provide an adequate return on investment
  - Only the economically most robust projects will proceed until prices increase & stabilise
  - The investment hurdle is lowest for the countries that are the most stable
- Significant capex differences and hence economics exist between settings
  - Onshore / shallow offshore WD<500m / deep water 500-1500m / ultra-deep >1500m
  - Discovery to FID or RFSU times can be considerably extended passing into deep and ultra-deep water
- Large conventional gas fields offshore are vastly different from CSG fields onshore
  - While costs are higher, the development is more predictable
- Even Australia struggles with immature domestic markets – the challenge shouldn't be underestimated
- The best way to find oil and gas is to promote exploration via appropriate terms
  - GA, Acreage Release Programme & Retention leases have all encouraged exploration within Australia
- Australia has a wealth of experience and capabilities
  - Especially in Perth, where the major operators and contractors are
  - Perth is a centre of oil and gas expertise in the various research institutions

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