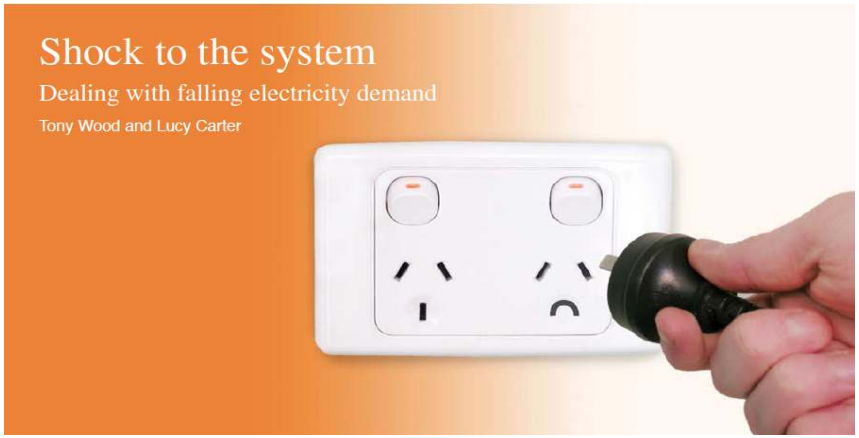

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Natural gas: victim or villain?

Public Policy Pitch
21 July 2015

Gas: part of the solution/problem to climate change?

The G7 countries have committed to decarbonisation of the global economy this century

The global gas industry has argued that natural gas can contribute to this objective in ways that coal cannot.

Yet, to have 50% probability to stay below 2 degrees, the majority of proven and probable fossil fuel reserves are unburnable

Can clean burning gas be part of the solution but as a fossil fuel also be part of the problem?

The world is committed to addressing climate change

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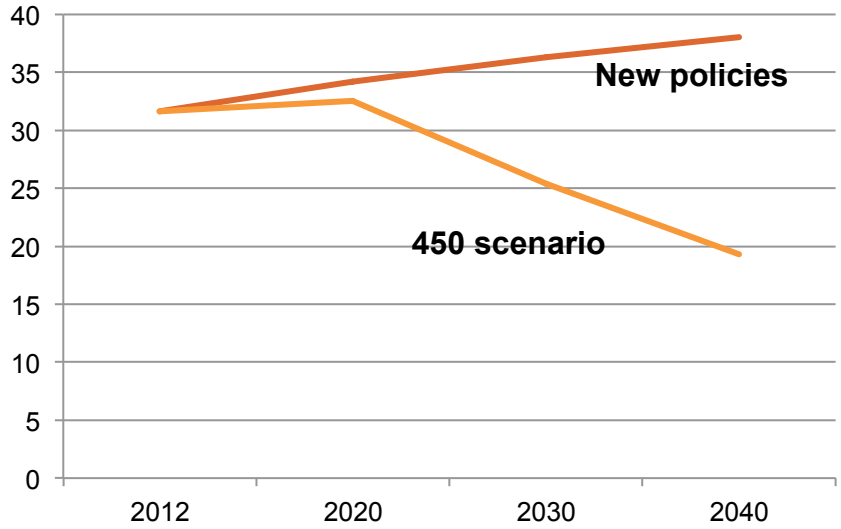
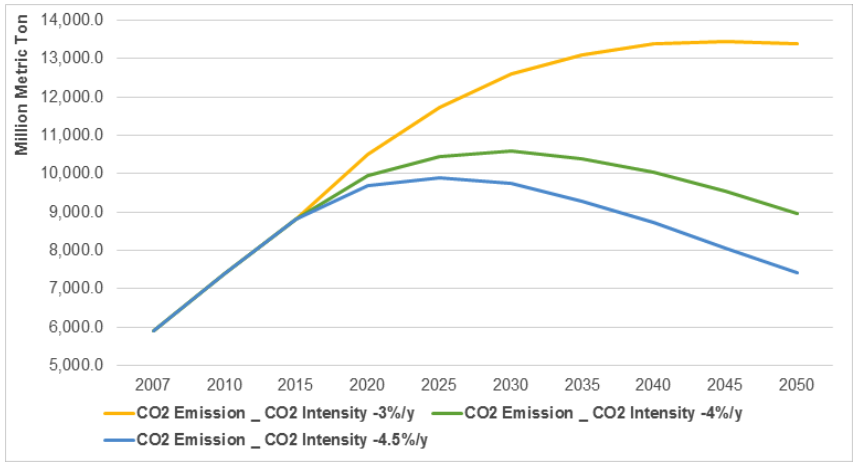
Global energy-related CO_2 emissions (Gt)



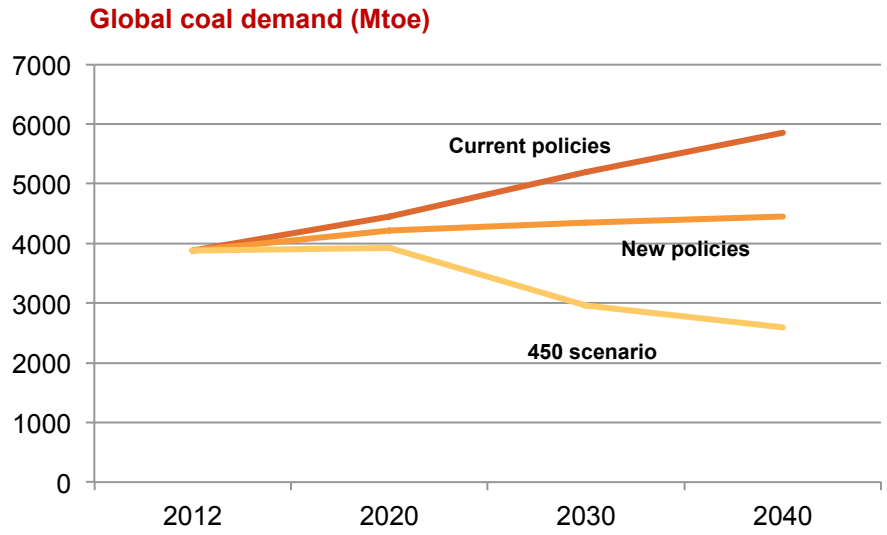
CO_2 emissions in the PRC



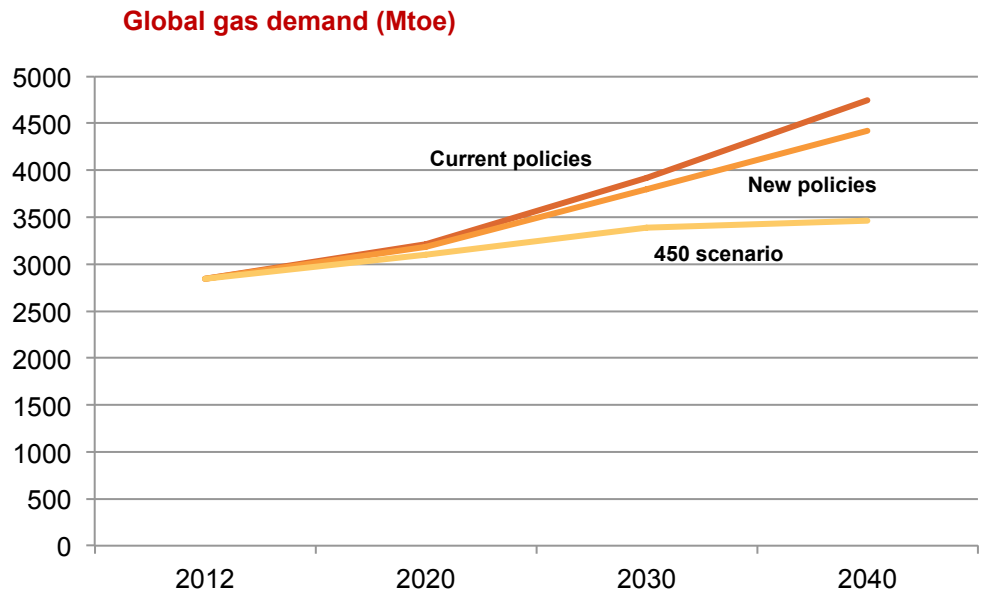
- **Global: limit the maximum global average temperature increase to no more than 2 degrees Celsius**
- **EU: at least 40% domestic reduction in emissions by 2030**
- **USA: reduce CO_2 emissions by 26%-28% below 2005 levels in 2025 and "to make best efforts to reduce emissions by 28%."**
- **China: achieve the peaking of CO_2 emissions around 2030 and "to make best efforts to peak early"**

Source: IEA WEO 2014; Asian Development Bank TA

Changing the demand outlook for fossil fuels



If governments continue their current energy and climate policies, and implement the ones they have proposed, the energy path is one that is consistent with a global temperature increase of about 4 degrees Celsius.



We have less than half our carbon budget remaining and are set to exhaust it by 2040

Source: IEA World Energy Outlook 2014

Gas: part of the solution

GRATTAN Institute

World Gas Conference:

- Natural gas emits half as much CO_2 as coal. For example, US CO_2 emissions have fallen sharply via shale gas
- Energy companies have accepted that reducing CO_2 emissions is now firmly established on political and corporate agendas across the world
- Gas emits 90% fewer air pollutants than coal - important in a world where there are seven million deaths linked to pollution every year.
- Gas is the most environmentally-friendly fossil fuel to act as a back up when variable solar and wind power cannot satisfy demand.
- Gas can be used to power vehicles with much lower emissions than oil-based petrol or diesel.

Gas: part of the solution

GRATTAN Institute

Importance to Australia:

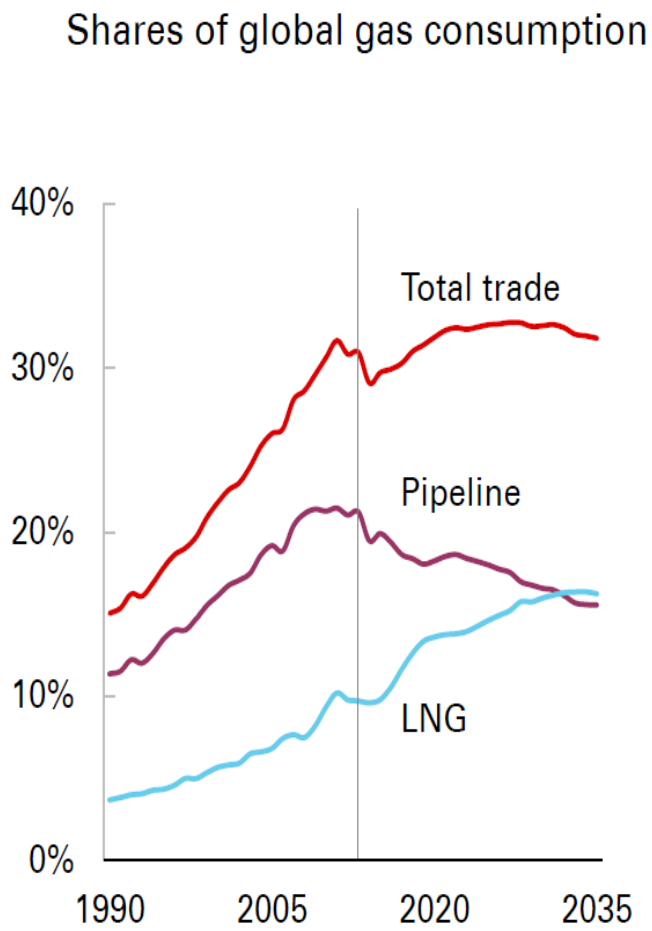
- In 2013-14, Australia exported 24.1 million tonnes of liquefied natural gas
- Australia was the third largest LNG exporter
- LNG export earnings were $16 billion
- Additional 62 million tonnes of LNG capacity will make Australia the largest exporter

Gas: part of the problem

GRATTAN Institute

- Natural gas remains a fossil fuel that emits harmful CO_2. And lots of it.
- If all the coal power stations in the world were turned off and replaced with modern gas-fired plants, total global CO_2 emissions would fall by about five billion tonnes a year to 25 billion tonnes. But emissions need to fall to about five billion tonnes for the climate to stabilise (IEA)
- The extraction of unconventional gas (shale gas and coal seam gas) adds significant emissions to those produced when gas is burned, and has major risks for water supplies.
- At some point in the next 20-30 years, gas use will have to start falling to avoid dangerous climate change. CCS remains unproven and expensive.
- Rather than rely on gas, governments should invest in large-scale energy storage systems and in renewable energy that is not variable, such as tidal and geothermal.

Growing demand for LNG

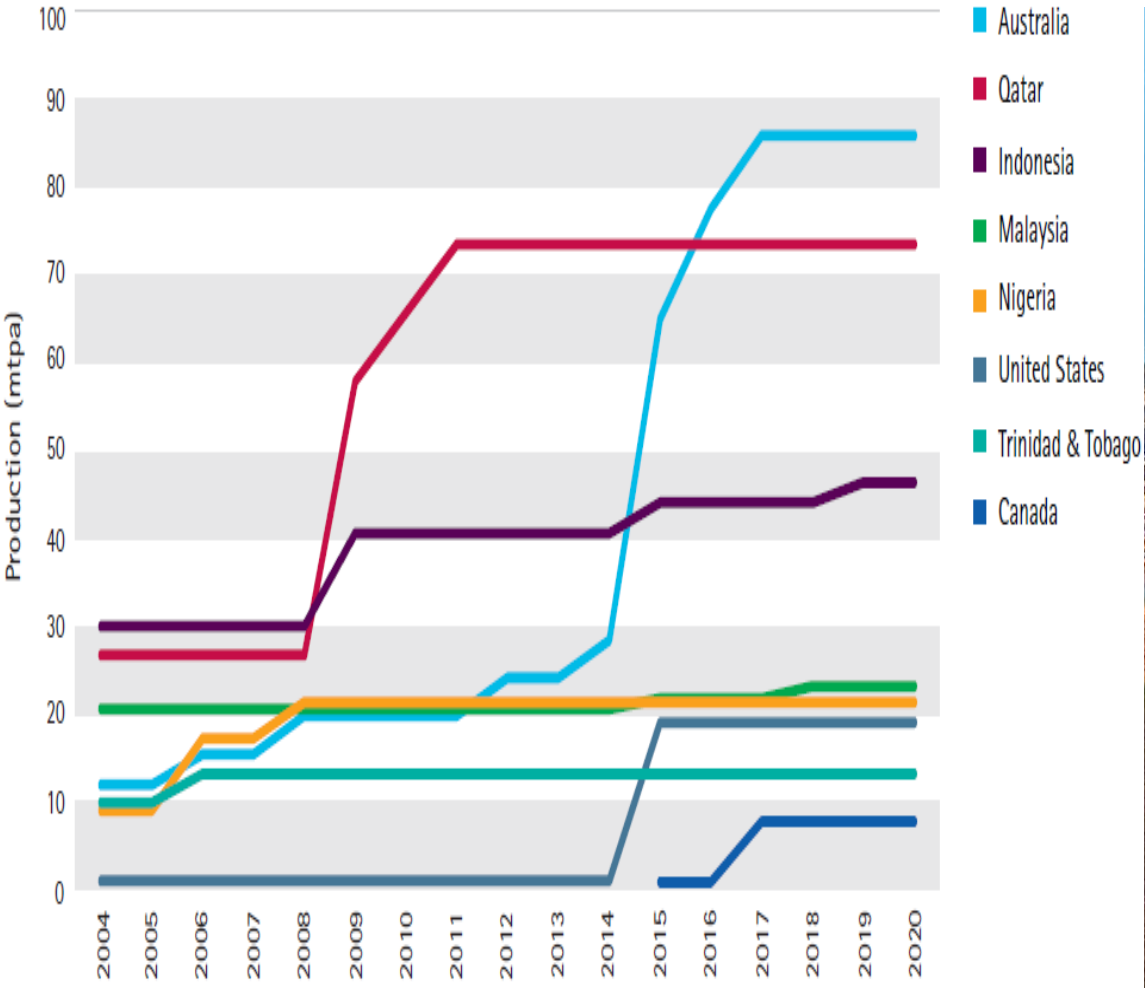


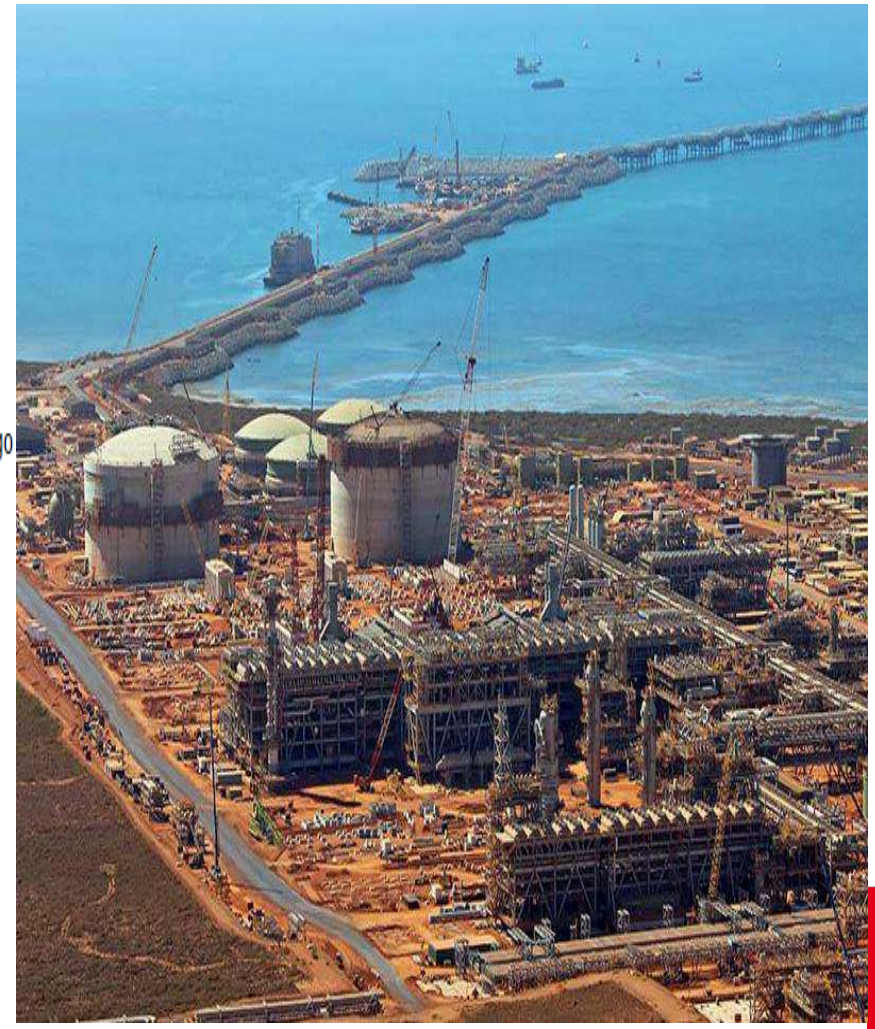
- LNG supply grows by 48 Bcf/d by 2035
- Australia (16 Bcf/d) will contribute around a third of that increase

LNG Tanker ©Shell

Source: BP, 2015, World Gas Conference, June 2015

Australian LNG nameplate capacity



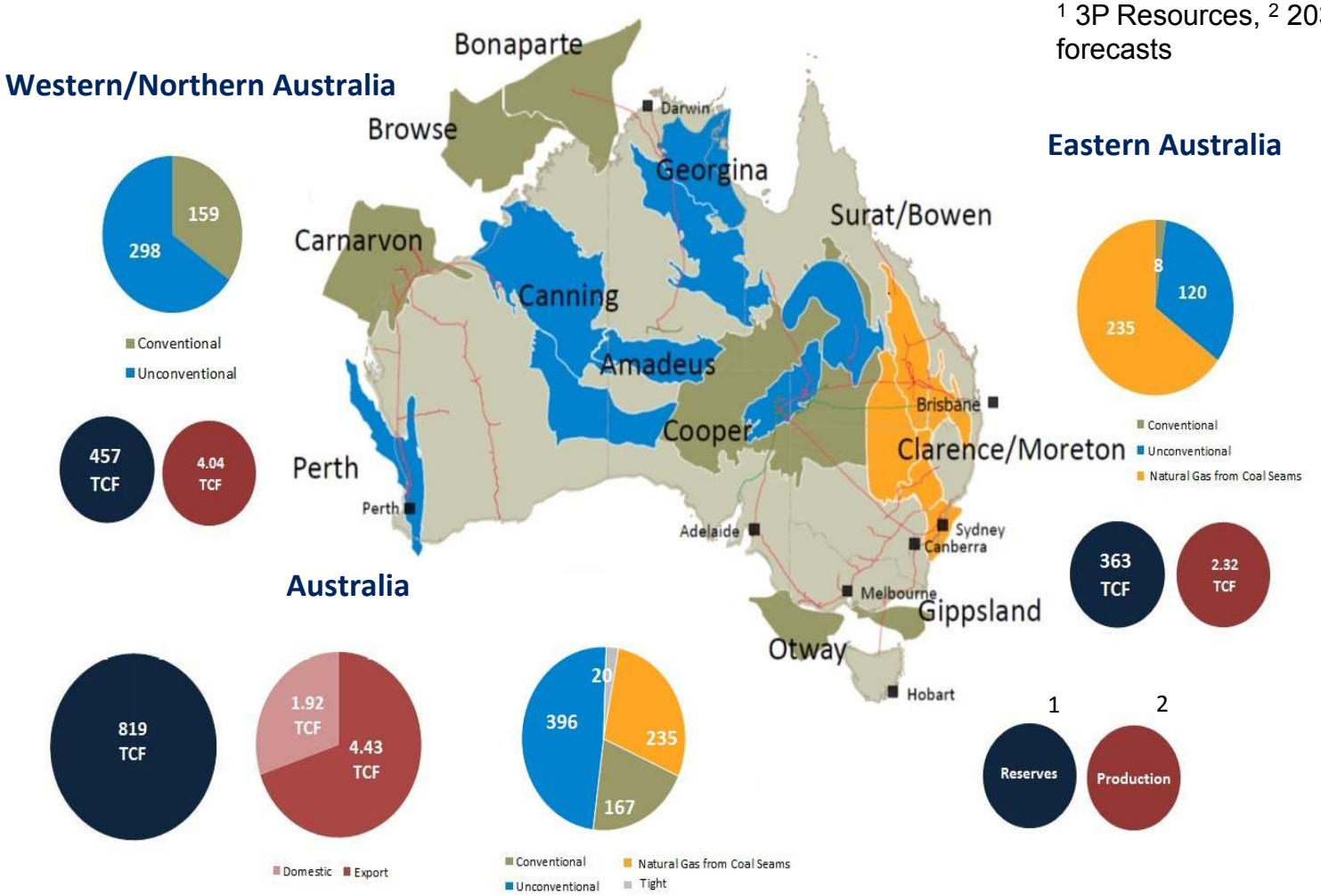


Source: Accenture, 2015, World Gas Conference, June 2015

Gorgon LNG Project ©Chevron

Australia's gas resources by major basins

[1] 3P Resources, [2] 2034-35 annual forecasts



Source: BREE, GA (2014); EIA World Shale Gas Resources (2013), World Gas Conference, June 2015

Overview

- Australia on verge of an unprecedented transition to be world's leading LNG producer
- Growth enabled by resources, innovation, policy settings and proximity to Asia
- A focus on sustaining competitive advantages and securing next wave of investment

Karratha Gas Plant ©Woodside

Source: World Gas Conference, June 2015

ClimateWorks AUSTRALIA

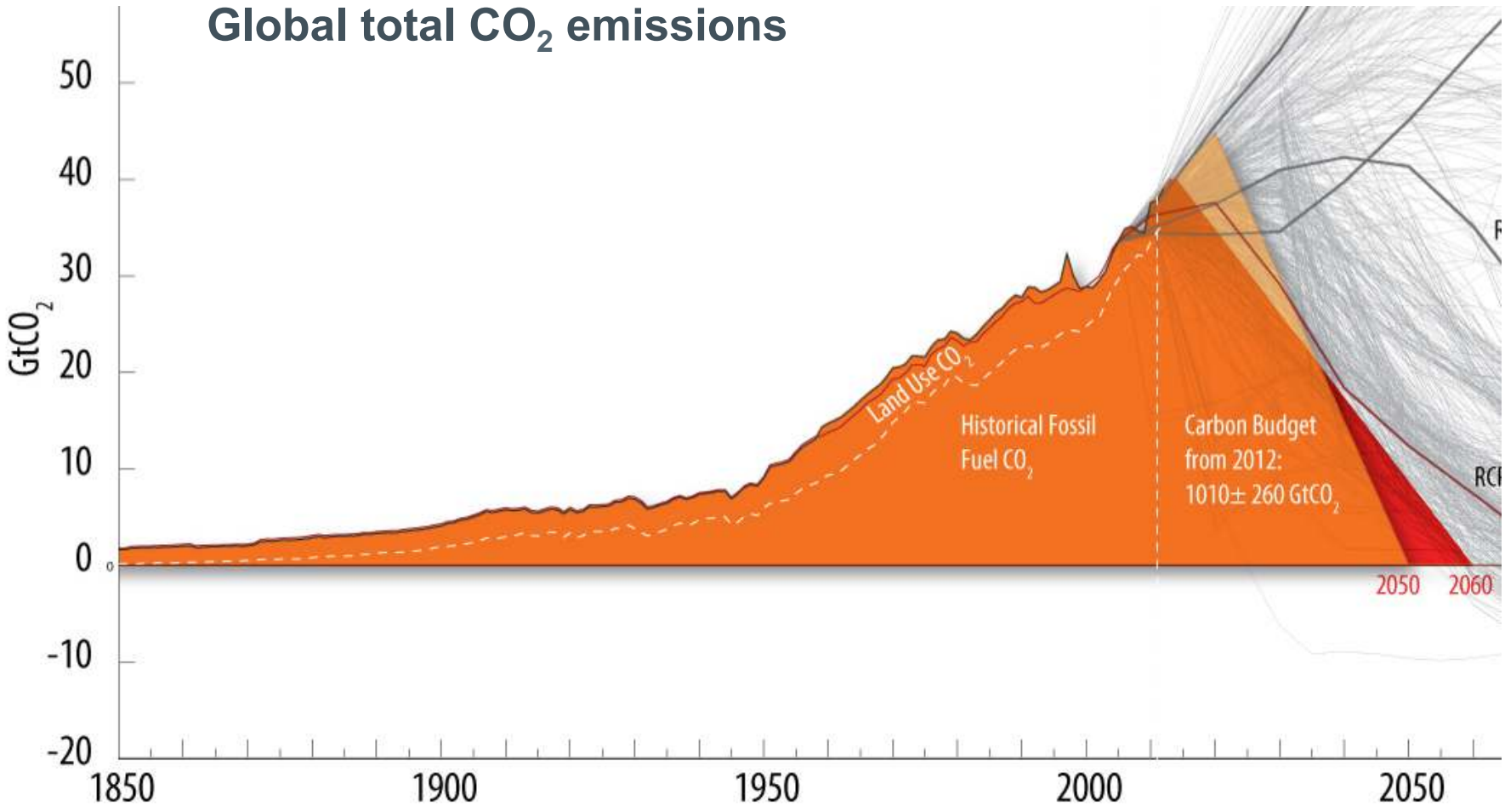
ACHIEVING NET ZERO EMISSIONS: THE ROLE OF GAS

GRATTAN POLICY PITCH EVENT

21 July 2015

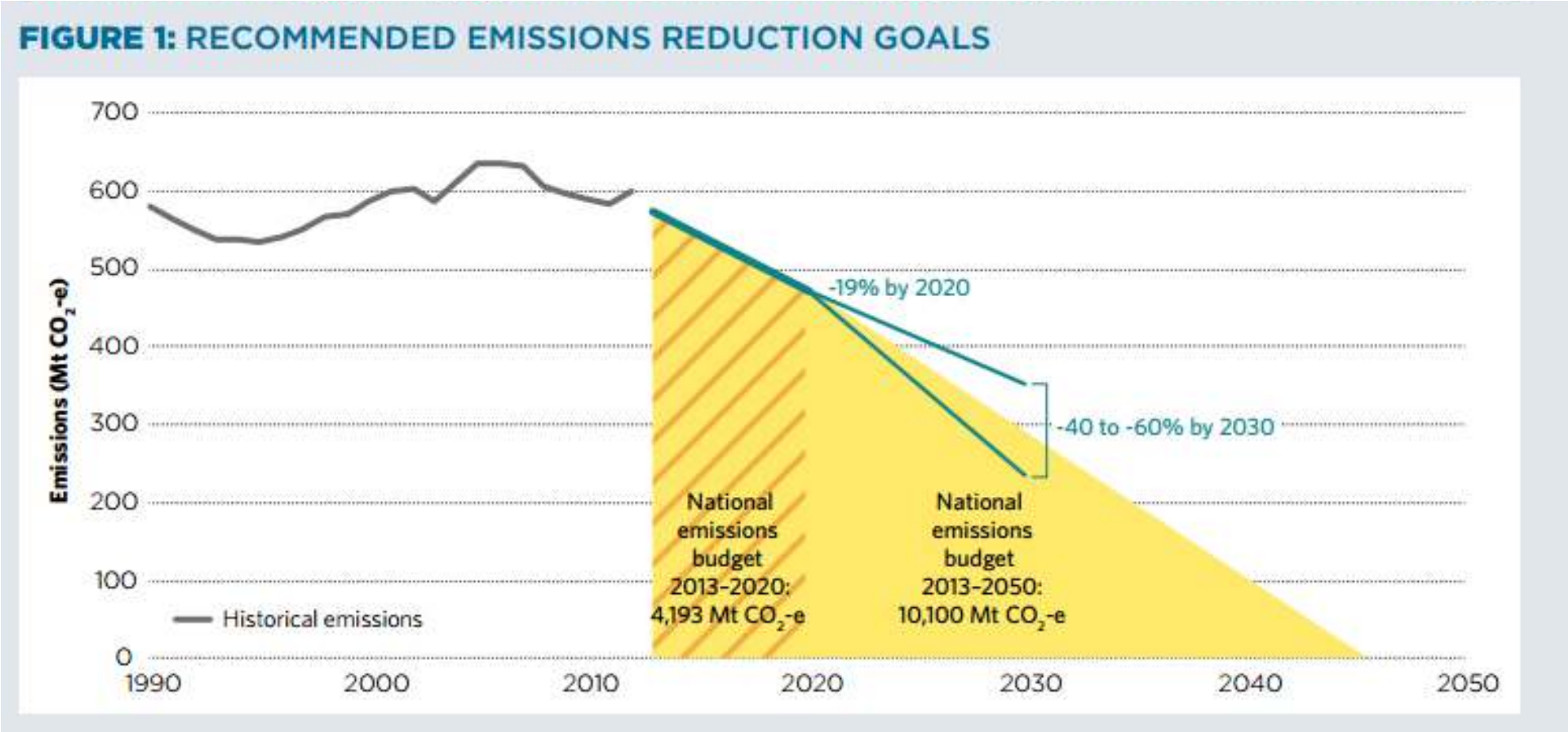
Anna Skarbek,
CEO ClimateWorks Australia

There is a finite "carbon budget" to avoid exceeding 2°C rise



SOURCE: Malte Meinshausen *(*https://ccep.crawford.anu.edu.au/sites/default/files/events/attachments/2015-03/malte_meinshausen.pdf*)*

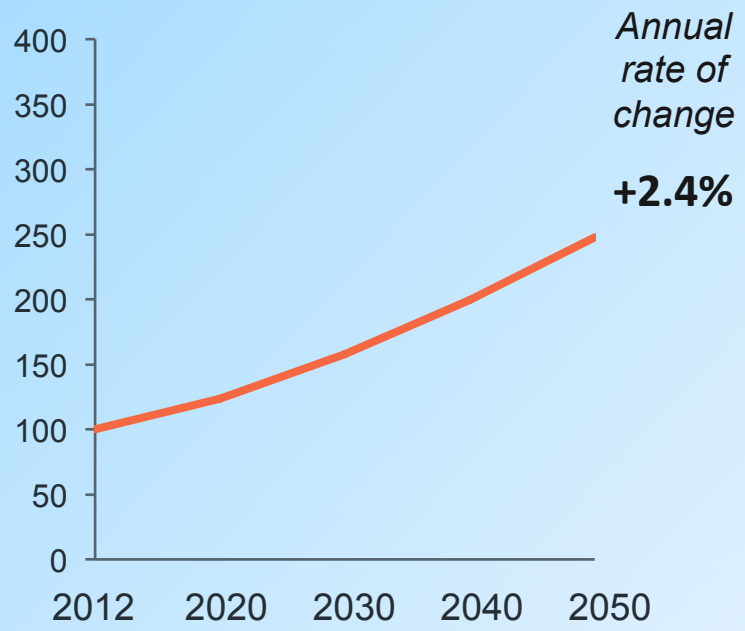
Australia's share has been calculated by the Climate Change Authority



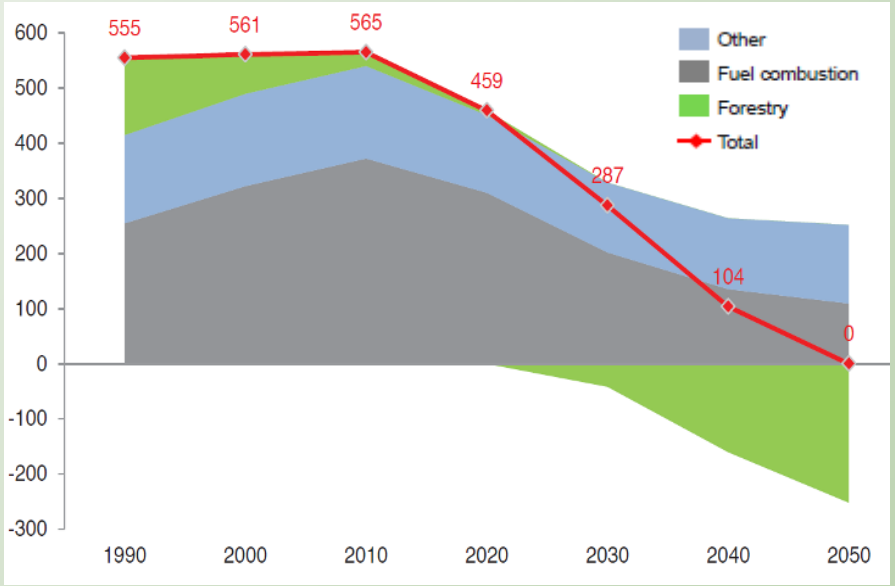
SOURCE: Exhibit 9.1, page 121, *Targets and Progress Review Final Report*, Climate Change Authority, February 2014

Our research shows that Australia can reach zero net emissions by 2050, while our economy continues to grow, in a 2ºC scenario

Our economy grows by 150% by 2050
Real GDP



Australia can reach zero net emissions by 2050
Emissions, MtCO2e



This is achieved through four “pillars” of transformation, focused on energy emissions and sequestration

COMMON TO ALL COUNTRIES

Ambitious Energy Efficiency
in all sectors leads to a halving of the energy intensity of the economy.

Low Carbon Electricity
Low carbon electricity is supplied by renewable energy or a mix of renewable energy and either CCS or nuclear power at similar costs.

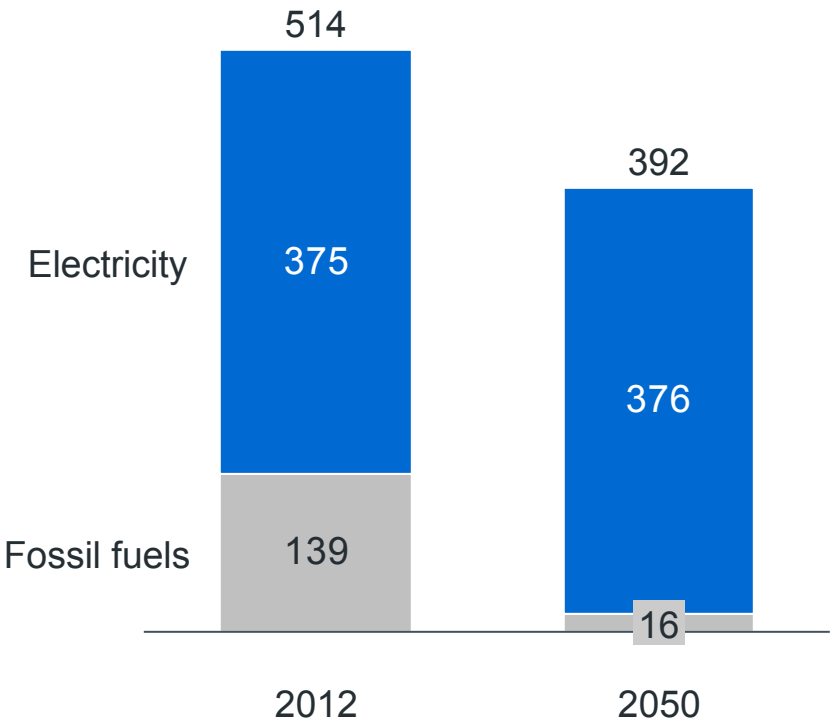
Electrification and Fuel Switching
from fossil fuels to bioenergy, and from coal and oil to gas reduces emissions from transport, industry and buildings.

Non-Energy Emissions
are reduced through process improvements and CCS in industry, while a profitable shift from livestock grazing to carbon forestry offsets any remaining emissions.

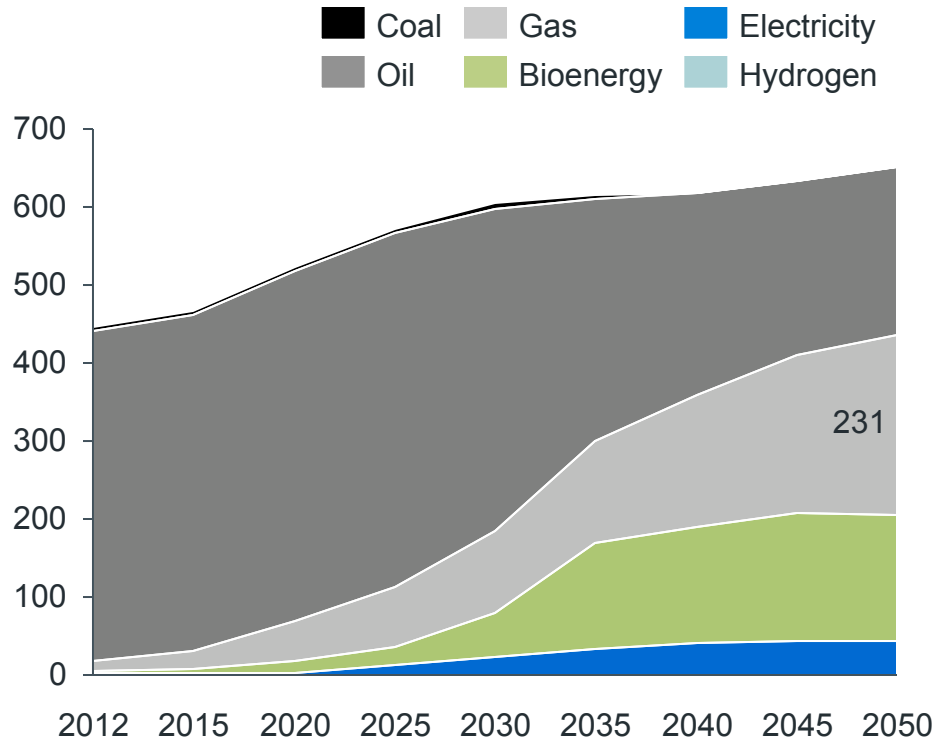
CCS

While use of gas in buildings would decrease to near zero, an equivalent demand would come from shift from oil to gas in road freight

Buildings energy use, PJ

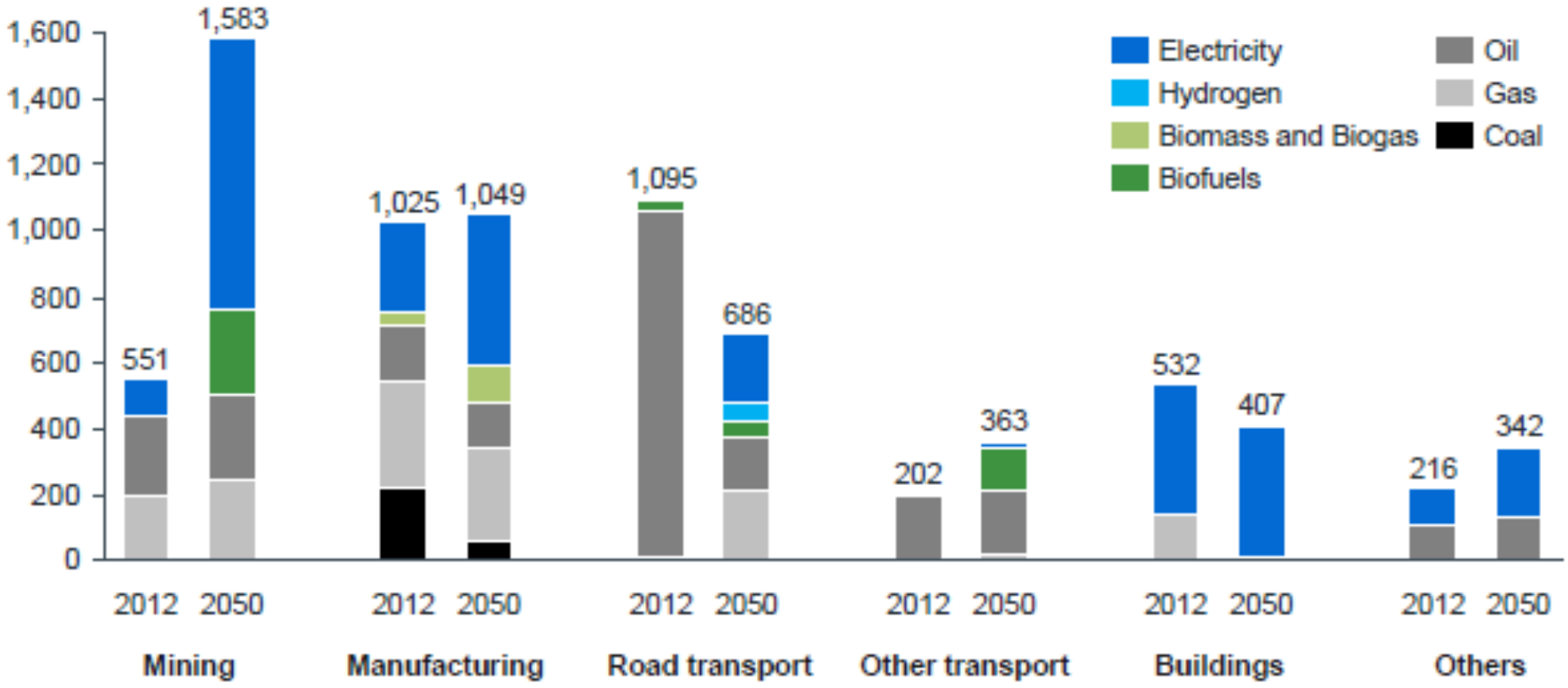


Fuel use for freight and aviation transport, PJ

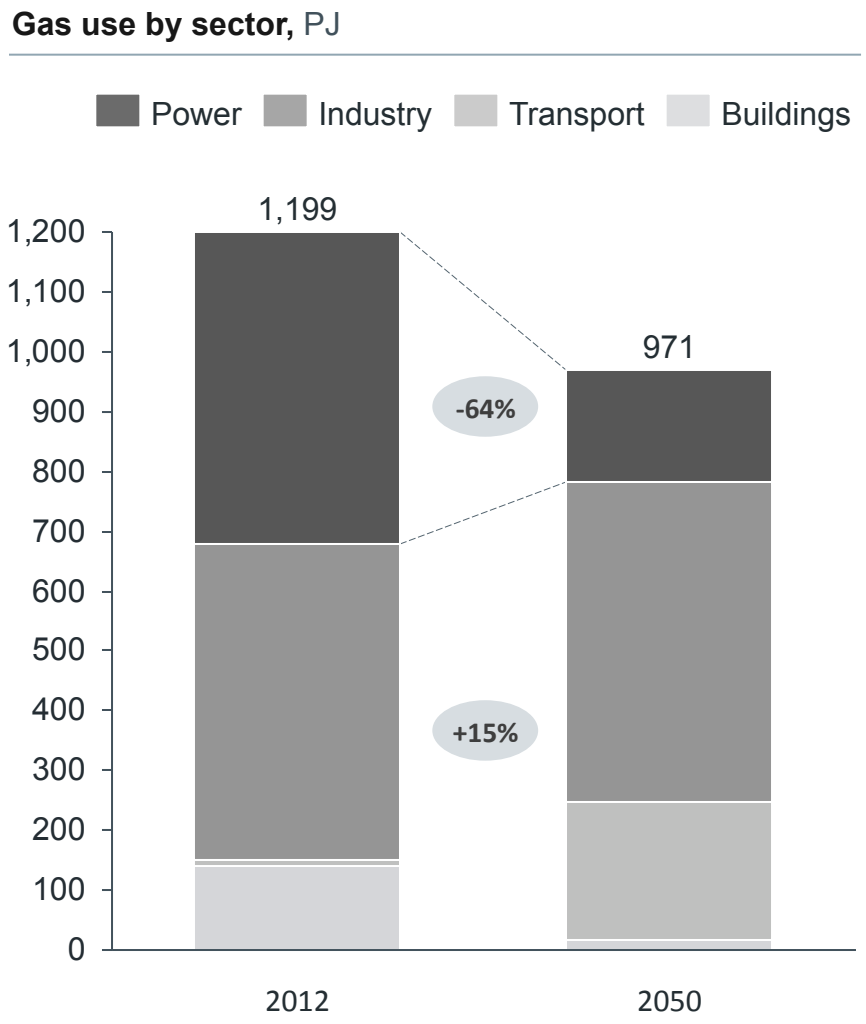


Gas use in mining and manufacturing remains at similar levels, a result of industry growth being offset by efficiency and fuel switch

Figure 1.11 – Final energy use by fuel type and by sector, PJ[3]



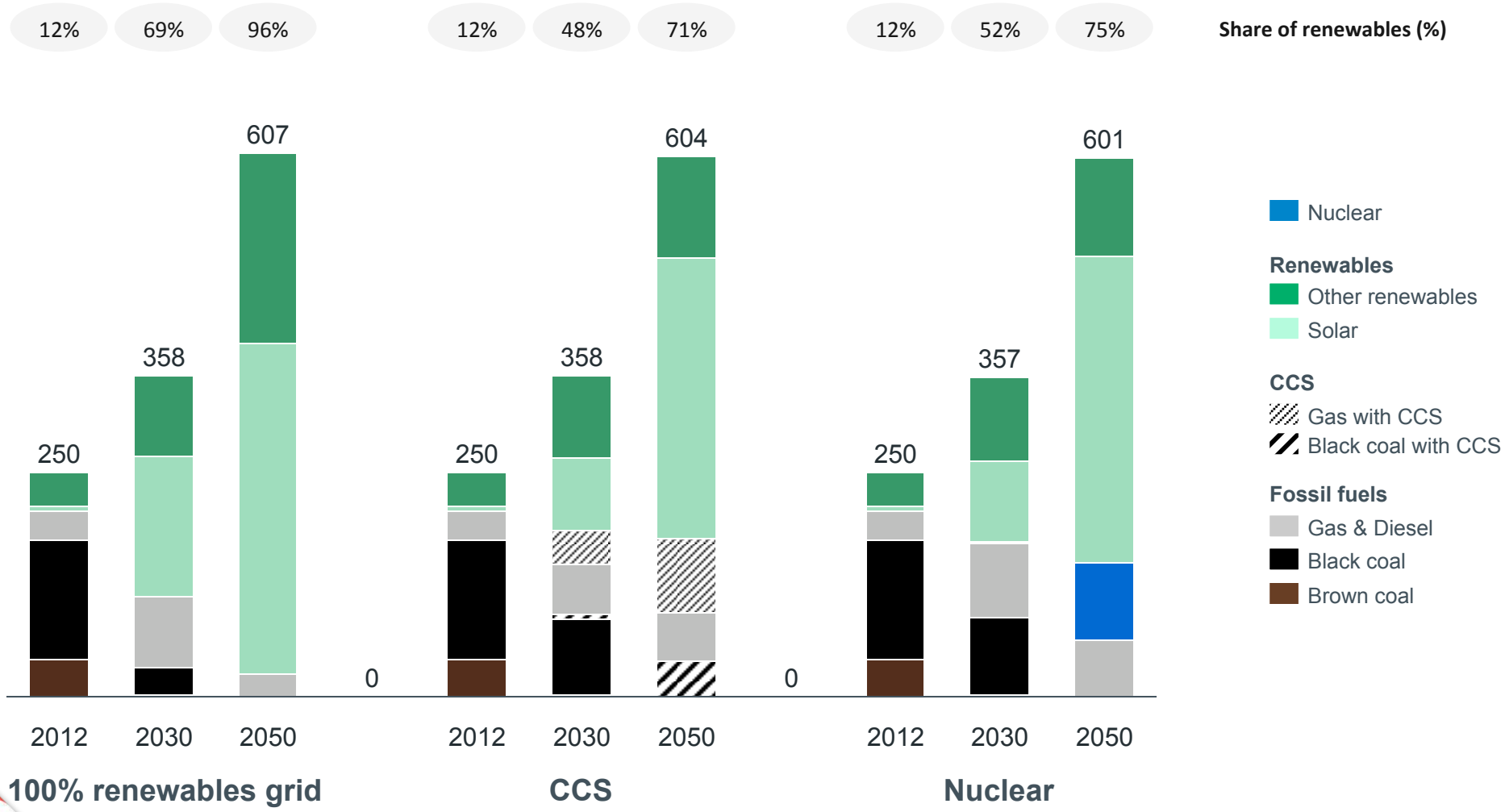
Nationally, primary use of gas would decrease but final use would increase slightly, with a shift of demand from buildings to transport



Source: Pathways To Deep Decarbonisation In 2050: How Australia Can Prosper In A Low Carbon World - ClimateWorks Australia and ANU

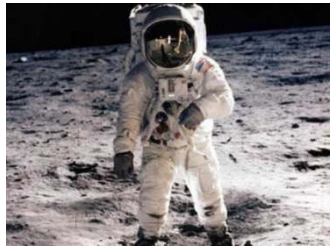
Renewables becomes the dominant electricity source as Australia's electricity grid can be almost completely decarbonised – three scenarios at similar costs

Generation for three electricity scenarios, TWh



Past developments also show that technological step change is achievable within the required time frame

- In 1933 the world was still emerging from the great depression but by 1969...



- Today, solar panels cost less than 10% of their 1980 cost and half their cost in 1998

- 20 years ago very few people had an email address @

- 7 years ago very few people had a smartphone

FOR FURTHER INFORMATION:

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http://www.climateworksaustralia.org/project/current-project/pathways-deep-decarbonisation-2050-how-australia-can-prosper-low-carbon

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Transport Fuels from Australia's Gas Resources

Advancing Australia's Energy Security

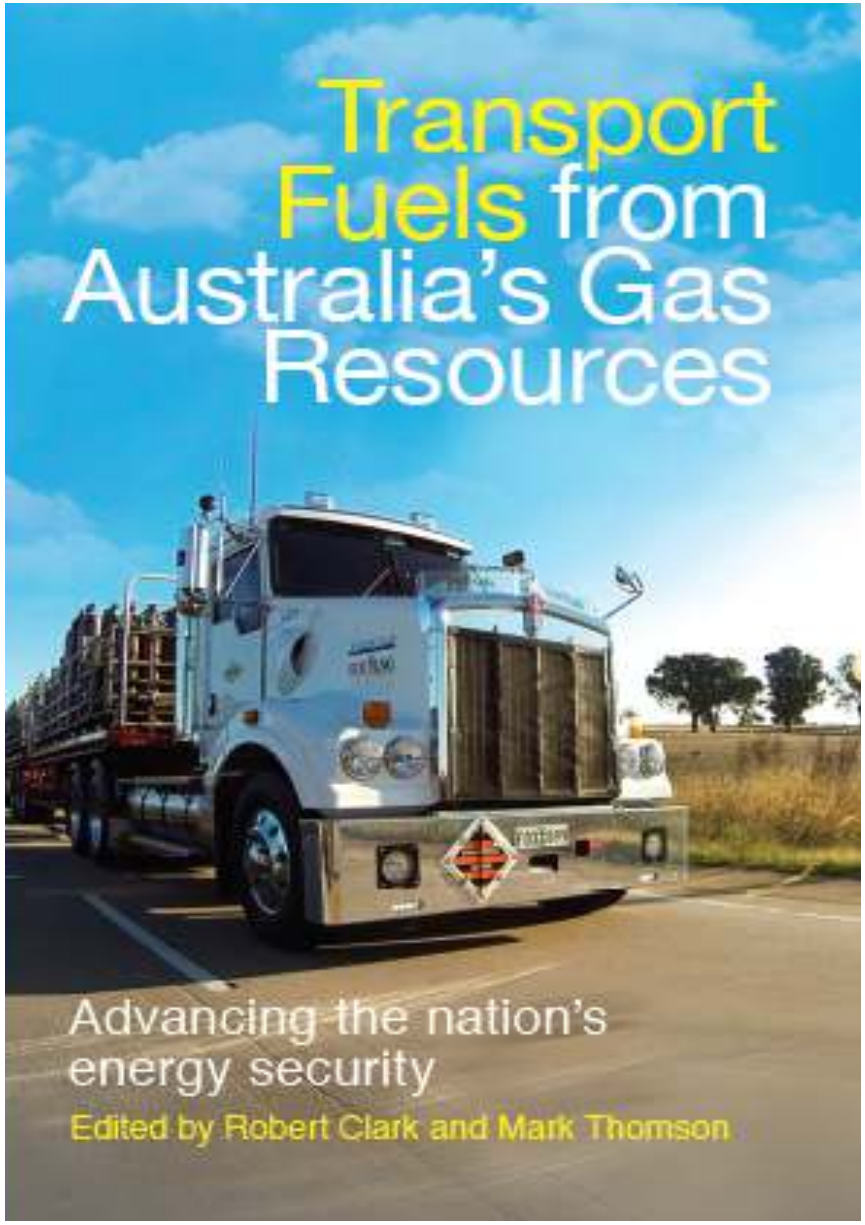
UNSW Press Book – December 2014

Institutional Lead Authors

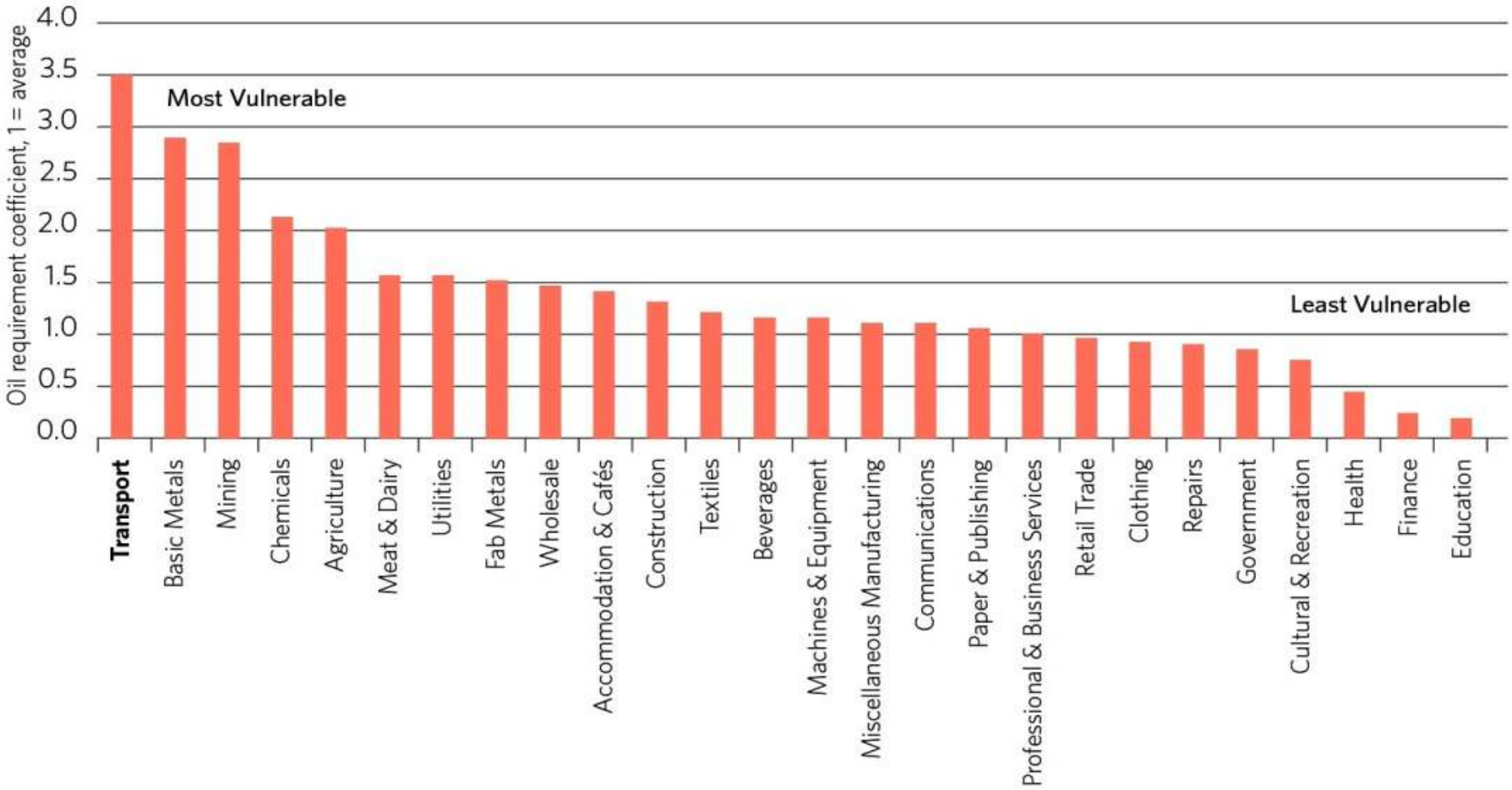
- **Dr Mark Thomson – *Australian Strategic Policy Institute***
- **Professor Dianne Wiley, Professor Sandra Kentish – *CO2CRC***
- **Dr Paul Graham, Dr Nick Burke, Dr Justine Lacey – *CSIRO***
- **Mr Barry Goldstein, Mr Nick Panagopoulos – *SA Govt***
- **Drs Clinton Foster, Marita Bradshaw, Andrew Stacey – *GA***
- **Mr Tony Wood – *Grattan Institute and Clinton Foundation***
- **Dr Susan Pond AM – *United States Studies Centre***
- **Professor Robert Clark AO – *UNSW***

Grattan Institute & State Library of Victoria, Tuesday 21 July 2015

Policy Pitch – Natural gas: part of the problem or part of the solution?

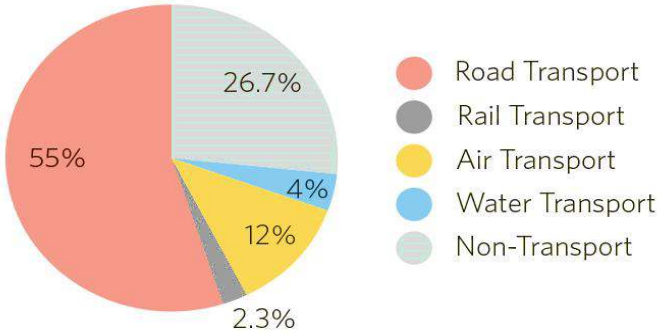


AUSTRALIA: OIL REQUIREMENT BY INDUSTRY SECTOR



Source: ABS, UBS, AMP Capital Investors

AUSTRALIA: OIL CONSUMPTION BY TRANSPORT SECTOR, 2009



ARTICULATED TRUCKS: ROAD FREIGHT SHARE BY BROAD COMMODITY CLASS, 2007

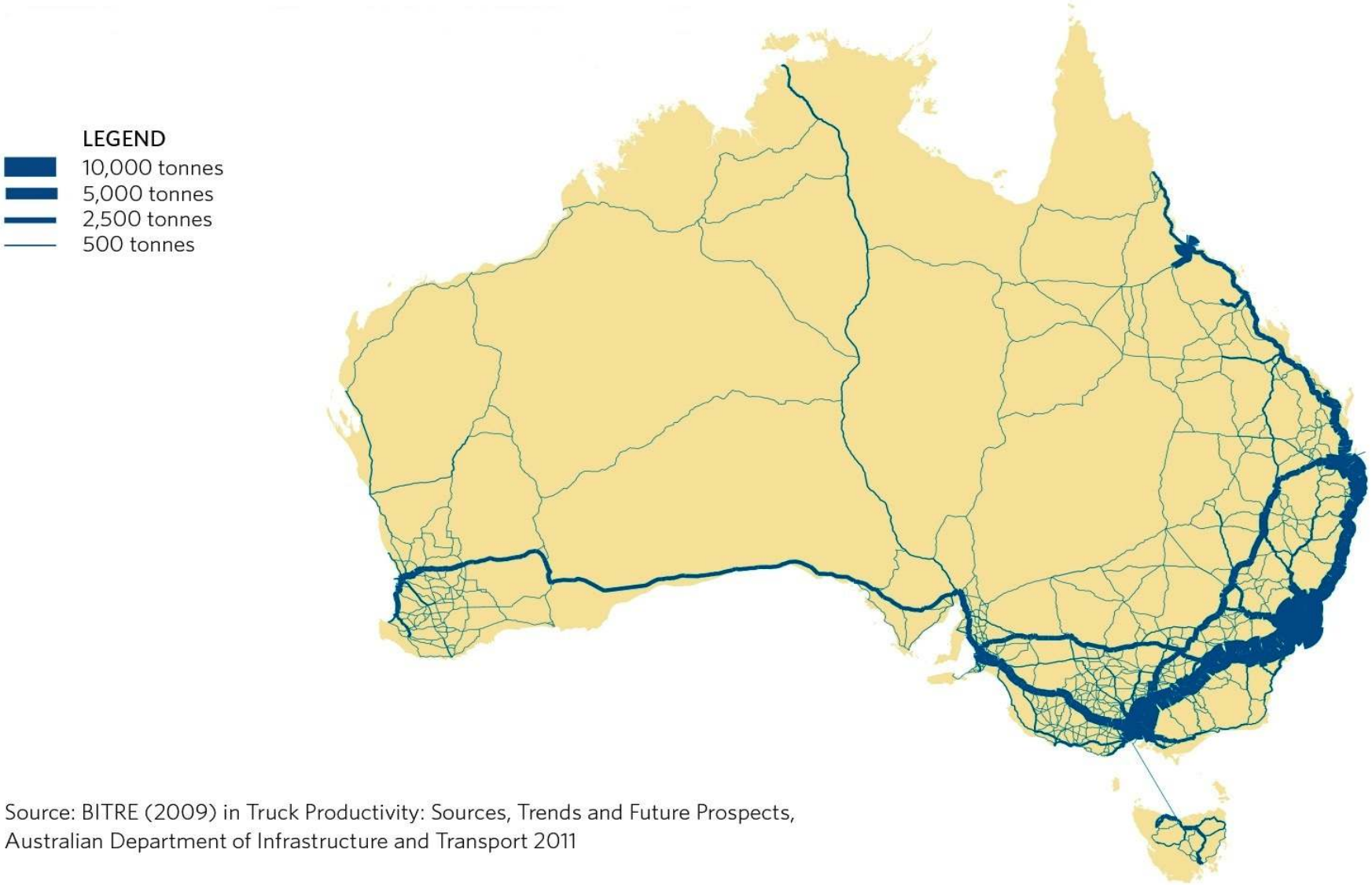
AUSTRALIA: ROAD TRANSPORT VEHICLE STATISTICS, 2012

All Vehicles	Number (M)	Total km per year (B)	Freight Vehicle Average km per year (,000)	Litres of Fuel per year (B)	Freight Vehicle Average Fuel Consumption (L/100 km)	Freight Tonne-km per year (B)	Vehicle Average Load (t)	POTENTIAL FUTURE
Passenger	12.68	167.5		18.5 (85% petrol)		-		
Freight	3.12	60.5		12.5 (see below)		194		**LNG/CNG**
Other	0.8	4.5		1		-		
TOTAL	**16.6**	**232.5**		**32**		**194**		
Light Commercial	2.58	43.7	16.9	5.5 (50% diesel) (43% petrol)	12.6	7.76	0.4	**CNG**
Rigid Truck	0.44	9.3	20.8	2.65 (diesel)	28.7	35.3	5.6	↑↓
Articulated Truck	0.087	7.4	83.0	4.26 (diesel)	57.7	151	24.8	**LNG**

Retabulated from:
Survey of Motor Vehicle Use, Australia 2012, ABS

4.3 BL/a diesel ~ 7 BL/a LNG (x1.62) ~ 3 Mt/a LNG
3 Mt/a LNG requires ~ 0.15 Tcf/a gas
0.15 Tcf/a gas requires ~ 300 shale gas wells (at avge 1.5mmcf/d)

ASSIGNED INTER-REGIONAL ROAD FREIGHT, 2005



Source: BITRE (2009) in Truck Productivity: Sources, Trends and Future Prospects, Australian Department of Infrastructure and Transport 2011

ROAD FREIGHT IN AUSTRALIA, 2007: INTERSTATE, CAPITAL CITY, REST-OF-STATE

(Billions Tonne-Km)

Australia	Capital City		Interstate				Rest-of-State
				From	To	Through	
182.5	Sydney	11.20	NSW	13.72	12.24	7.13	16.33
	Melbourne	11.20	VIC	7.31	7.57	0.62	12.67
	Brisbane	7.47	QLD	2.61	2.59	-	20.84
	Perth	5.09	WA	1.99	1.28	-	20.61
	Adelaide	2.61	SA	2.81	3.00	0.86	5.03
	Hobart	0.36	TAS	-		-	3.03
	Darwin	0.26	NT	0.31	0.64	-	0.79
	Canberra	0.26	ACT	0.01	0.04	-	-
Total							
182.5		38.4			64.7		79.3
Articulated truck percentage							
78%		49%	~100%				88%

Source: 'Road Freight Estimates and Forecasts in Australia' & 'Truck Productivity', BITRE 2010 & 2011

80% of Australian road freight is transported over distances of < 100km

MICRO LNG SUPPLY CHAIN: LOGGING TRUCKS, TASMANIA

LNG Plant

LNG Refuelling Station

LNG Dispenser

Truck LNG Tank

Source: RARE Consulting - LNG for Trucking in Tasmania, ANGVA 2011 Conference

US HEAVY DUTY VEHICLE LIFECYCLE GHG EMISSION REDUCTIONS – LNG/CNG VS DIESEL

		Reductions		
Vehicle/Fuel	Baseline Vehicle/Fuel	WTT	TTW	WTW
HDV LNG (NA NG)	Heavy Duty Truck Ultra-low-sulfur Diesel	22-57%	20%	21-28%
HDV CNG (NA NG)	Heavy Duty Truck Ultra-low-sulfur Diesel	53%	22%	29%

HDV – Heavy Duty Vehicle
TTW – Tank to Wheels
NA NG – North American Natural Gas
WTW – Well to Wheels
WTT – Well to Tank

AUSTRALIAN TAIL PIPE EMISSION REQUIREMENTS: DIESEL/NG HEAVY DUTY VEHICLES

Standard	Date Introduced	Emission Limits (g/kWh)				Emissions Test
		CO	NMHC	NOx	PM	
ADR 80/3	Jan 2010 – Jan 2011	1.5 4.0	0.46 0.55	2.0 2.0	0.02 0.03	ESC ETC

ADR – Australian Design Rule
NMHC – Non-Methane Hydrocarbon
ESC – Euro Stationary Cycle
PM – Particulate Matter
ETC – Euro Transient Cycle

US: SENSITIVITY OF PAYBACK PERIODS TO ASSUMPTIONS

INTEREST RATE	FUEL PRICE DIFFERENTIAL ($ per gallon)	VEHICLE COST DIFFERENTIAL								
		$35,000			$70,000			$100,000		
		FUEL ECONOMY								
		5.6 mpg	5.1 mpg	4.6 mpg	5.1 mpg			5.6 mpg	5.1 mpg	4.6 mpg
		VMT 70K			VMT 125K	VMT 90K	VMT 70K	VMT 70K		
0.05	$1.50	1.62	1.82	2.14	2.05	2.91	3.82	5.03	5.70	6.81
	$0.75	3.04	3.82	5.54	4.33	6.29	8.52	10.27	13.63	23.17
	$0.50	4.30	6.03	11.98	6.89	10.36	14.62	15.93	26.73	-
0.10	$1.50	1.73	1.95	2.31	2.22	3.22	4.36	5.99	6.98	8.75
	$0.75	3.39	4.36	6.74	5.03	7.90	11.96	16.30	37.30	-
	$0.50	4.99	7.48	22.72	8.88	16.54	-	-	-	-
0.31	$1.50	12.09	-	-	3.30	6.35	-	-	-	-
	$0.75	-	-	-	-	-	-	-	-	-
	$0.50	-	-	-	-	-	-	-	-	-

Payback period < 4 years beyond 15 years infinite

VMT: Vehicle Miles Travelled per Year mpg: Miles per Gallon

Source: Resources for the Future/National Energy Policy Institute – Energy, Greenhouse Gas and Economic Implications of Natural Gas Trucks, A. Krupnick, 2010

LNG for Articulated Trucks – Summary

- Replacement of diesel with LNG as a transport fuel for heavy articulated trucks that distribute Australia's critical freight would provide a *significant energy security enhancement.*
- *Left to market, LNG penetration* of diesel fuel for trucks likely to be *only ~ 5% or less over 5 years.*
- The key economic factor for *truck operators*, assuming refuelling infrastructure is available, is *payback period - 2 years or less can be decisive.* The increased cost and availability of NG trucks is a central issue.
- The *key barrier* for LNG transport fuel penetration significantly beyond 5% is the *cost and commercial risk of scaling up to LNG plant around 1 M t/a capacity.*
- *Commercially-available technology* for LNG as a transport fuel for Australian truck requirements has been developed for all aspects of the supply chain – *but there are availability issues.*
- LNG offers important *life-cycle GHG emission reductions* over diesel with reductions at the *20% level,* together with around *50% noise reduction.*
- Overall, LNG as a transport fuel for heavy trucks is *still 'below the line'* with regard to current supply chain economics in Australia, due to a number of detailed factors. *None of these factors appear to be insurmountable however.*
- LNG for heavy articulated trucks is only likely to happen through the *development of a compact between government and industry to forge a national roll-out plan.* Both *metropolitan* and *major highway* scenarios should be considered.
- LNG for trucks initiative *aligns well with TIC truck plan* submitted to government.

Key Recommendations

- The priority action to assess a road freight natural gas supply chain in Australia is for government and industry to jointly convene a task force of supply-chain stakeholders to examine the economics, policy and regulatory settings, costs and benefits, prospective routes and hubs to commence deployment, and examine the commercial readiness of infrastructure and technical options.

- Where the use of natural gas in road transport falls short of commercial viability in the immediate future, as a second key step the Federal Government, in consultation with state governments through the Council of Australian Governments (COAG) process, should consider the findings of the task force to determine whether intervention by regulation and government investment is appropriate.

- In the context of Australia's energy security risk profile and to achieve greater resilience, government intervention to accelerate the uptake of natural-gas-fuelled heavy road freight beyond penetration rates anticipated from market forces alone may be appropriate.

- More specifically, establishment of natural gas supply-chain infrastructure at Port Botany, Port Melbourne and Port Brisbane hubs for metropolitan freight distribution, in addition to the key long-haul Melbourne–Sydney–Brisbane freight corridor, should be considered.

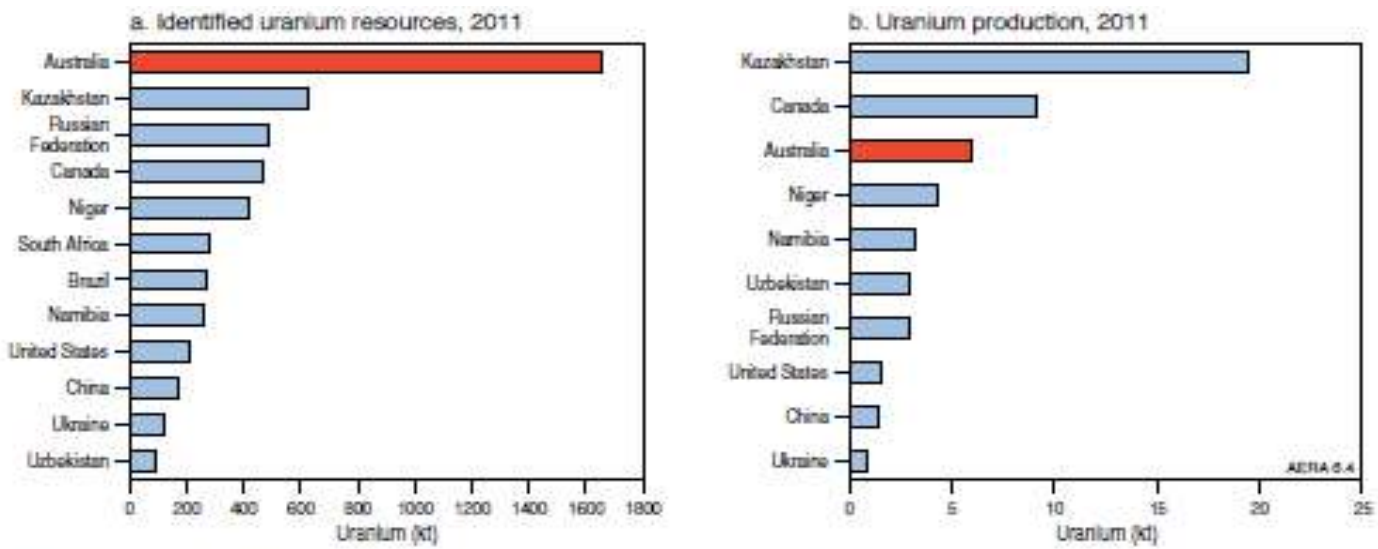
- In this consideration, Australian assembly of natural gas trucks, their emissions and safety benefits, and issues related to accessing commercial-ready fit-for-purpose natural gas engines, require detailed deliberation.

Case for Nuclear in Australia's Energy Mix?

In the context of coal and gas: driver – emissions

Some Numbers:

- Emissions – Electricity generation largest contributor to global CO_2 emissions
  2003 – 40% (10 Bt CO_2), 2030 projection – 50 % of increase
- World – Average penetration of nuclear in electricity generation ~15%
- Australia – Total electricity generation~ 250 Twh
  – 15 % nuclear penetration = 5 x 1000 MW reactors
  – Uranium oxide exports ~ 8,000 – 12,000 tonnes
  = 250 – 375 Twh
  or 100 – 150% Australia's electricity generation



- Australia's uranium oxide exports displace ~ 400 Mt CO_2 each year (relative to black coal)