



Australia's Electricity Generation

Dr Mark Ho

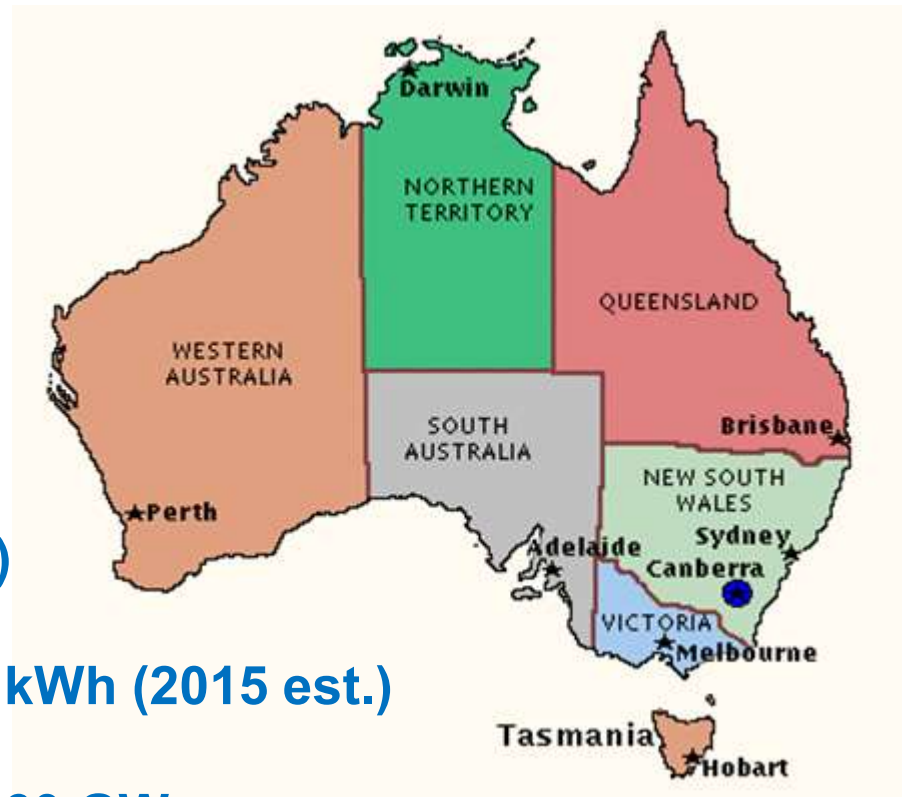
Australian Nuclear Science and Technology Organisation

IAEA SMR-TWG meeting April 2018

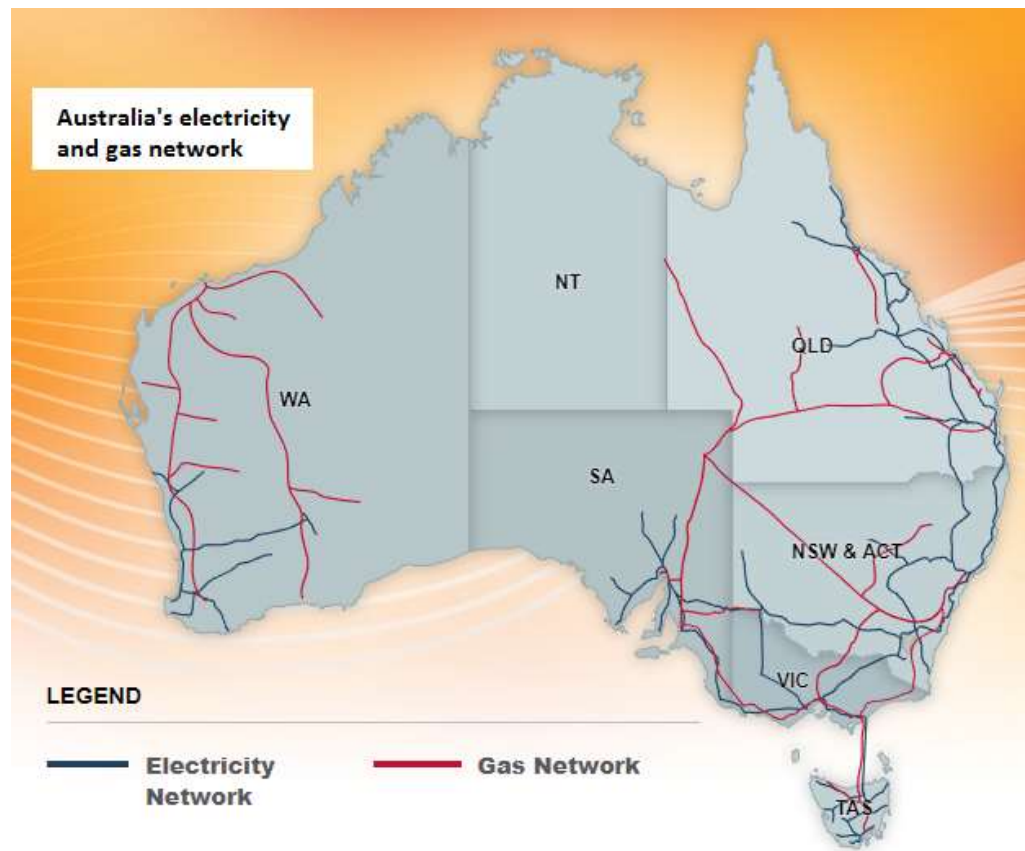
Australia

Quick Facts

- 25 Million people
- 7.7 million km²
- Coast dwelling
- GDP: 1.482 trillion USD (13th)
- E-consumption 223.6 billion kWh (2015 est.)
- Total Generation Capacity ~ 60 GW



Electricity and Gas Network



Source: Australian Electricity Market Operator (AEMO)



2016-17 transmission congestion heat map

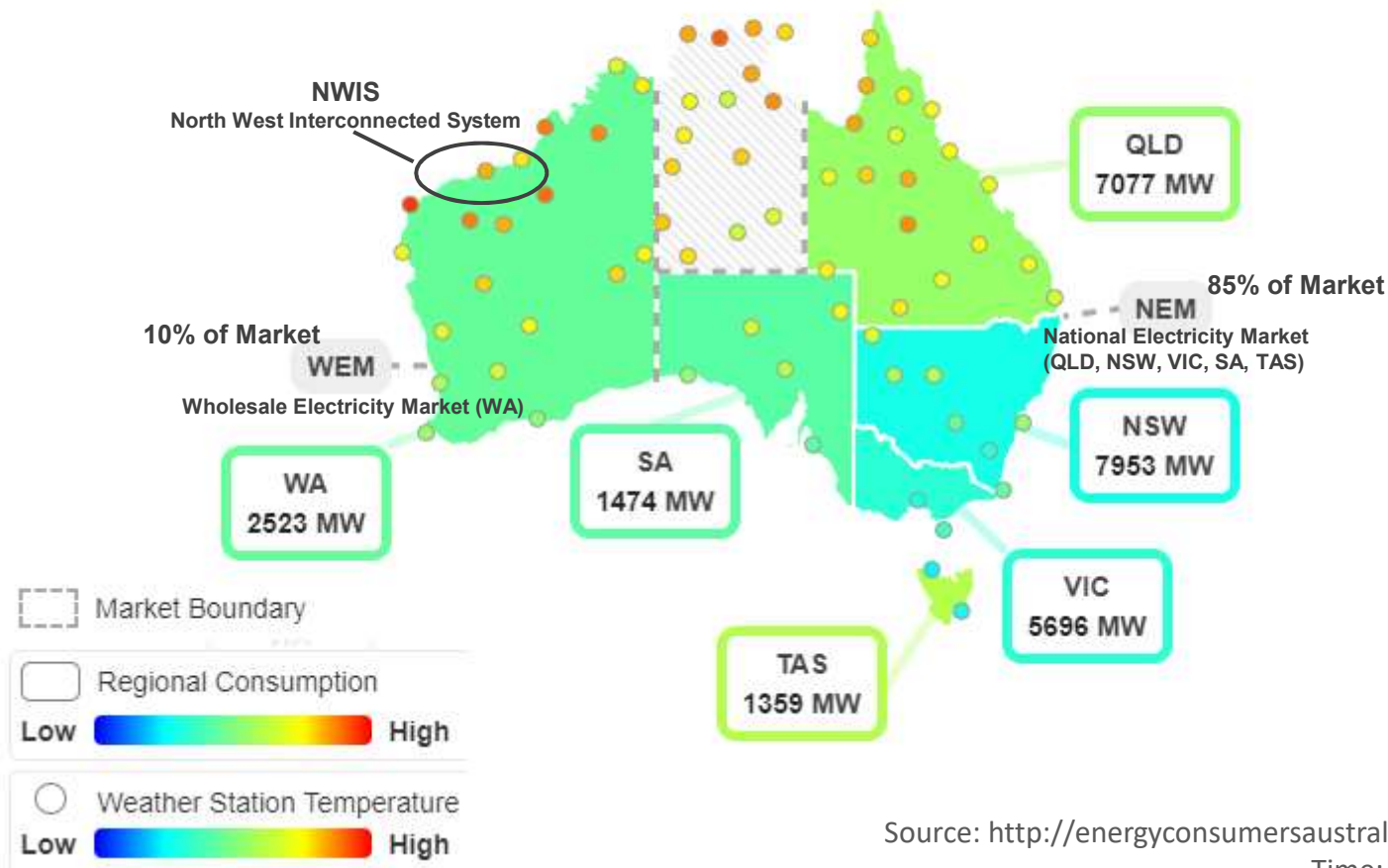
Electricity Consumption



Live Electricity Consumption
sponsored by ECA



Live: Tue 17th Apr 18 20:52 UTC +10:00

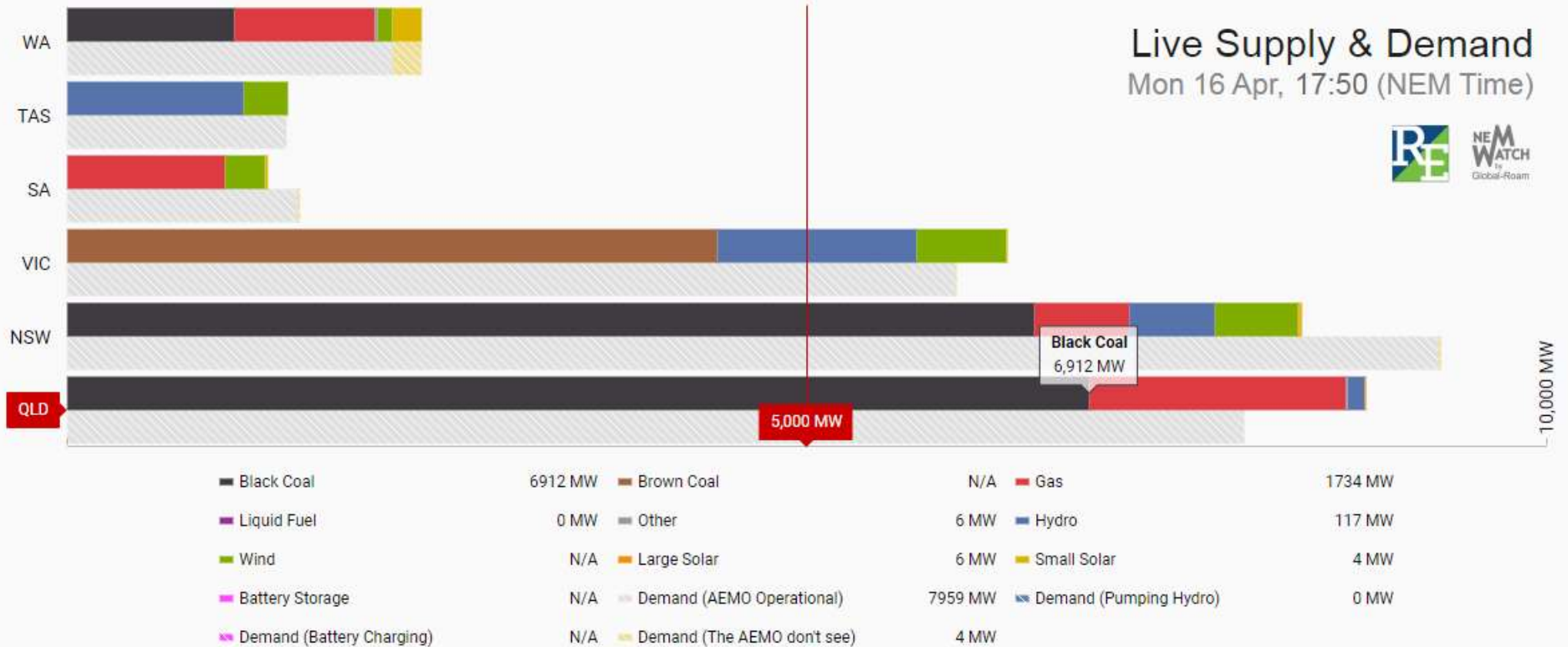


State	historic high [MW]	historic low [MW]
NSW	14835	5114
VIC	10572	3271
QLD	9605	4037
SA	3441	11 ^[1]
WA	2451	1285
TAS	1910	524

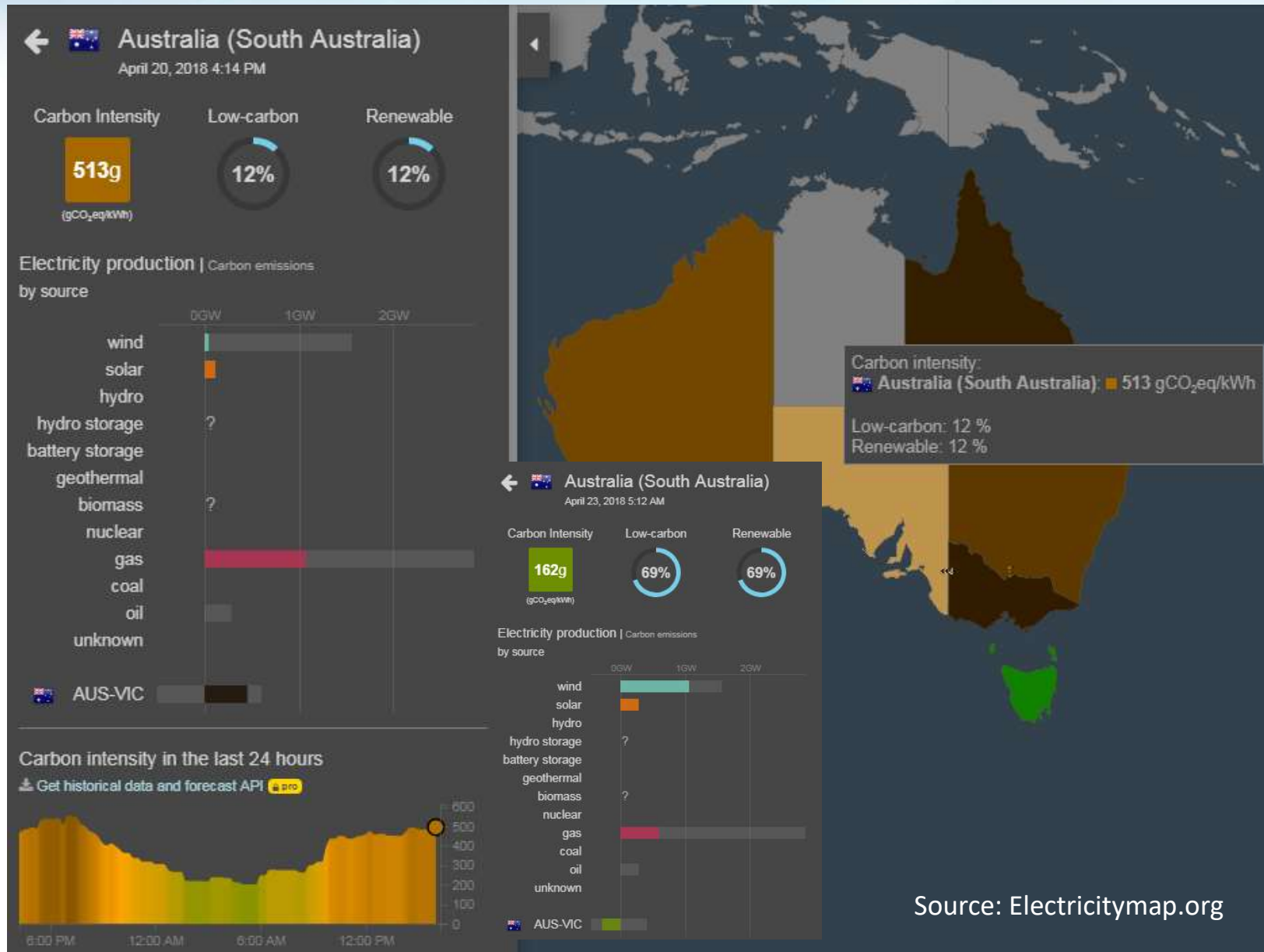
¹SA state blackout, September 28th, 2016

Source: <http://energyconsumersaustralia.com.au/connect/electricity-map/>.
Time: April 17th 8:50pm Eastern Std. Time.

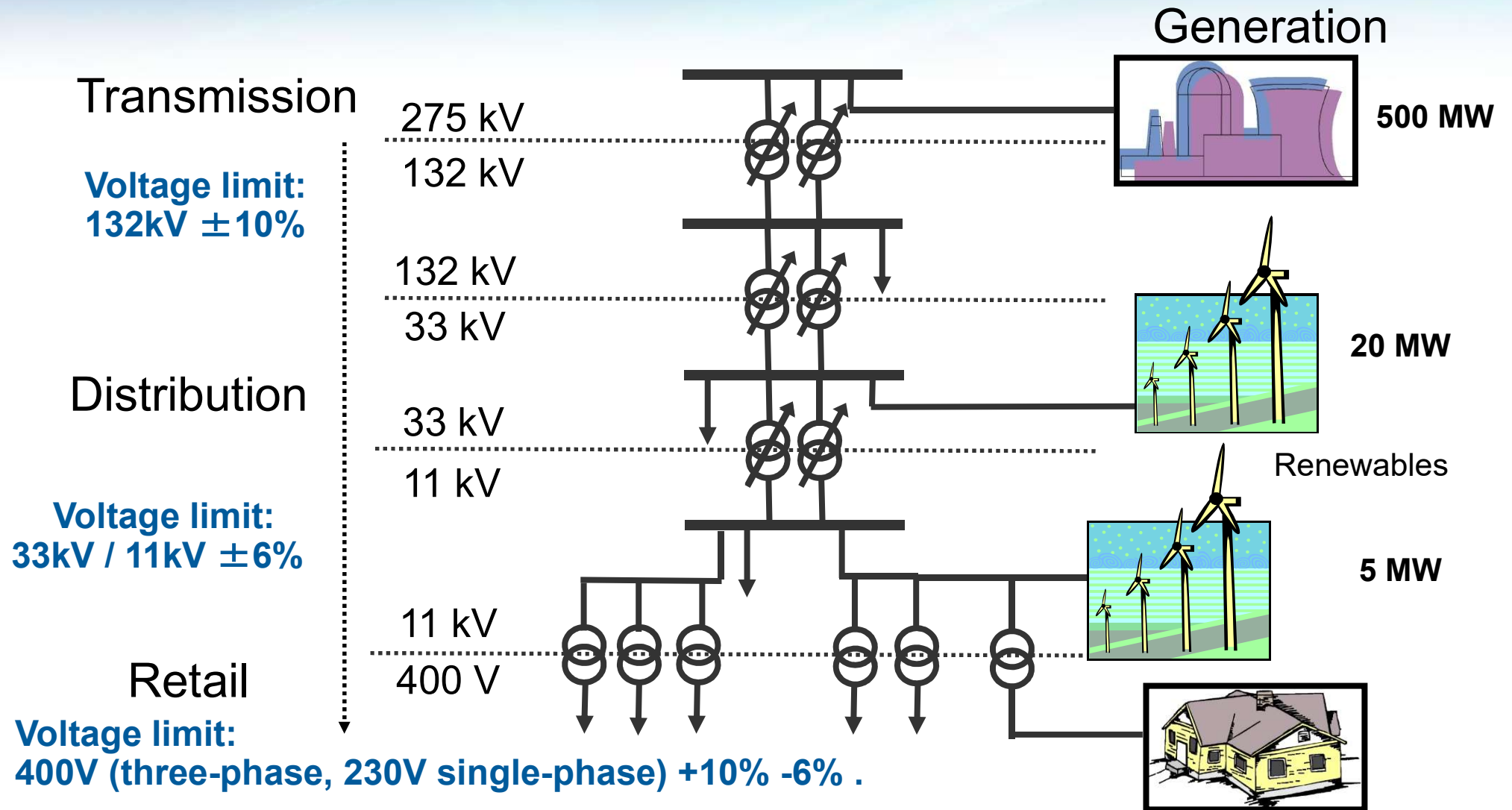
Snapshot of peak usage.



Carbon Intensities



Network Structure



Source: Professor John Fletcher (UNSW)

Market players in Australia

- Generators
 - Delta, TRUEnergy, AGL-Macquarie
- Transmission network operators (275 kW)
 - Transgrid, Power link
- Distribution network operators (33 kW)
 - Endeavour, Ausgrid, Essential Energy
- Retailers
 - AGL, Origin, EnergyAustralia

Electricity costs

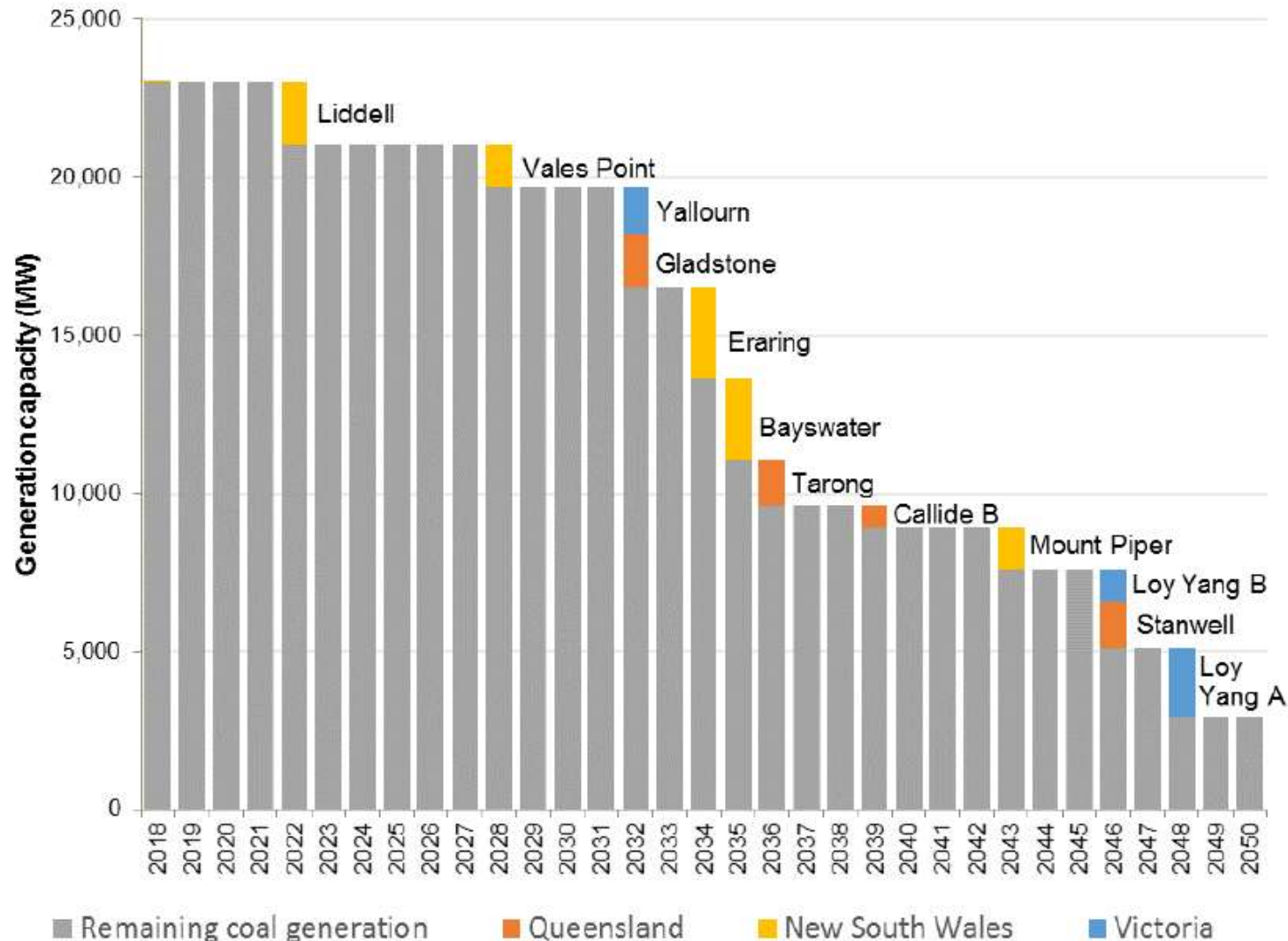
Each dollar paid in an electricity bill is distributed as follows (approx):

- Generation – 20 cents
- Transmission – 20 cents
- Distribution – 40 cents
- Retailer – 20 cents

What does this mean?

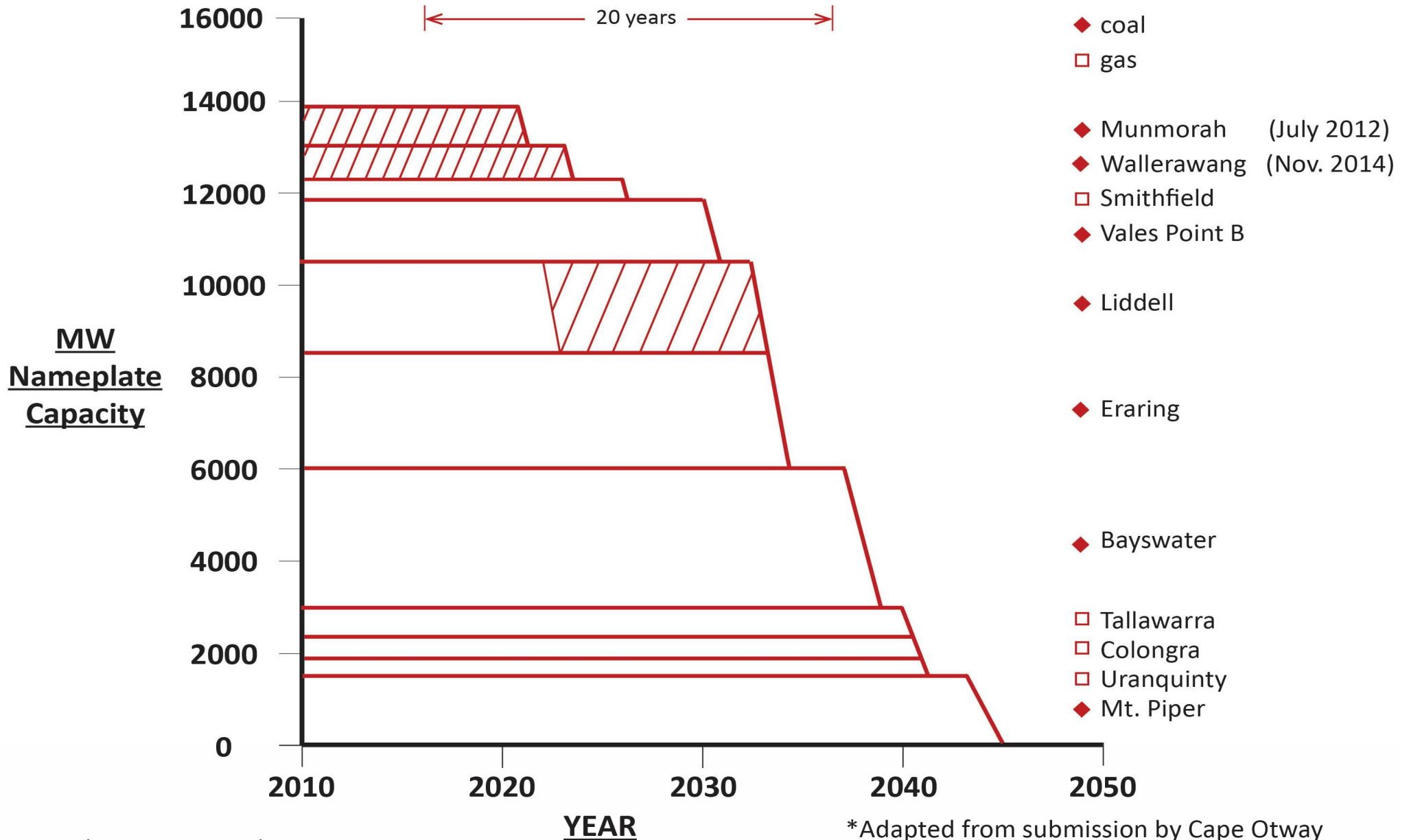
Only 20% of the bill buys the energy used in each households.

Energy Transition



NEM coal generation fleet operating life to 2050, by 50th year from full operation or announced retirement (AEMO)

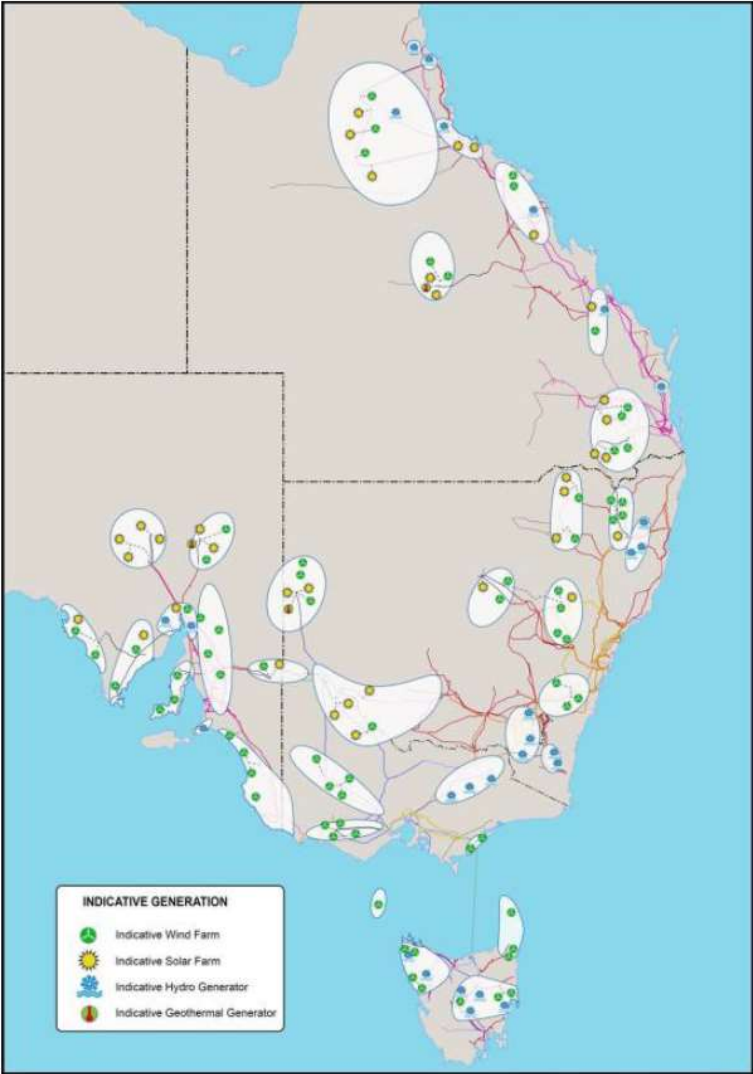
NSW thermal generation outlook



Graphics :Barry Murphy.

*Adapted from submission by Cape Otway Associates to Finkel Inquiry, June 2017

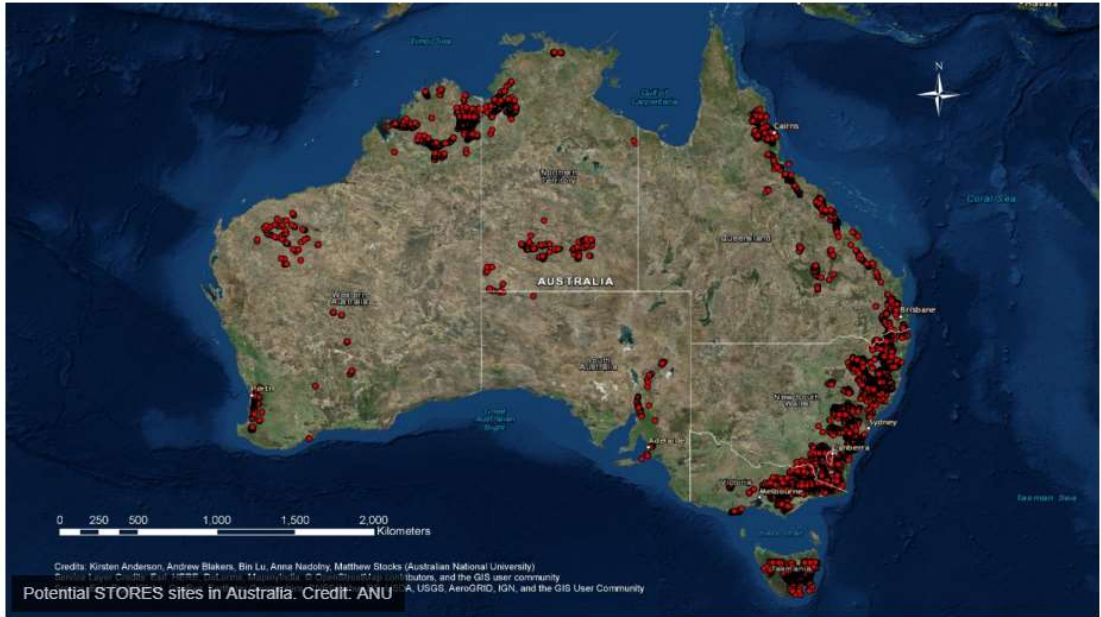
Renewables & Storage



Possible “renewable energy zones” (AEMO)

ANU finds 22,000 potential pumped hydro sites in Australia

21 SEPTEMBER 2017



The Australian National University (ANU) has completed an audit of 22,000 potential sites across Australia for pumped hydro energy storage, which can be used to support a secure and cheap national electricity grid with 100 per cent renewable energy.

The zero-emissions grid would mainly rely

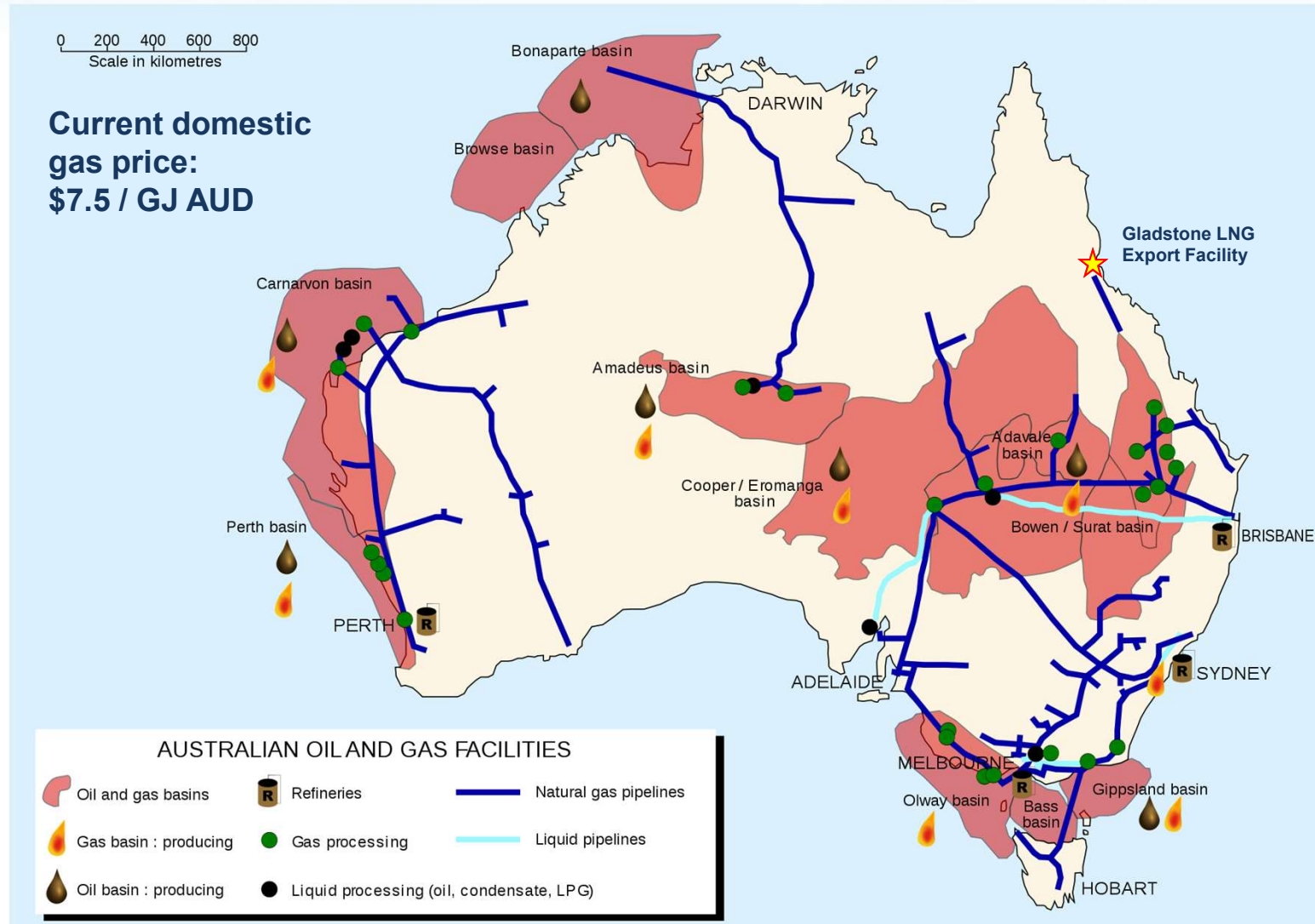
“Fast tracking the development of a few of the best sites by 2022 could balance the grid when Liddell and other coal power



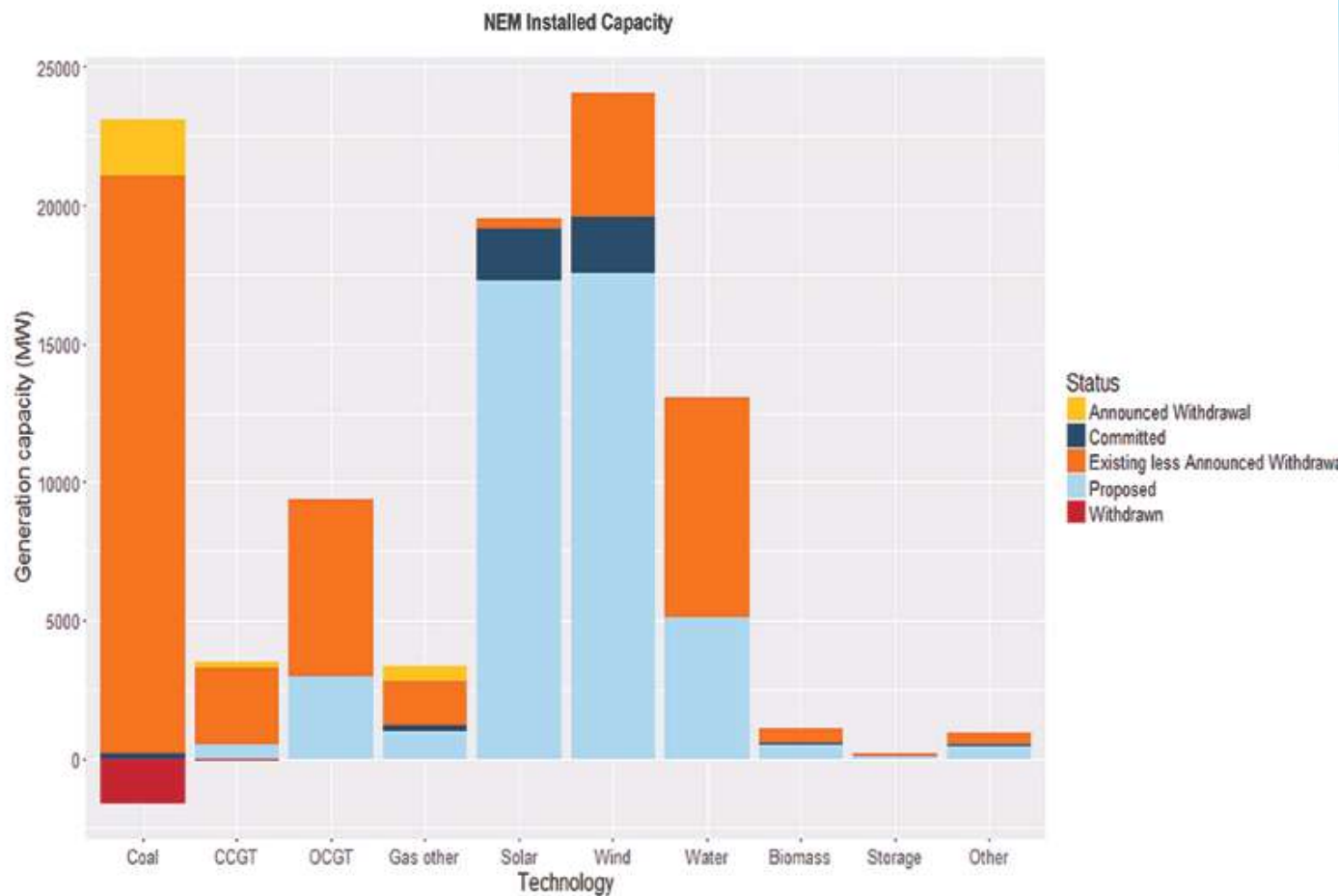
For journalists

<http://www.anu.edu.au/news/all-news/anu-finds-22000-potential-pumped-hydro-sites-in-australia>

Gas Resources



AEMO future planning



Status	Coal	CCGT	OCGT	Gas other	Solar*	Wind	Water	Biomass	Storage	Other	Total
Existing	22,916	3,013	6,439	2,159	323	4,462	7,941	580	100	419	48,352
Announced Withdrawal	2,000	208	34	510	-	-	-	-	-	-	2,752
Existing less Announced Withdrawal	20,916	2,805	6,405	1,649	323	4,462	7,941	580	100	419	45,600
Committed	178	-	4	210	1,877	2,032	4	24	32	29	4,390
Proposed	-	500	2,960	975	17,297	17,568	5,098	521	80	475	45,484
Withdrawn	1,600	62	-	-	-	-	-	-	-	-	1,662

Note: Existing includes Announced Withdrawal. This data is current as at 16 March 2018

* Excludes rooftop PV installations

Source: AEMO

Climbing Costs

Australians pay highest power prices in world

3-6 August 2017
The Australian Financial Review | www.afr.com

Exclusive

Ben Potter and Andrew Tillett

Australian residential customers are paying the highest electricity prices in the world – two to three times more than American households – but experts say they need more than information to navigate the thicket of discounts and offers.

South Australian households are paying the highest prices in the world at 47.13c per kilowatt hour, more than Germany, Denmark and Italy, which benefit from energy, after the huge increases on July 1, Carbon + Energy Markets' Markham data service says.

When the nation's new National Electricity Market was formed in the late 1990s, Australia had the lowest retail prices in the world along with the United States and Canada, CME director Bruce Mountain said.

The shocking reveal explains why Prime Minister Malcolm Turnbull has nominated energy retailer chief executives to Canberra next week to explain why they are charging households and small businesses so much compared to their counterparts in other countries.

In a letter he complained that big retailers were content to let customers slip off the deep discounts they attracted them with after a year or two, and were a costly standing offer or a much smaller discount.

AGL Energy chief executive Andy Veary admitted last year that big power companies were guilty of punishing their most loyal customers in this way, but said subsequently AGL was abandoning the practice.

Australian Competition and Consumer Commission chairman Rod Sims said last week he wanted to help consumers find better offers and lower barriers to new entrants to curtail the market power of AGL, Origin Energy, EnergyAustralia and Queensland's state-owned power monopoly.

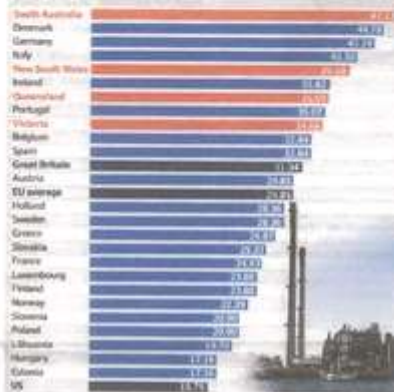
Now households typically pay 20c/kWh – based on Italy's levels – while Queensland and Victoria's typical retail charges of 34.7c to 35.5c/kWh exceed those in all but the four or five most expensive European countries, the Markham data shows.

When taxes are excluded, the four Australian NEM states have the costliest residential electricity in the world. American households – which benefit from a large market and cheap and abundant natural gas – pay just 10.2c/kWh (0.575c), the US Energy Information Administration says.

The annual cost to households of accepting a standing offer from one of the big three retailers instead of the best offer in the market has been estimated by the St Vincent de Paul Society to be \$400 in Victoria, \$800 in Queensland and \$1000 to \$2000 in NSW and South Australia.

Electric shock

Retail electricity prices of NEM states, including taxes, compared to selected countries (\$ per kWh)



Mr Mountain said ordinary customers without sophisticated spreadsheets and analytical skills had little hope of analysing competing offers to work out the best power deal.

Private competition websites do not include all market offers and charge retailers for switching customers, while the websites offered by the Australian Energy Regulator and the Victorian

It's a market characterised by very high search costs, which means it is very hard to find the right offer.

Bruce Mountain, CME director

government do not provide the tools consumers need to discriminate among offers.

"It's a market characterised by very high search costs, which means it is very hard to find the right offer and people make mistakes," Mr Mountain said. "Customers are stressed and it's characterised as 'people are lazy'."

Energy Minister Josh Frydenberg said the government wanted energy retailers to be more transparent around electricity bills, and left open the option of regulation.

"People may get a discount for one or two years but reverts on a contract for five or six years, but they don't know when the discount ends and therefore they don't know when they could be getting a better deal elsewhere," he told the AFR.

"The Prime Minister wants to eyeball the retailers and to tell them that we all need to do better to ensure particularly vulnerable households ... get the best possible deal become right now, it seems, many of them are stuck on standing offers, which are not as attractive as market offers."

Energy executives did not comment on the retail price comparisons. "We're actively aware of how price rises are impacting Australian households and businesses," Origin chief Frank Calabrese said. "All of us in the industry and the government need to work urgently together on the issue."

An EnergyAustralia spokesperson said recent price and output trends in the NEM suggest that the energy system is working as intended, in the interests of families and businesses, and electricity "must be available when people need it and at an affordable price".

EnergyAustralia urged governments to make it easier for consumers by creating a national comparison rate for electricity prices, and a national accreditation scheme for energy comparison services to improve consumer confidence and understanding.

THE AUSTRALIAN BUSINESS REVIEW

NEWS OPINION BUSINESS REVIEW NATIONAL AFFAIRS SPORT LIFE TECH ARTS TRAVEL HIGHER

MINING & ENERGY

Wholesale energy prices double in a year in Victoria and South Australia



Victorian Premier Daniel Andrews. Picture: AFP

The Australian | 12:00AM January 30, 2018

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Save



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Average wholesale energy prices in Victoria and South Australia have more than doubled since this time last year, as experts warn that blackouts and supply issues are

Final report reveals the causes of South Australia's statewide blackout

A FINAL report into South Australia's statewide blackout has been released today that highlights what authorities need to do to keep the lights on.



Charis Chang [@CharisChang2](#)

news [CONFIRM](#) MARCH 28, 2017 2:50 PM



One of the damaged power towers on private property near Melbourne in South Australia. Source: News Corp Australia

AUSTRALIA'S electricity system needs to adapt to the increasing use of renewable energy, a final report into South Australia's statewide blackout has found.

The Australian Energy Market Operator has highlighted valuable lessons and challenges identified following the blackout of September 28, which cut power to 850,000 customers in South Australia.

While the [Federal Government](#) was keen to blame the state's reliance on renewable energy for the blackout, AEMO said two tornadoes were the likely cause of five electrical faults that happened before the network went down.

The state was left without electricity for hours when the tornadoes brought down three major transmission lines in the state's north.

But AEMO's investigations found nine of the state's 13 wind farms did switch off because they were unable to withstand voltage disturbances.

This ultimately caused faults in the system that caused the blackout because it overloaded the Heywood interconnector, which provides SA with electricity from Victoria.

Electricity Market Reform – ESB, NEG

- At the moment there is only an Energy Market but not a Capacity Market.
- Hazelwood (1.4GW in Victoria) has already closed.
- AGL (Australian Gas and Light) set to close Liddell Coal fired power plant (2GW). There's pressure for AGL to sell to Alinta¹.
- Investor uncertainty for new generation.

ESB: Energy Security Board

NEG: National Energy Guarantee

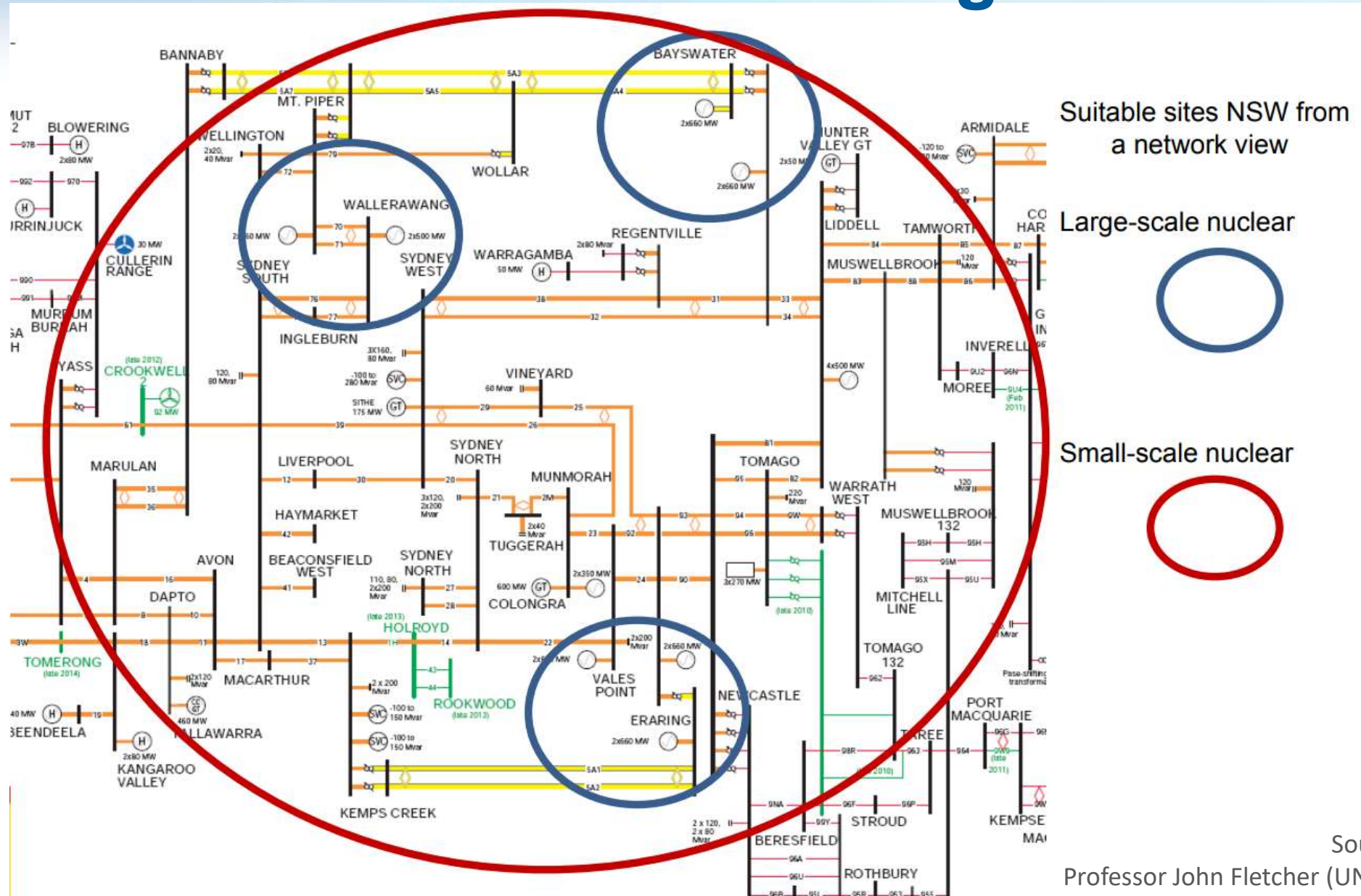
1. <http://www.afr.com/news/malcolm-turnbull-pressure-agl-to-sell-liddell-to-alinta-20180403-h0yang>

How could SMRs compare?



	NuScale SMR (3 x 50 MWe)	Macarthur Wind Farm (140 turbines)	Ivanpah Concentrated Thermal
Capex (AUD)	\$1 billion	\$ 1 billion	\$ 2.9 billion
TWh / annum	1.183	1.288	1.078
Land area	18	5,500	1,420
Dispatchable?	Yes	No	No
Capacity factor	90%	35%	20.5%
Lifespan	40-60	25	25

SMR flexible siting



Nuclear activities

1. NFC Royal Commission in South Australia (2016).
2. Ongoing work by the Department of Industries on the National Radioactive Waste Management Facility (NRWMF).
3. Recent ascension to Gen IV forum.
4. Australia remains a major exporter of uranium
5. Robust operations of the OPAL (20 MW_{th}) research reactor

South Aust. NFC RC Recommendations

1. Pursue removal at the federal level of existing prohibitions on nuclear power generation to allow it to contribute to a low-carbon electricity system, if required;
2. Promote and collaborate on the development of a comprehensive national energy policy that enables all technologies, including nuclear, to contribute to a reliable, low-carbon electricity network at the lowest possible system cost;
3. Collaborate with the Australian Government to commission expert monitoring and reporting on the commercialization of new nuclear reactor designs that may offer economic value for nuclear power generation;
4. Pursue the opportunity to establish used nuclear fuel and intermediate level waste storage and disposal facilities in South Australia.



Thanks for listening.

Questions?