



The Electric Power system

Australia



cigre

For power system expertise

Power System of Australia

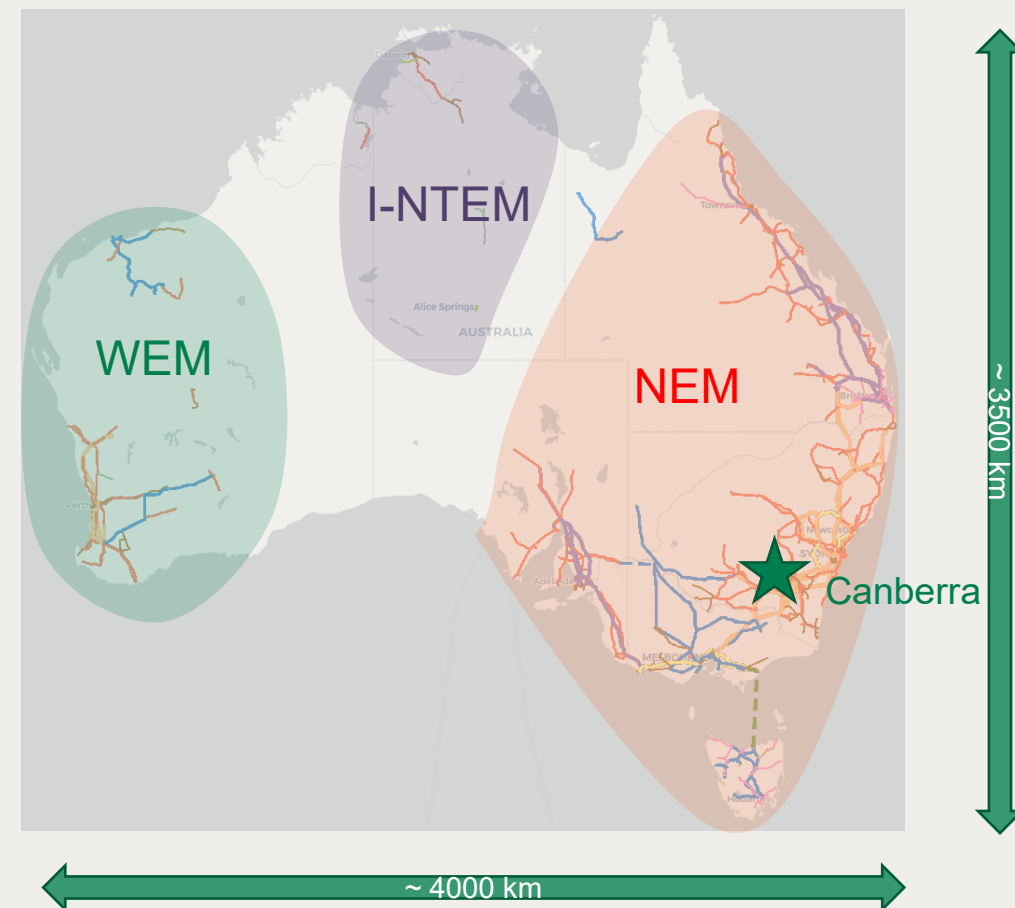
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Introduction

- 4 large scale electricity networks
- National Electricity Market (NEM) comprises the states of Queensland (Qld), New South Wales (NSW), Victoria (Vic), South Australia (SA) and Tasmania (Tas)
- Due to geographic vastness of Australia, Western Australia (WA) and the Northern Territory (NT) have three electricity systems and markets.
 - SWIS and NWIS in WA
 - DKIS in NT
 - Gas pipelines have recently connected Qld and NT



Basic Facts

- Area: 7,741,220 sq km
- Population: 25,464,116 (as at 30 September 2019 - ABS)
- Annual growth rate: 1.5% (ABS)
- Number of electricity consumers: 9.35m (7.1m (NEM), 1.1m (WEM), 0.25m (I-NTEM))
- Three distinct large scale Electricity Markets:
 - National Electricity Market (NEM): Eastern Australia incl Tasmania
 - West Australian Energy Market (WEM)
 - Interim Northern Territory Electricity Market (I-NTEM)

Source: ABS , AER (State of Market 2019), WattClarity

Basic Facts

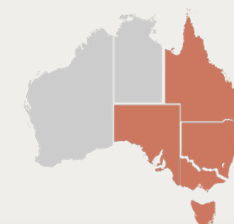
- Transmission System Operators : 8
 - 6 in the NEM
 - 1 in Northern Territory
 - 1 in Western Australia
- Distribution System Operators : 15
 - 13 in the NEM
 - 1 in Northern Territory
 - 1 in Western Australia
- Peak Demand: NEM: ~34,200 MW Summer Peaking
WA: ~4,000 MW Summer Peaking
NT: ~400MW Summer Peaking

Source: ABS , AER (State of Market 2019), WattClarity

Interconnector Capacities

Interconnector Description	Market Identifier	Common reference	Voltage type	Type	Import Capacity	Towards	Export Capacity	Towards
NSW to QLD AC Interconnection - QNI	NSW1-QLD1	QNI	AC	Regulated	1090	NSW	500	Qld
Directlink DC Interconnection	N-Q-MNSP1	Terranorra	DC	Regulated	150	NSW	150	Qld
VIC1-NSW1 Interconnection	VIC1-NSW1	Vic to NSW	AC	Regulated	1000	Vic	1500	NSW
Victoria to SA	V-SA	Heywood Interconnector	AC	Regulated	600	Vic	600	SA
Murraylink DC Interconnector (MNSP)	V-S-MNSP1	MurrayLink	DC	Regulated	200	Vic	200	SA
Basslink DC Interconnector (MNSP)	T-V-MNSP1	Basslink	DC	MNSP	500	Tas	500	Vic

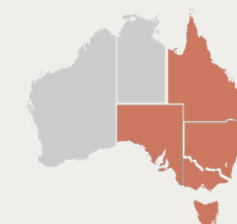
Source: AEMO



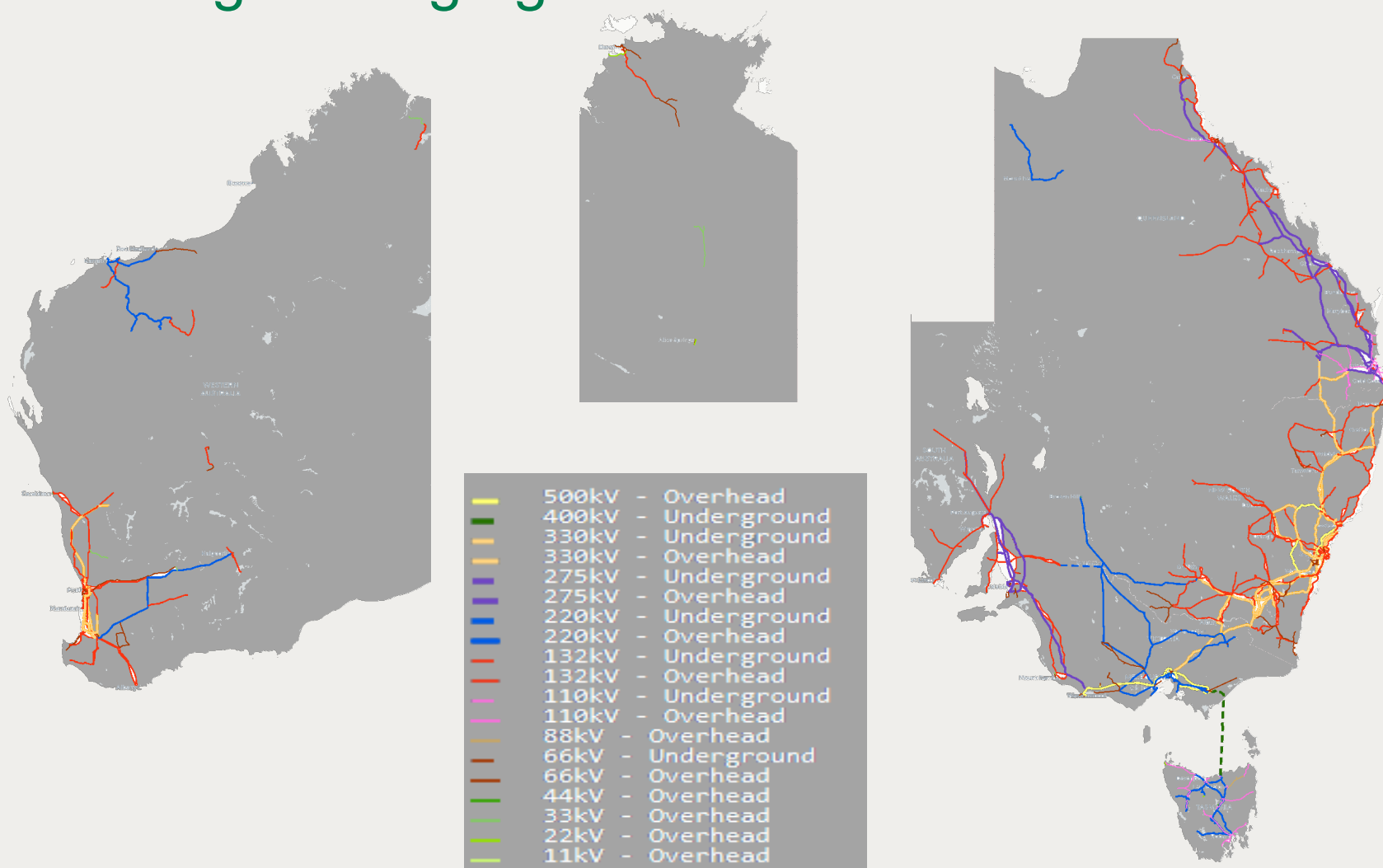
NEM Transmission Network and Interconnectors

Network	Asset Base \$Million (2019)	Owner
Powerlink	7,241	Queensland Government
Transgrid	6,485	Hastings 20%; Spark Infrastructure 15%; other private equity 65%
Ausnet	3,304	Listed company (Singapore Power 31.1%; State Grid Corporation 19.9%)
Electranet	2,606	State Grid Corporation 46.6%; YTL Power Investments 33.5%; Hastings Investment Management 19.9%
TasNetworks	1,456	Tasmanian Government
DirectLink	141	Energy Infrastructure Investments (Marubeni Corporation 49.9%; Osaka Gas 30.2%; APA 19.9%)
MurrayLink	115	Energy Infrastructure Investments (Marubeni Corporation 49.9%; Osaka Gas 30.2%; APA 19.9%)
Basslink	Unregulated	Keppel Infrastructure Trust

Source: AER

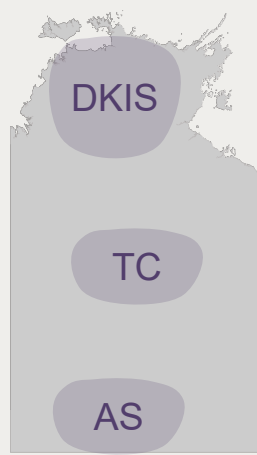
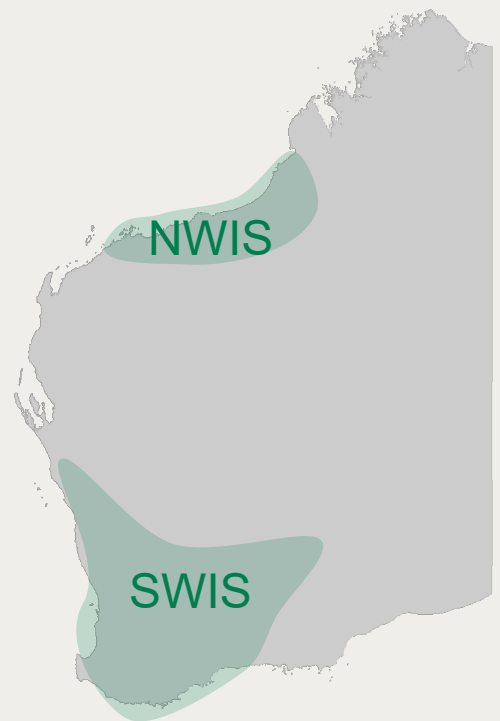


Map of the high voltage grid

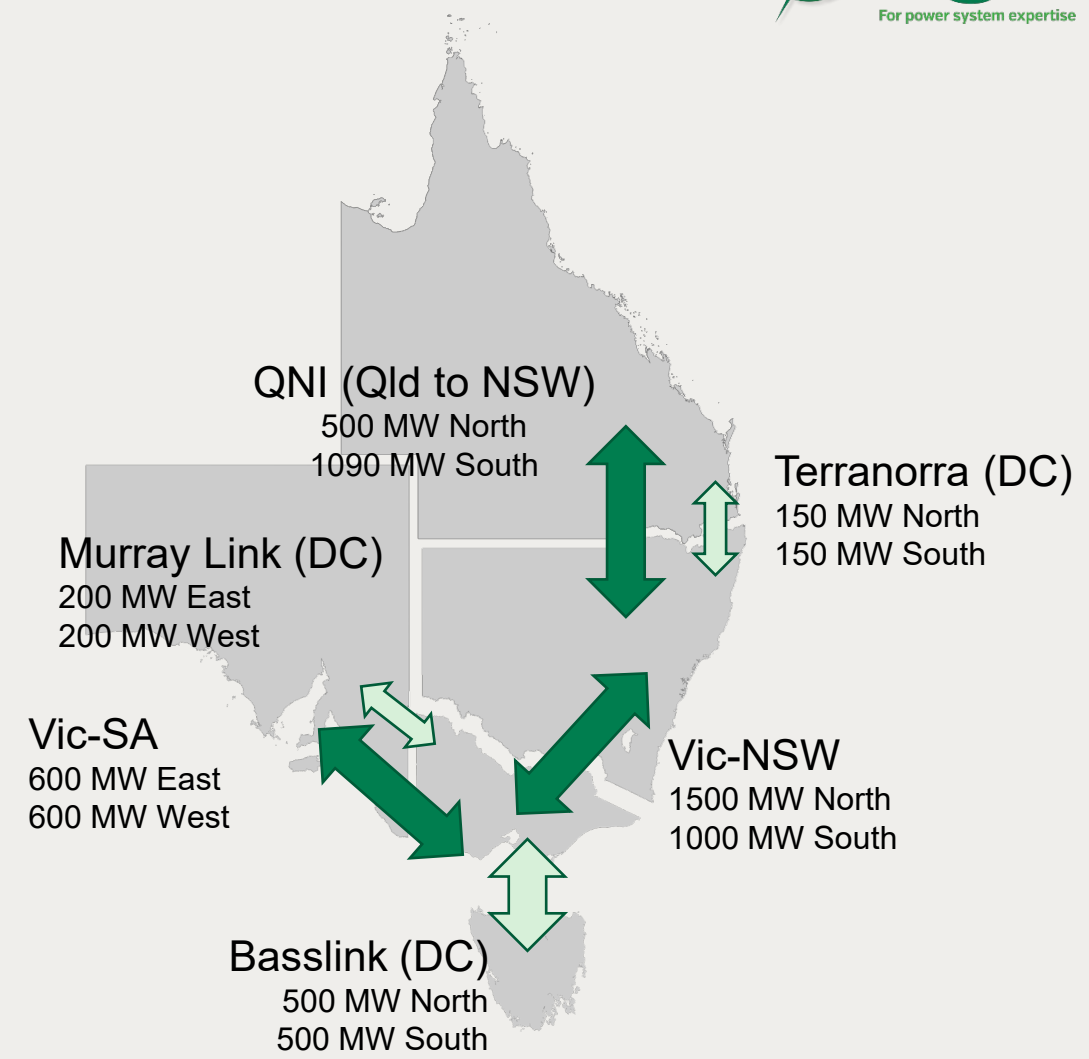


Map of Interconnections

SWIS: South West Interconnected System
 NWIS: North West Interconnected System



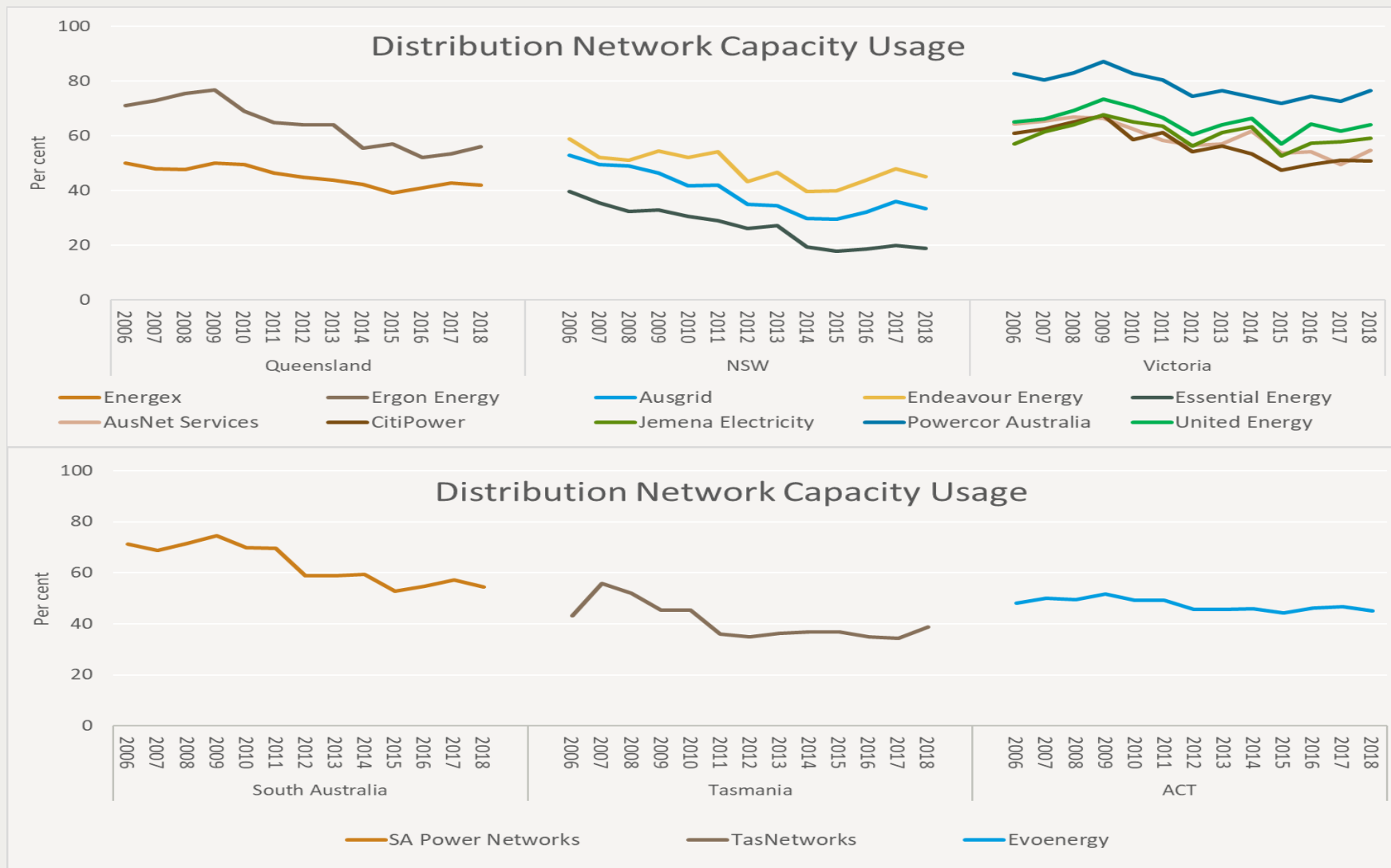
DKIS: Darwin-Katherine Interconnected System
 TC: Tennet Creek
 AS: Alice Springs



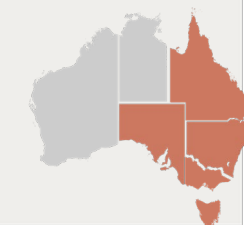
Network ownership

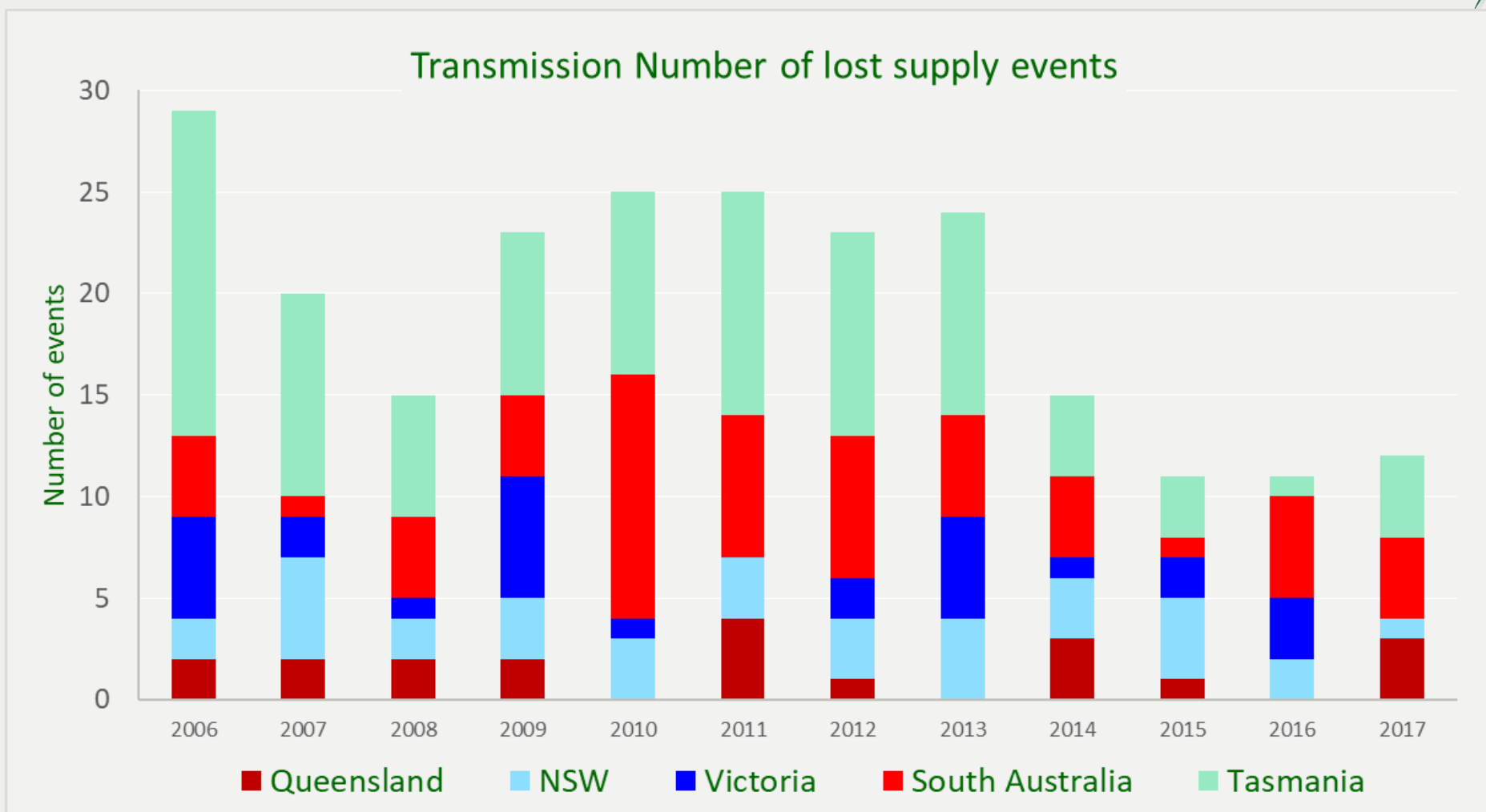


DSO Network Usage - NEM

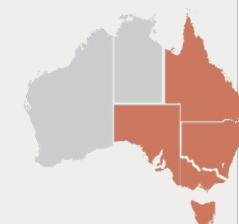


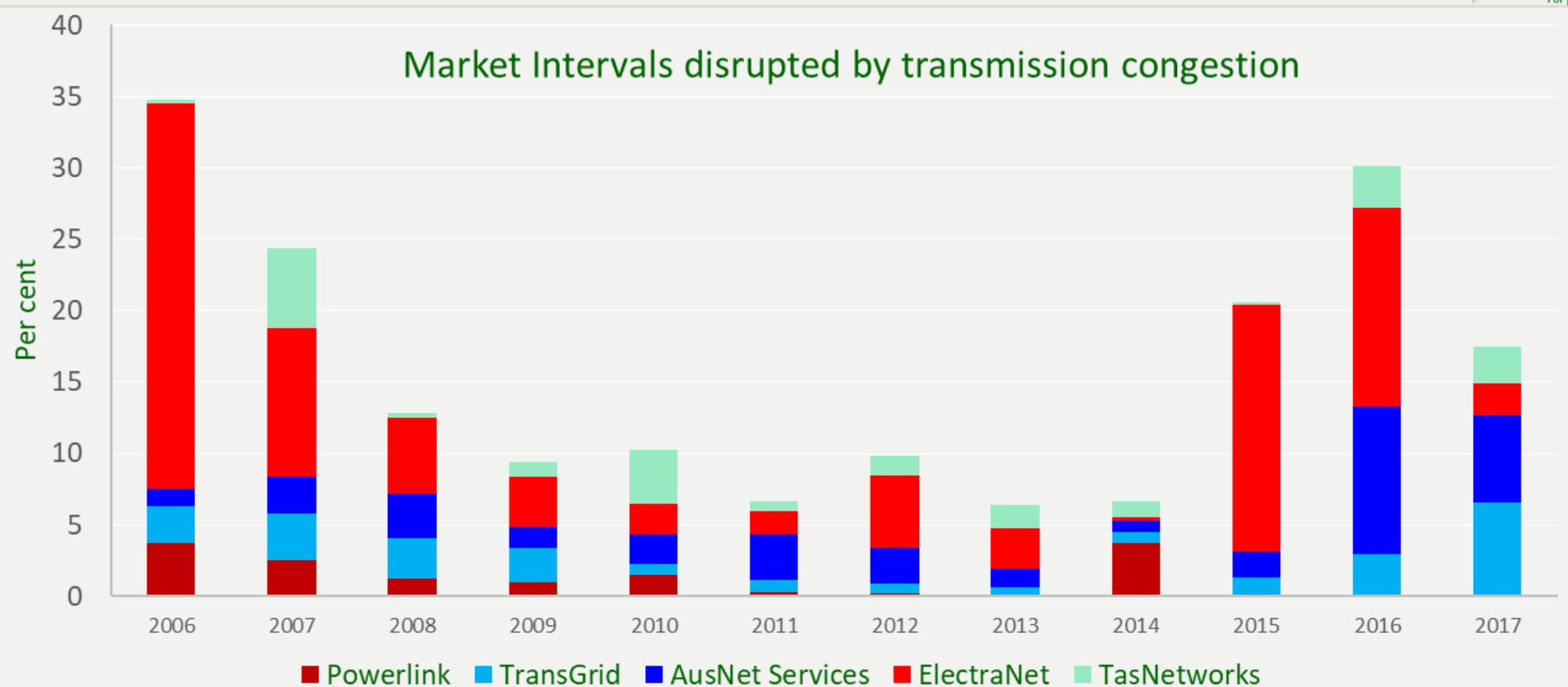
Source: AER



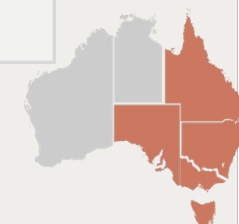


Source: AER





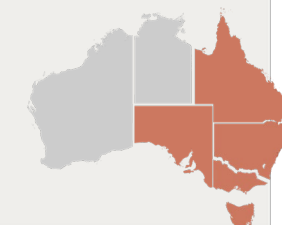
Source: AER



Grid Facts and Characteristics - NEM

Region	Network	Transmission Line Length km (2018)	Maximum Total Demand MW	Date of Max Demand	Electricity transmitted GWh (2018)
Queensland	Powerlink	14,528	10,044	Feb 2019	54,850
New South Wales	Transgrid	13,089	14,580	Feb 2011	75,700
Victoria	Ausnet	6,624	10,415	Jan 2009	42,163
South Australia	Electranet	5,522	3,385	Jan 2011	11,445
Tasmania	TasNetworks	3,545	1,760	Aug 2008	12,434
	Total	43,308			196,592

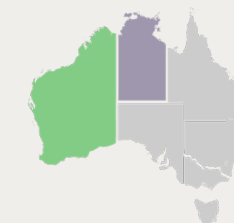
Source: AER, Max Demand figures using public market data



Grid Facts and Characteristics – WA / NT

Region	Network	Transmission Line Length km (2018)	Maximum Total Demand MW	Date of Max Demand	Electricity transmitted GWh (2018/2019)
Western Australia	Western Power	7,800	4,004	Feb 2016	18,000
	Horizon Power	472	480		900
Northern Territory	NT Power	10,520	400	Feb 2008	2,240

Source: AEMO (WA), Horizon Power, NT Power Water, GVSC

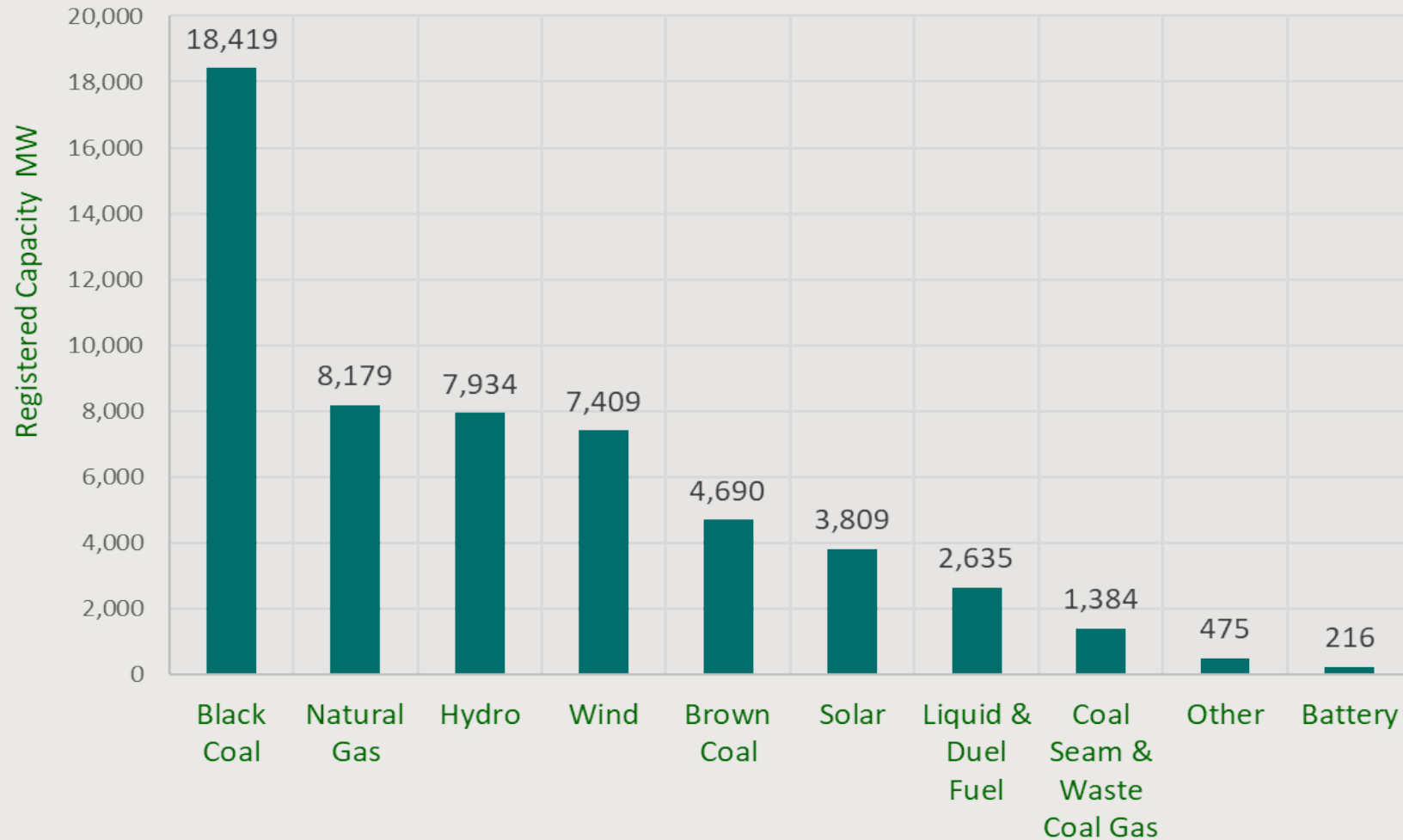


Generation Across Australia – Cal 2019

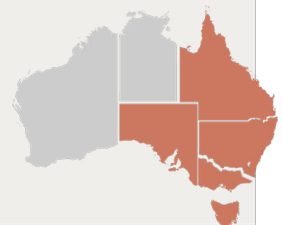
	NSW GWh	VIC GWh	QLD GWh	WA GWh	SA GWh	TAS GWh	NT GWh	AUSTRALIA GWh
Non-renewable fuels								
Black coal	56,431.9		50,000.4	9,926.7				116,359.0
Brown coal		33,136.8						33,136.8
Natural gas	2,989.6	3,894.3	10,576.2	26,180.0	7,530.3	608.3	2,578.9	54,357.5
Oil products	327.7	195.3	1,033.1	2,351.8	137.9	19.0	1,718.0	5,782.8
Total non-renewable	59,749.3	37,226.3	61,609.7	38,458.5	7,668.2	627.3	4,296.8	209,636.1
Renewable fuels								
Biomass	1,191.3	789.9	1,339.3	132.0	85.4	29.7	8.3	3,575.9
Wind	4,385.6	5,358.6	730.5	2,158.2	5,680.5	1,211.1		19,524.5
Hydro	3,420.1	960.7	1,064.5	217.1	8.8	8,758.7		14,429.9
Large-scale solar PV	1,685.9	739.7	2,526.4	95.5	410.9	1.5	35.4	5,495.4
Small-scale solar PV	3,099.3	2,159.4	3,693.2	1,647.4	1,546.0	172.3	137.7	12,455.3
Geothermal								
Total renewable	13,782.2	10,008.3	9,353.9	4,250.1	7,731.6	10,173.3	181.5	55,481.0
Total	73,531.5	47,234.6	70,963.6	42,708.6	15,399.8	10,800.6	4,478.3	265,117.1
<i>Per cent renewable generation</i>	<i>18.7%</i>	<i>21.2%</i>	<i>13.2%</i>	<i>10.0%</i>	<i>50.2%</i>	<i>94.2%</i>	<i>4.1%</i>	<i>20.9%</i>

Totals may not add due to rounding.

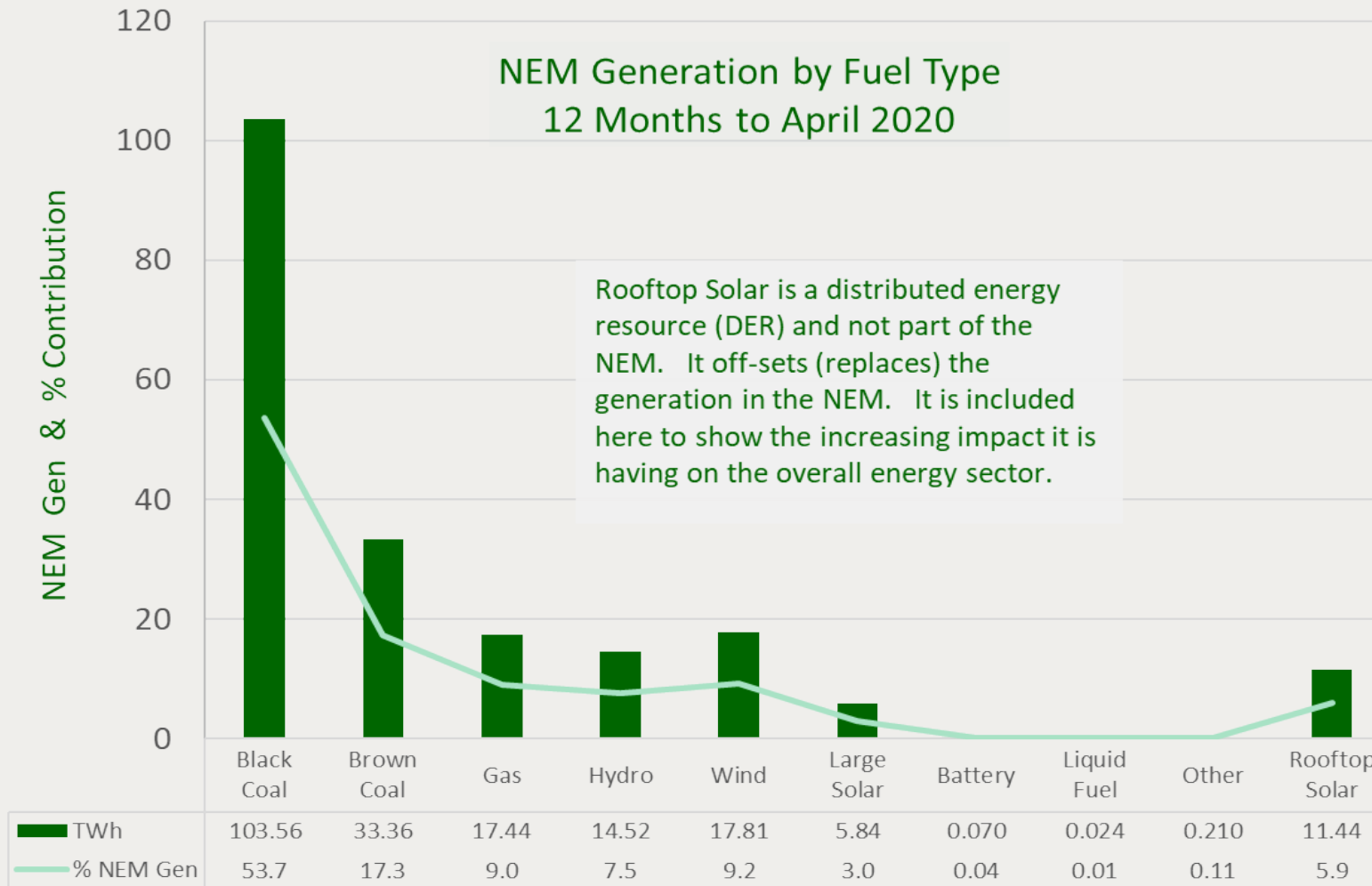
Registered Capacity of Installed Generation in the NEM by Fuel Type



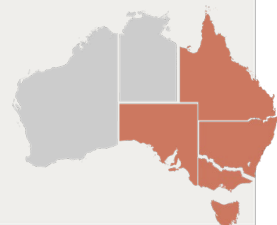
Source: AEMO (raw data as at 31 Dec 2019)



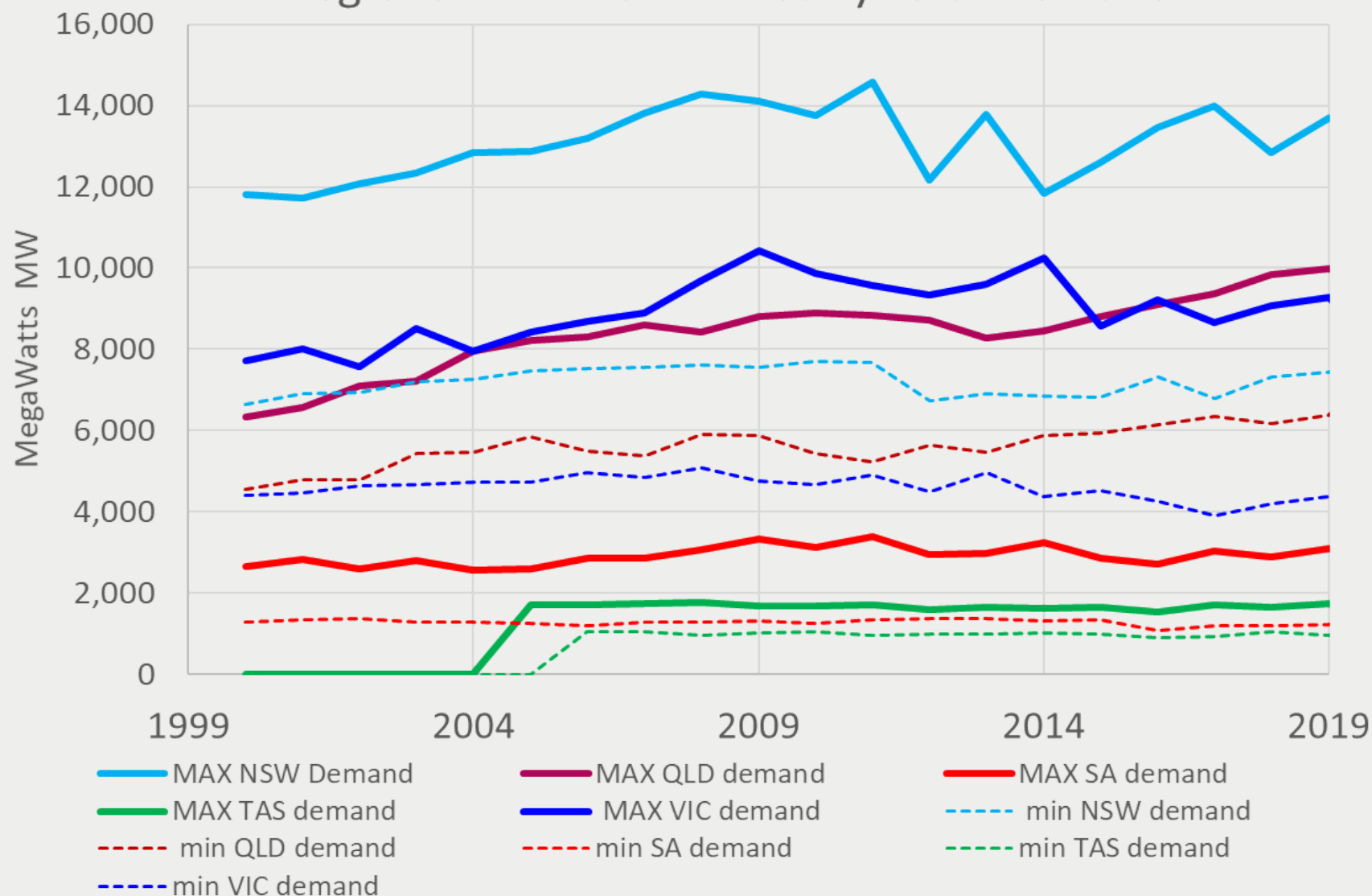
Electricity Generation in the NEM



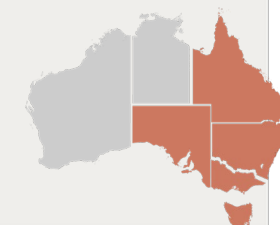
Source: GVSC



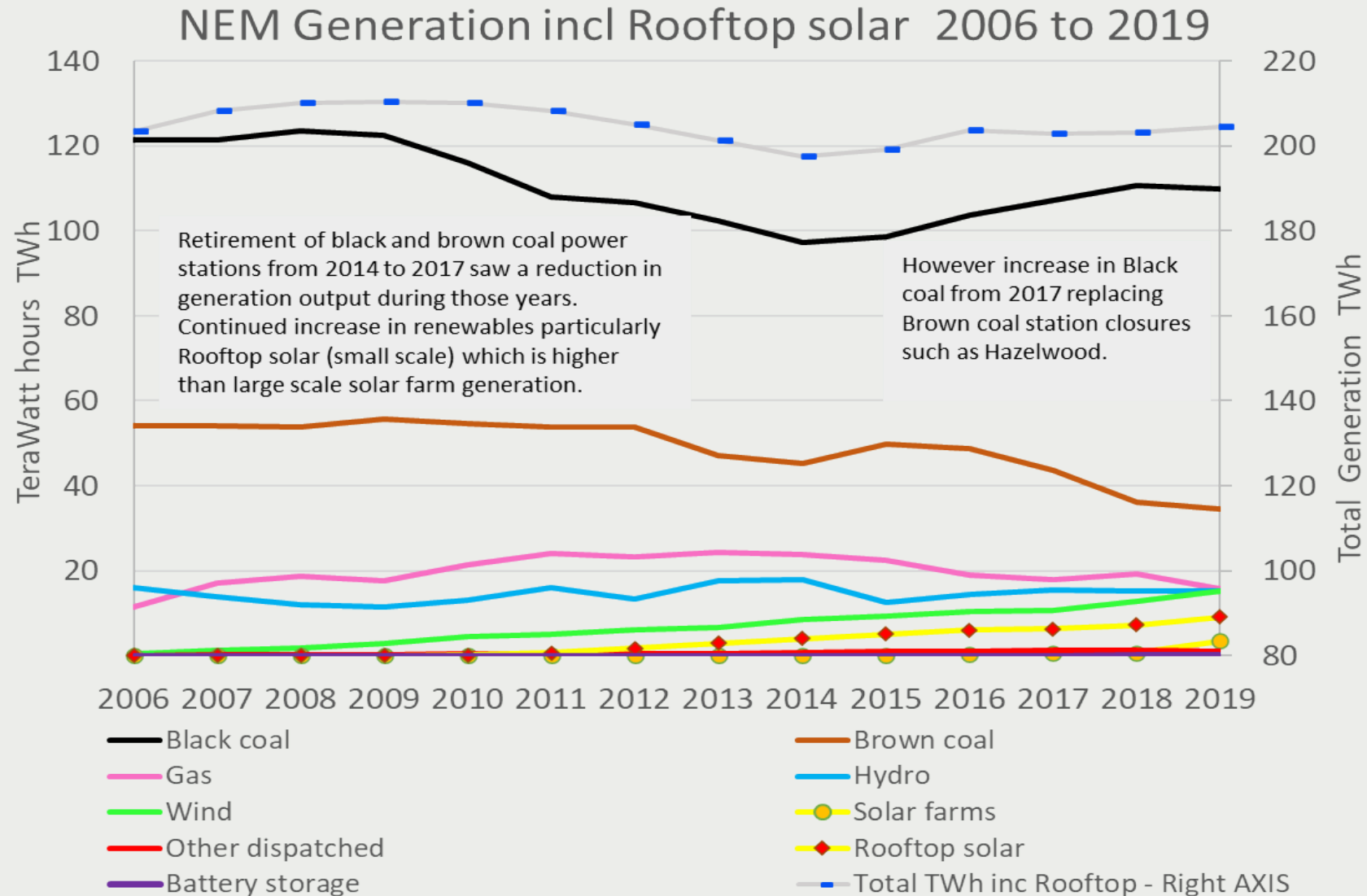
NEM Regions Max and Min Yearly Total Demand MW



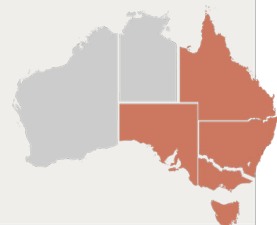
Source: GVSC



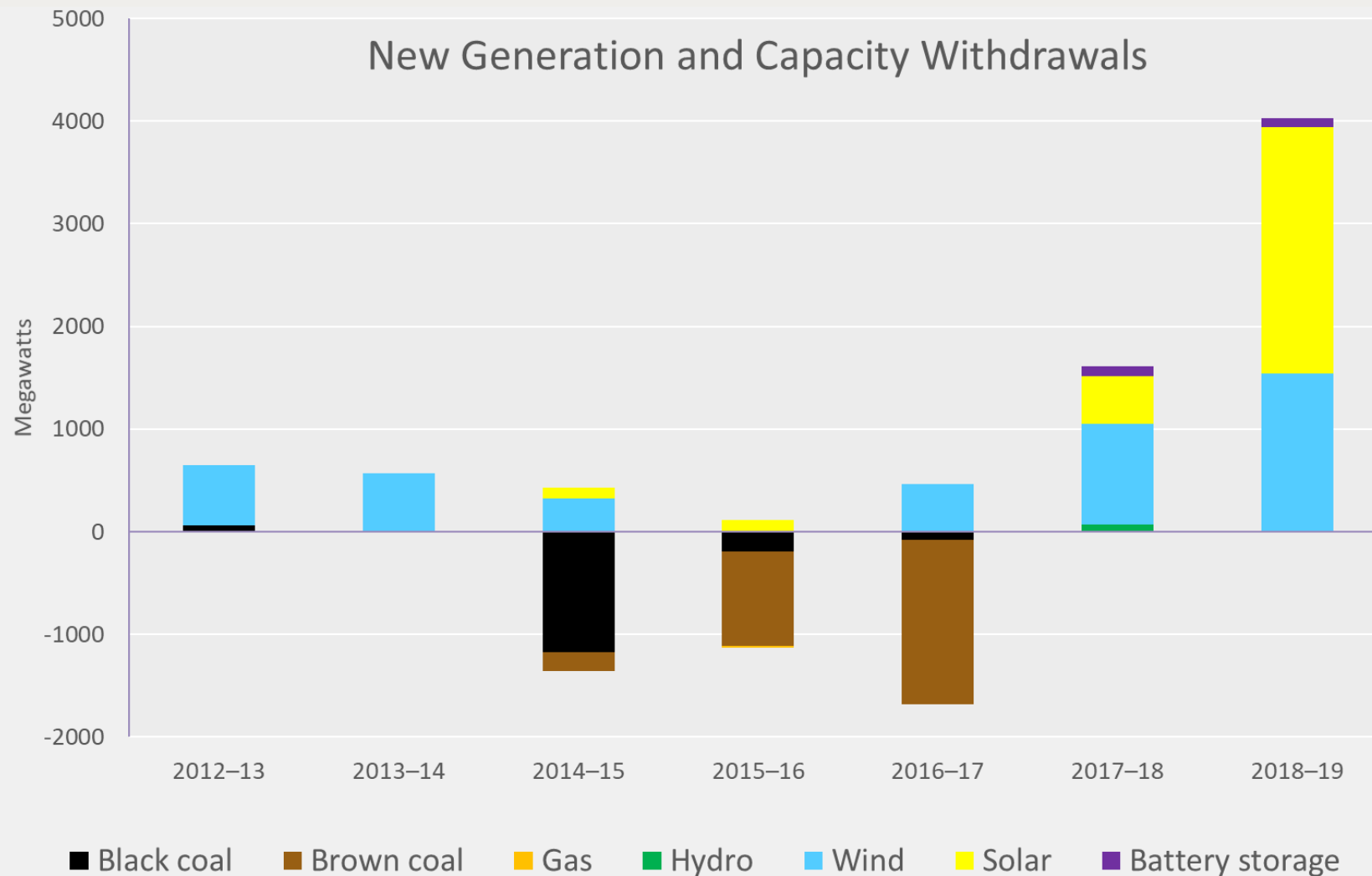
Historical Generation



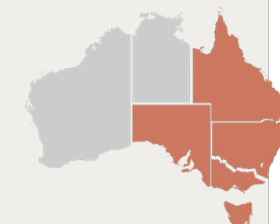
Source: GVSC



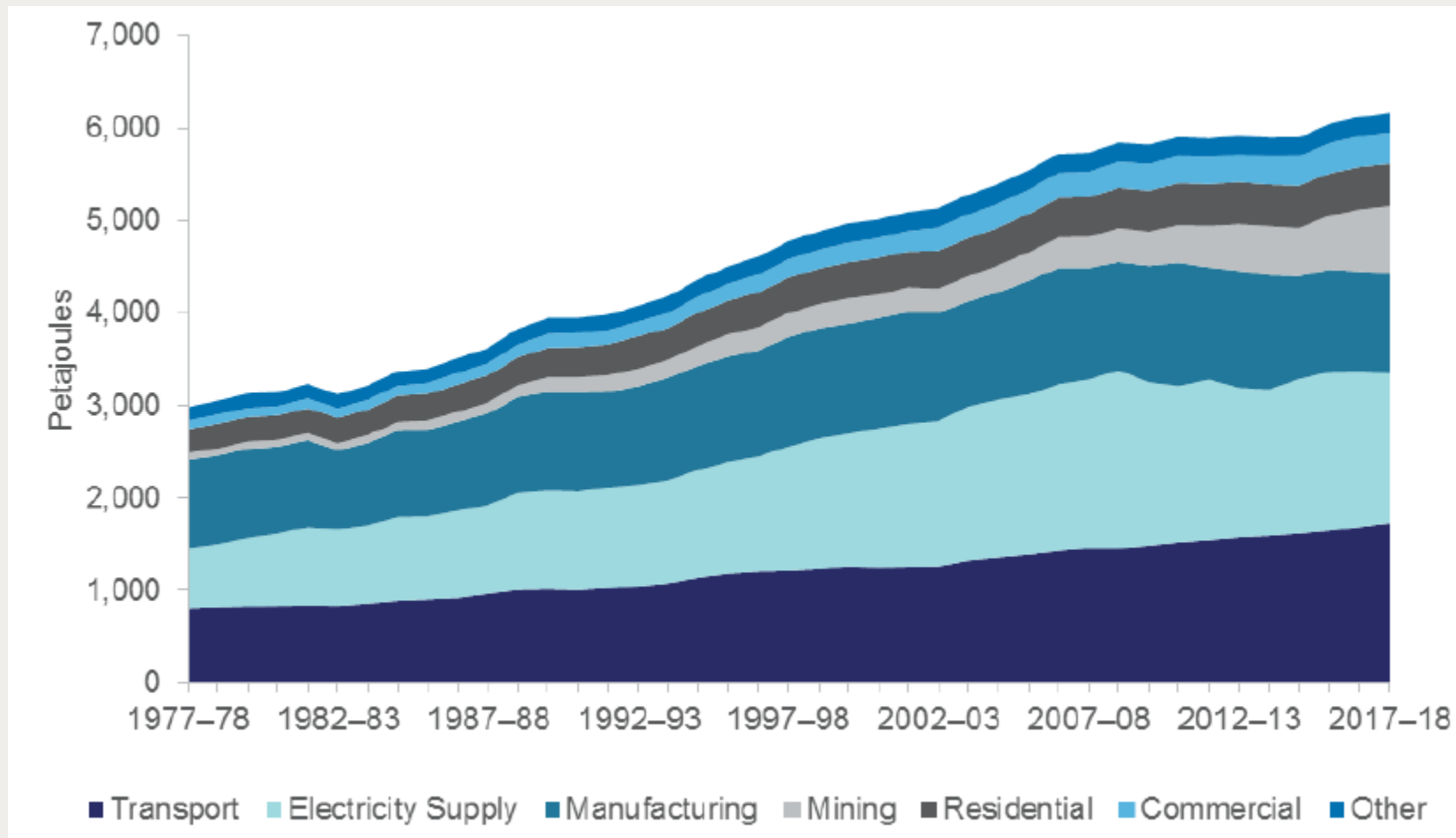
Changes in Generation Capacity



Source: AER



Consumption per customer groups



Source: Australian Govt

Changing Fuel Mix – 2018 compared to 2019

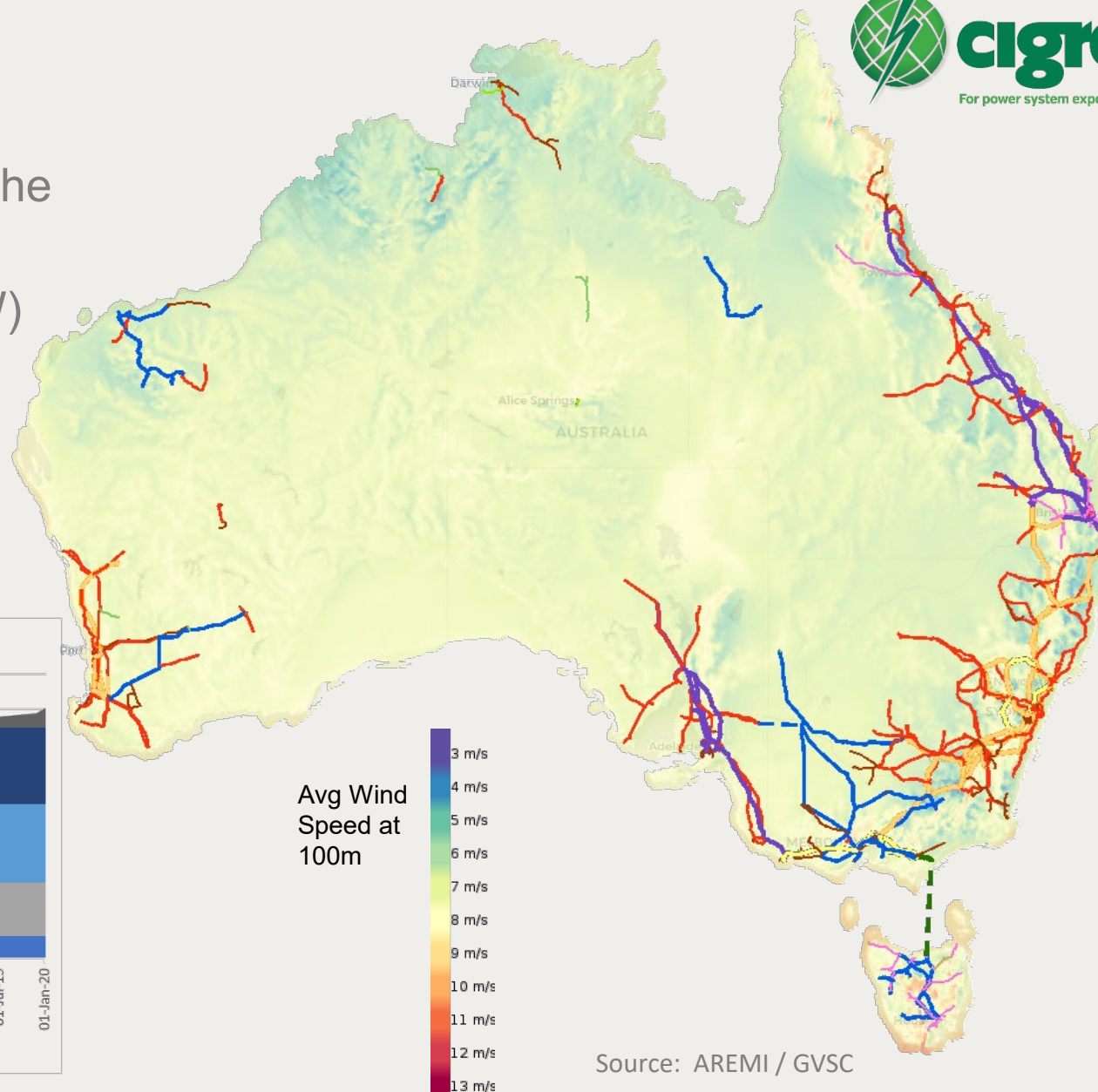
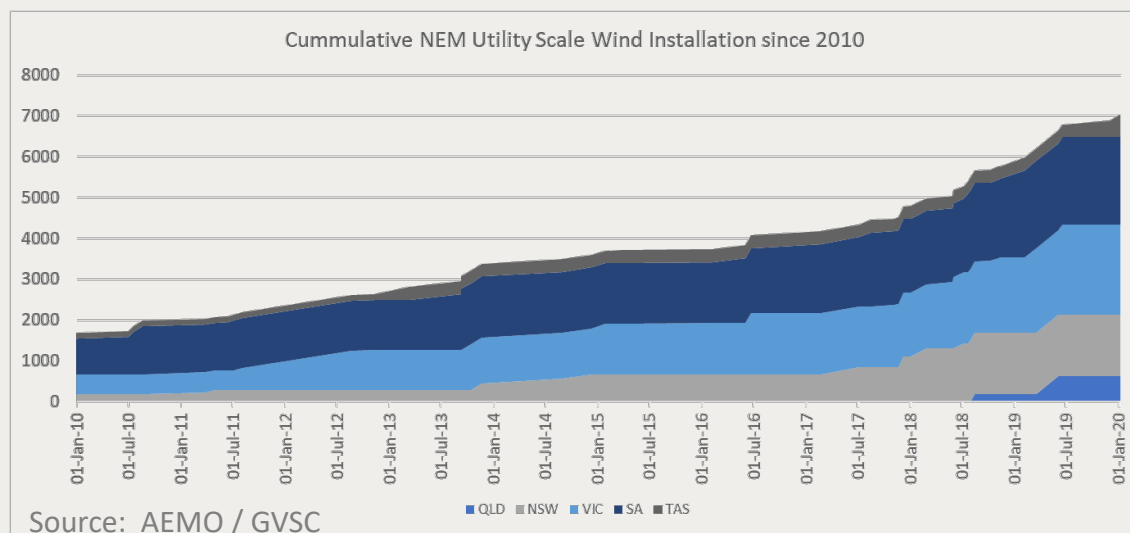
	NSW	VIC	QLD	WA	SA	TAS	NT	AUST
 Coal	▼1%	▼8%	▼6%	▼4%	na	na	na	▼5%
 Gas	▲31%	▲31%	▲1%	▲2%	▲11%	▼4%	▲2%	▲6%
 Wind	▲40%	▲16%	▲194%	▲33%	no change	▲10%	na	▲19%
 Hydro	▼31%	▼16%	▲29%	no change	▲16%	▼15%	no change	▼18%
 Solar	▲39%	▲56%	▲62%	▲25%	▲36%	▲15%	▲32%	▲46%

Year on year change from 2018

Source: Australian Govt

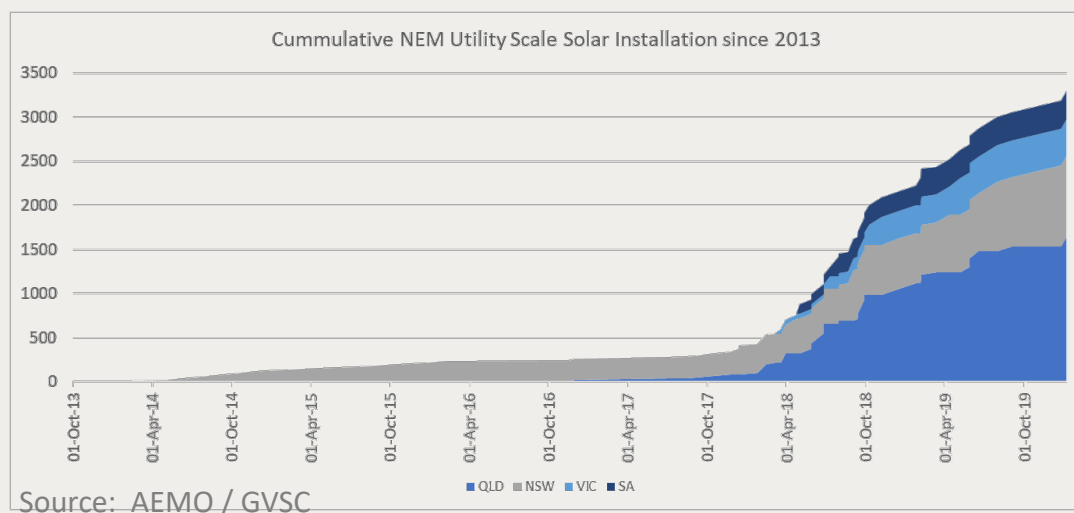
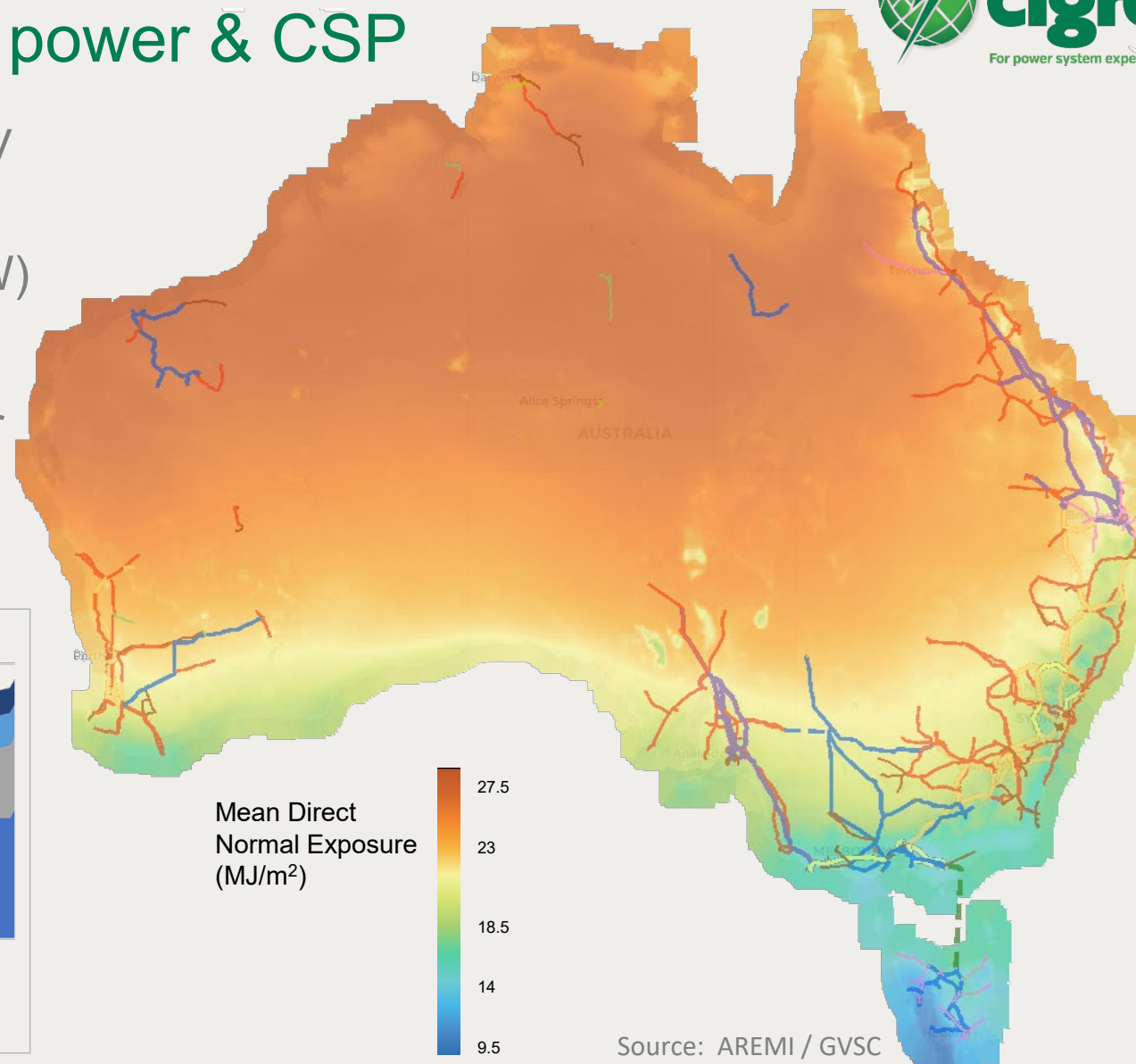
Development of wind power

- Significant Utility Wind construction in the past 4 years
- 62 NEM sites above 10MW (~7000MW)
- 8 WEM sites above 10MW (~620MW)
- No NT sites above 10MW



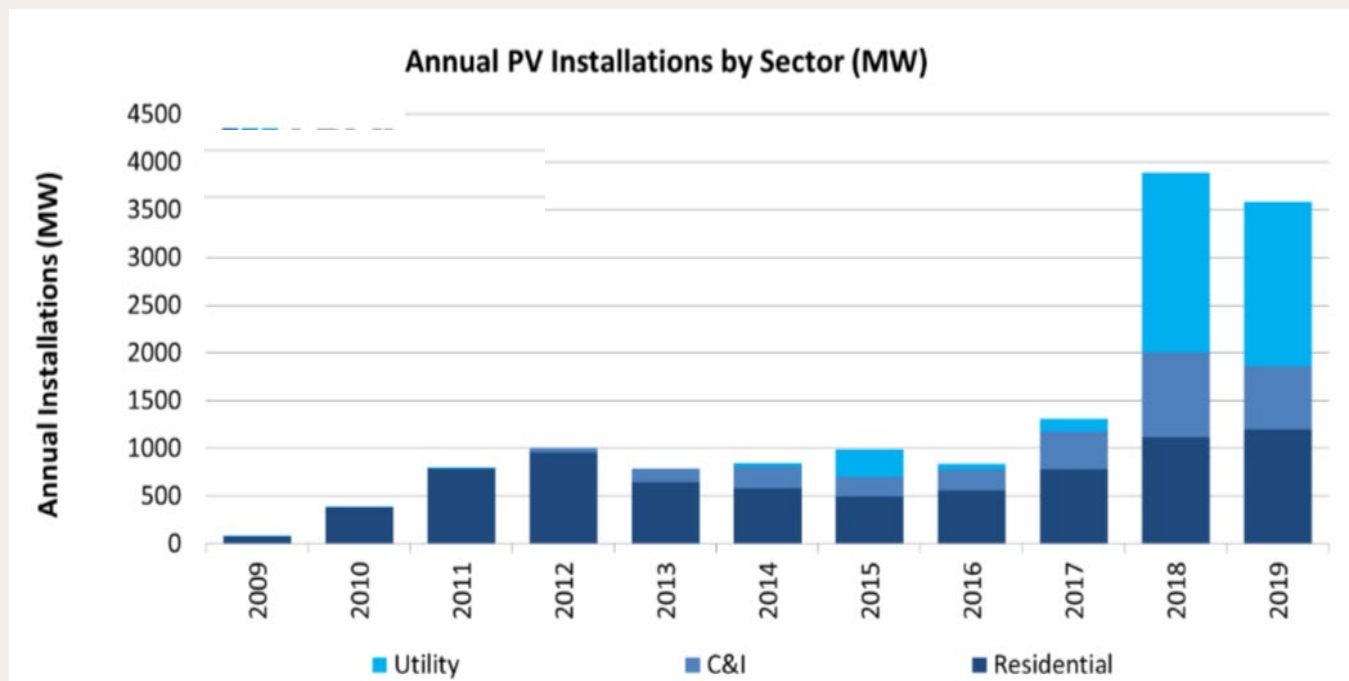
Development of photovoltaic power & CSP

- Significant Utility Solar and Rooftop PV construction in the past 4 years
- 49 NEM sites above 10MW (~3200MW)
- 2 WA sites above 10MW (~50MW)
- 2 NT sites (< 10MW), but 25MW under construction

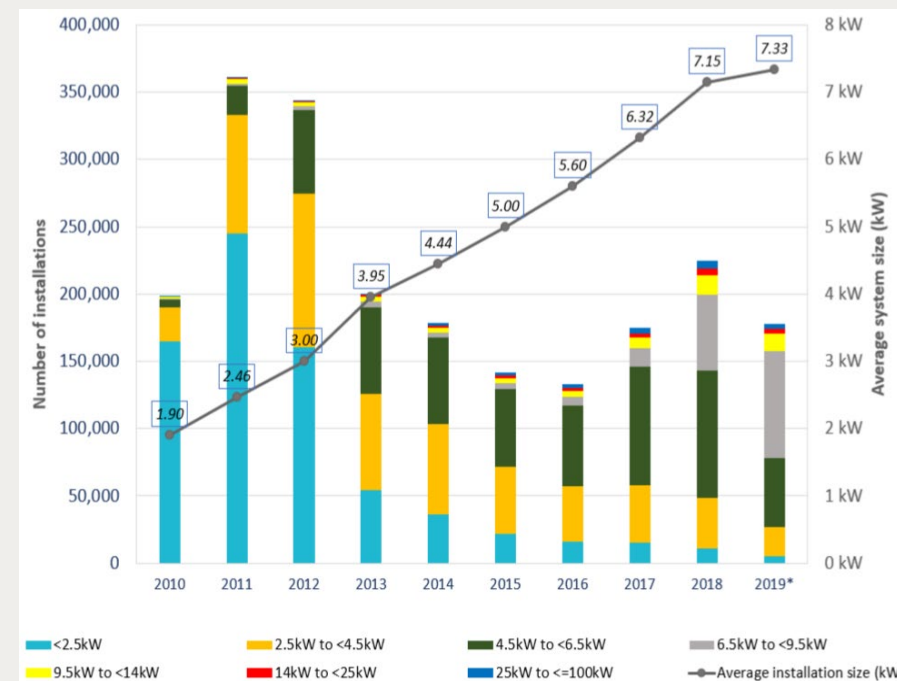


Residential installed capacity and production per annum

- Australia remains in the top ten PV markets in the world
- Over 2.2 million Australian homes and businesses now have a rooftop PV system – over 220,000 of which were added in 2019.
- PV size continues to increase



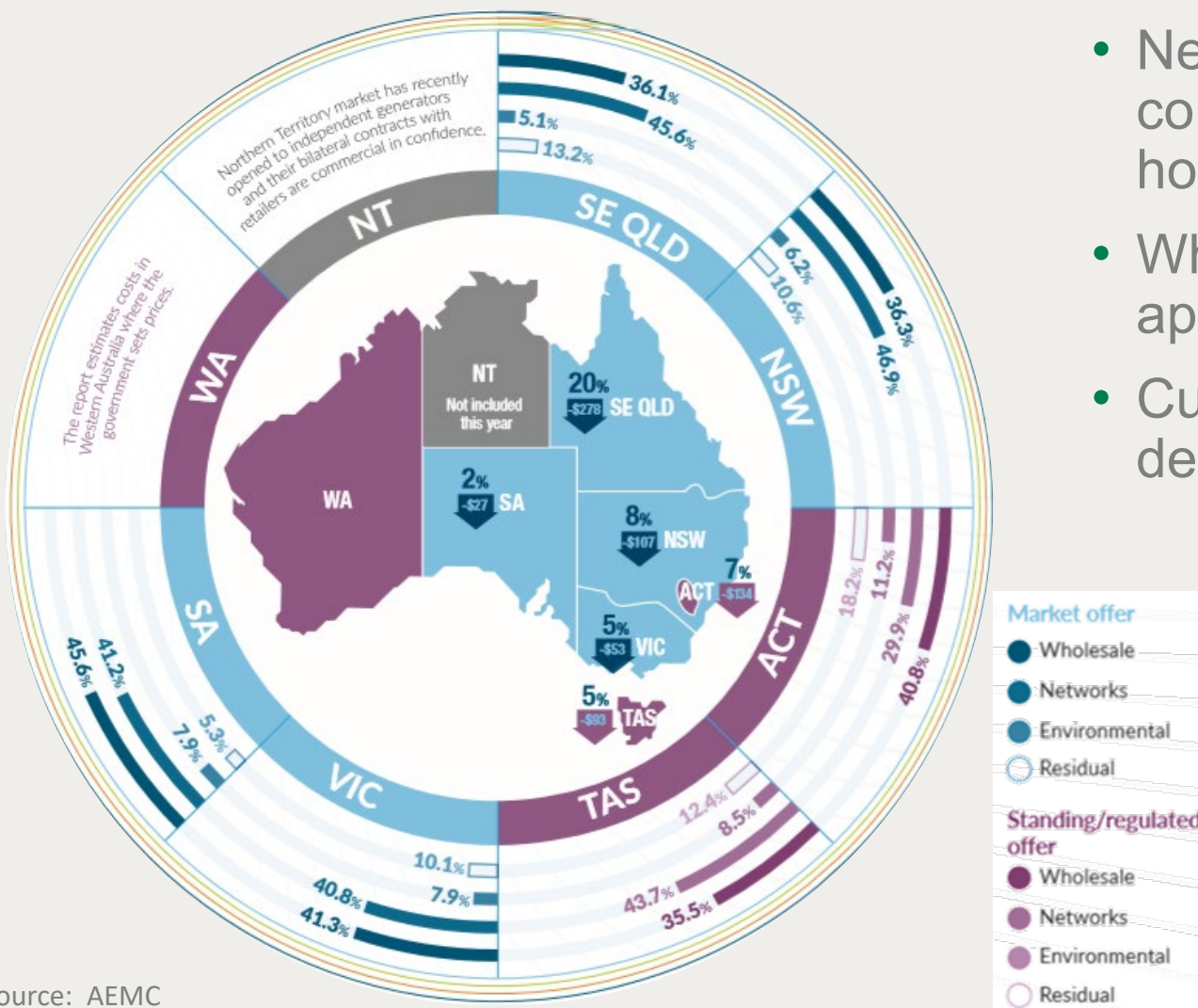
Source: APVI



Source: AEC

Price development for households

- Network continue to be the major component at approx 45-55% of total household bills
- Wholesale market costs make up approx 25%-35%
- Current price trend is down after a decade of rising prices



Source: AEMC

Electricity market organisation

- NEM infrastructure comprises both state and private assets managed by many participants.
- The NEM:
 - Supports 19 million residents.
 - At over 5,000 km from far north Queensland to Tasmania, and west to Adelaide and Port Augusta, is the longest alternating current system in the world.
 - Has about 40,000 km of transmission lines and cables.
 - Supplies about 200 TWh of energy to businesses and households each year.
 - Is long and linear compared with Europe and North America.
 - Can be costly to upgrade because of the large distances.

Future Changes

- Network Developments (NEM)
 - Market Re-design forecast to occur in 2025
 - New SA to NSW Interconnector
 - Second Basslink – MarinusLink
 - QNI Upgrade
 - Very large Synchronous Condensers in SA by Feb 2021
- Network Development (WA / NT)
 - Increasing levels of Solar PV / Battery
- Regulatory Changes
 - Change from 30min settlement to 5min settlement in NEM, initially planned for 2021, But pushed back to 2022.

Further Information

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CIGRE Australia wishes to thank Greenview Strategic Consulting for assistance in compiling this information.

(<http://www.greenviewstrategicconsulting.com.au>)