Centre for Energy and Environmental Markets

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High PV penetration in Australia, Challenges and Opportunities

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2018 ISES International Sustainable Energy Summit

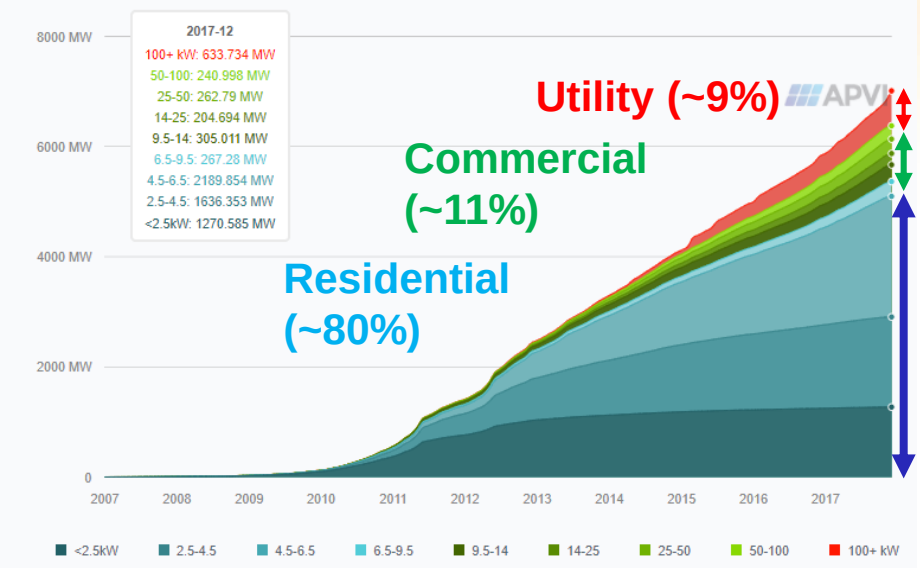
Sustainable Energy : The Future Is Here

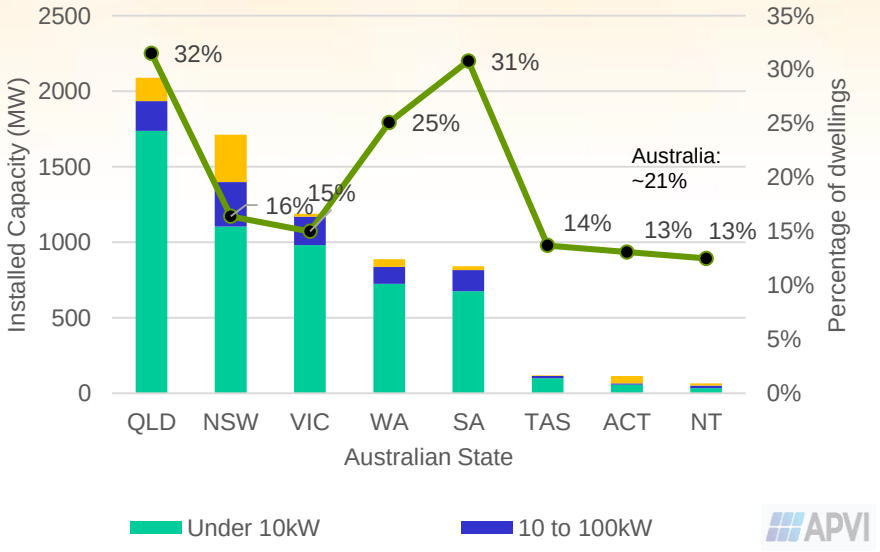
Deep Dive Workshop 1: Integrating Large Scale Distributed Solar PV Systems to the Grid

10th April 2018, International Sustainable Energy Summit, Kuching Sarawak

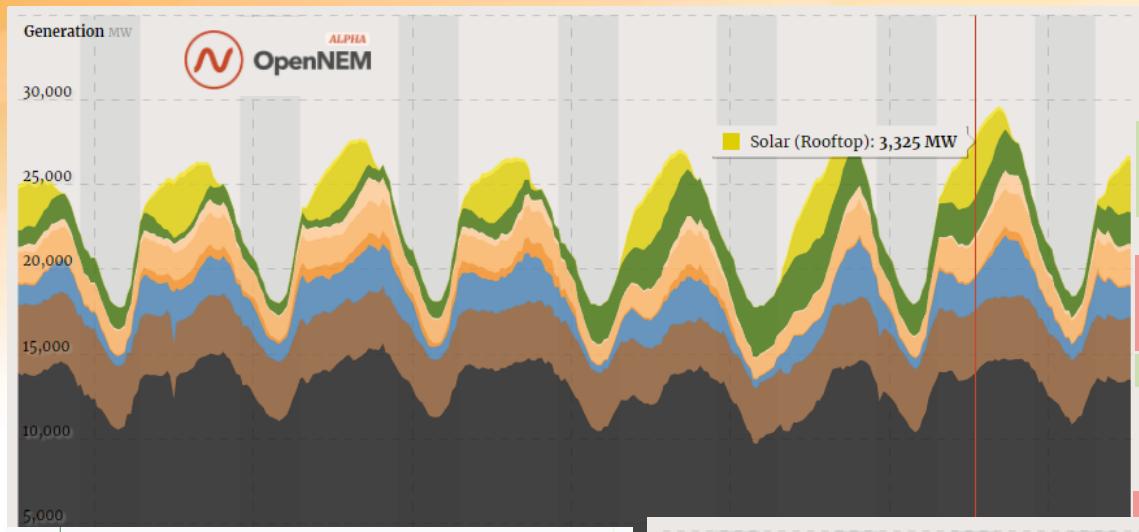
Australia's PV status

- **1.8** million PV installations (over **7GW** capacity)
- World's highest residential PV penetration (**21% of suitable dwellings**)
- **5th** in terms of per-capita PV capacity
- 2017 was a record year (**1.3 GW** PV installations)
- 2018 is set to break the record again!





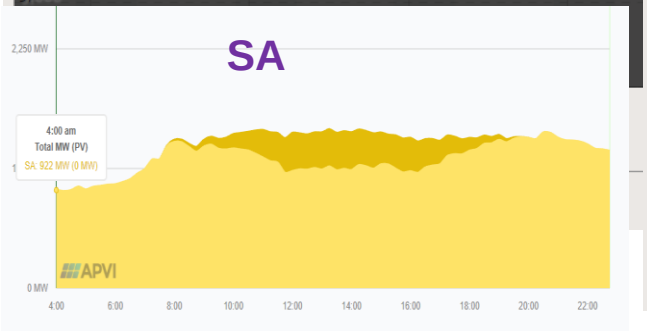
PV and wind contribution to generation

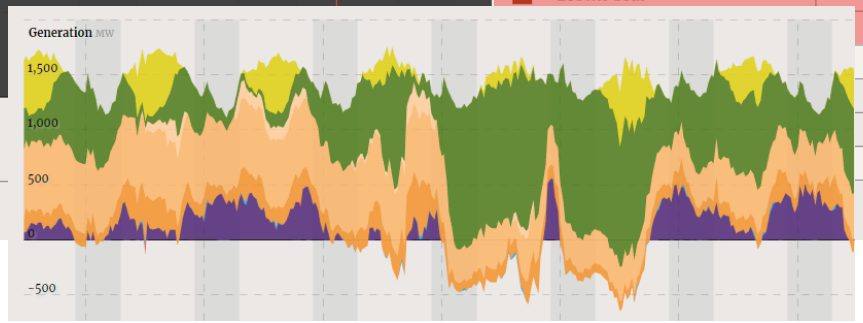


19 Mar 2018, 1:00pm	Power MW	Contribution %
Sources	27,811	
Solar (Utility)	295	1%
Solar (Rooftop)	3,325	12%
Wind	2,205	8%
Gas (Reciprocating)	88	0%
Gas (OCGT)	214	1%
Gas (CCGT)	2,061	7%
Gas (Steam)	126	0%
Hydro	1,958	7%
Battery (Discharging)	0	0%
Distillate	0	0%
Biomass	10	0%
Brown Coal	3,710	13%
	13,819	50%
	-	
	-	
	27,811	

28%

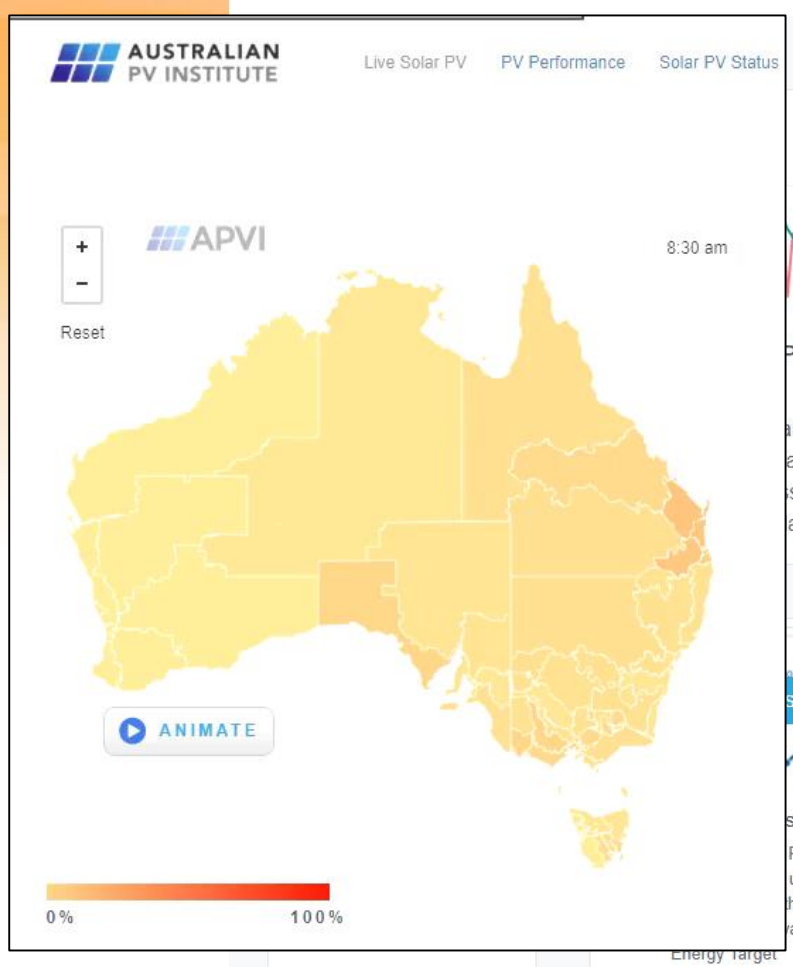
71%

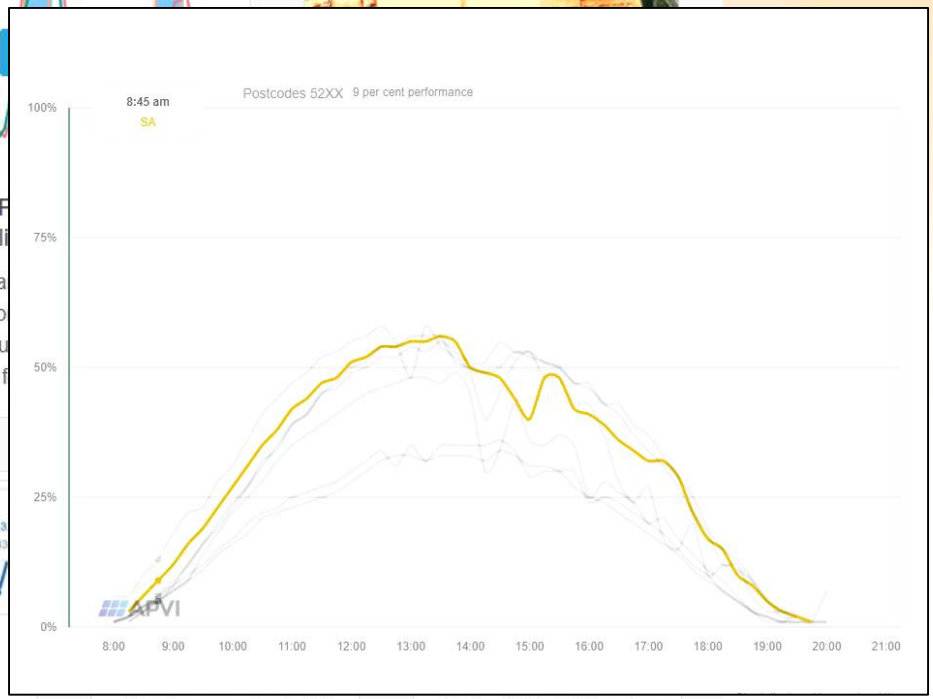




14 – 20 March 2018

APVI Mapping tools





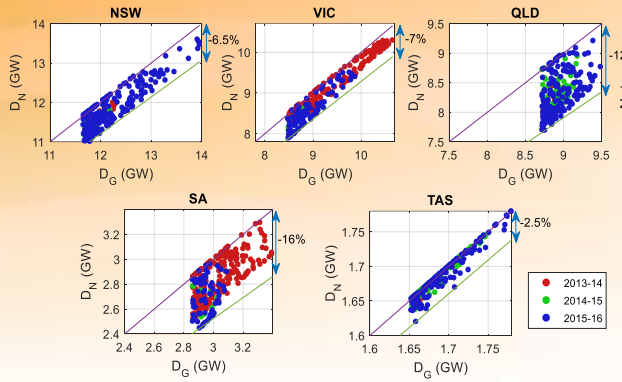
Visualise per-postcode PV installations across Australia since January 2007, by average system size and PV penetration

Explore PV installations by postcode and system size, with per-month installation figures since 2007

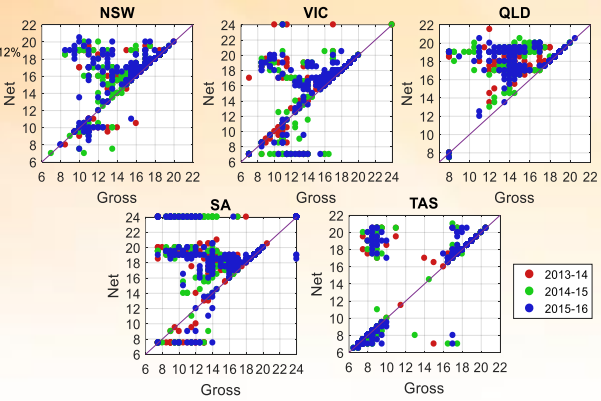
http://pv-map.apvi.org.au/

Impact on peak demand

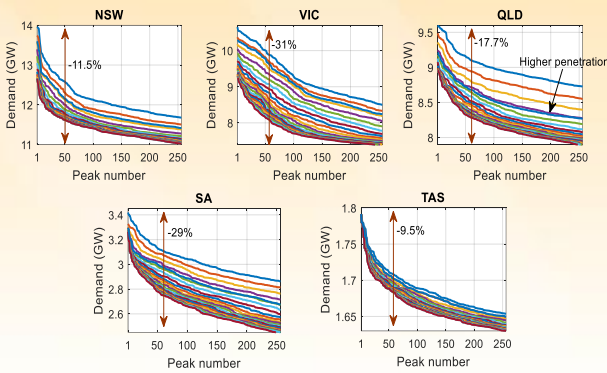
The impact of **current** and **future** PV penetration in reducing the peak is estimated using the real demand (AEMO) and distributed PV data (APVI) over the top 0.5% of peak times in three years.



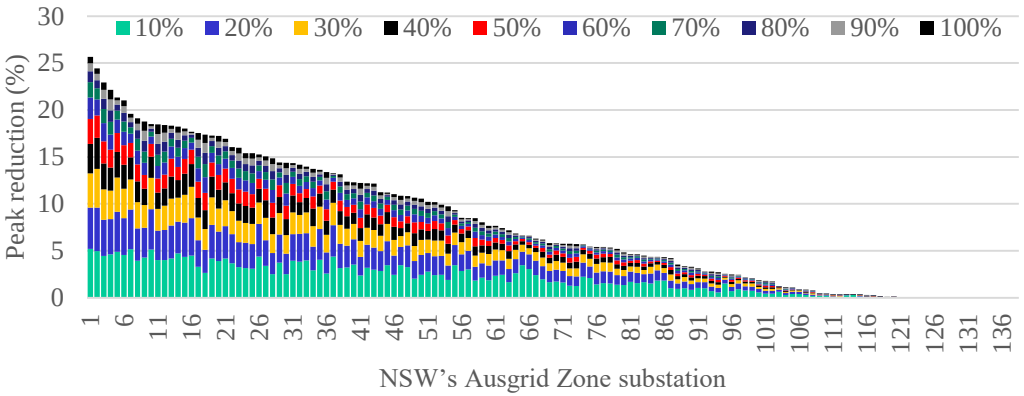
Net vs Gross load

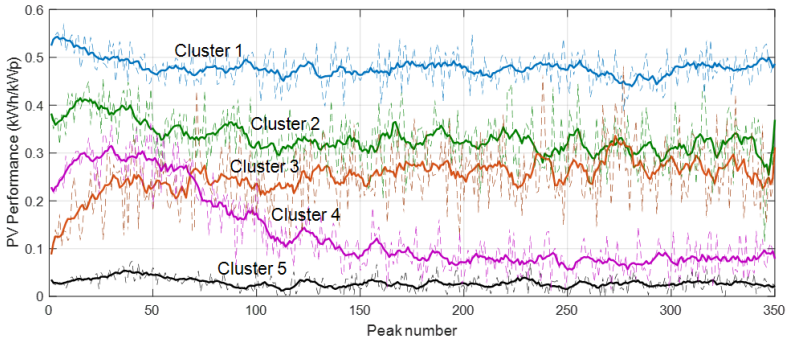


Peak time with and without PV contribution



Demand duration curve for higher PV penetrations



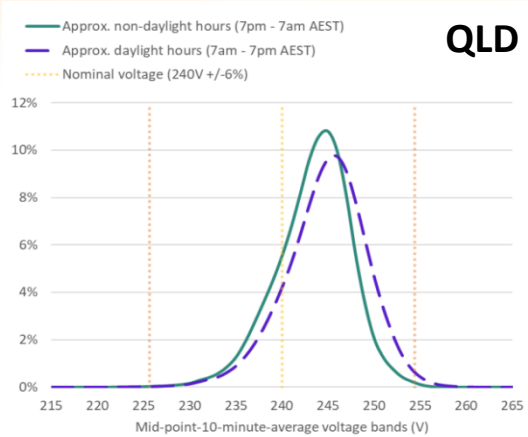


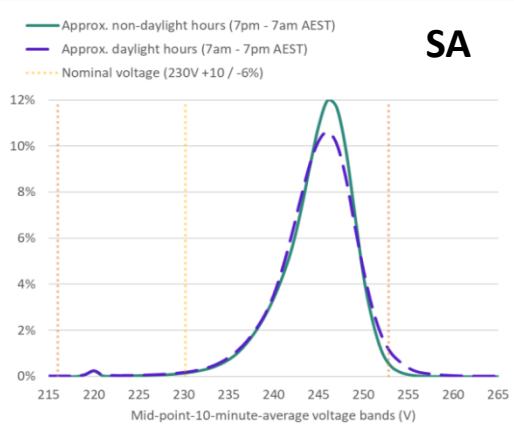
N. Haghdadi et.al *IEEE PESGM 2017*

N. Haghdadi et.al *IEEE Trans. Sus. Ene. 2017*

Distributed PV voltage implication

- The voltage measurements of 2000+ distributed PV systems show some variations over nominal voltage.
- These variations have implications for the performance of PV systems
- During the widespread voltage excursions, a huge portion of distributed PV systems can be curtailed which then can increase the demand and introduce a security risk
- Lack of visibility over the distributed PV systems as well as control over the PV systems operation can be a serious issue for secure and reliable grid operation



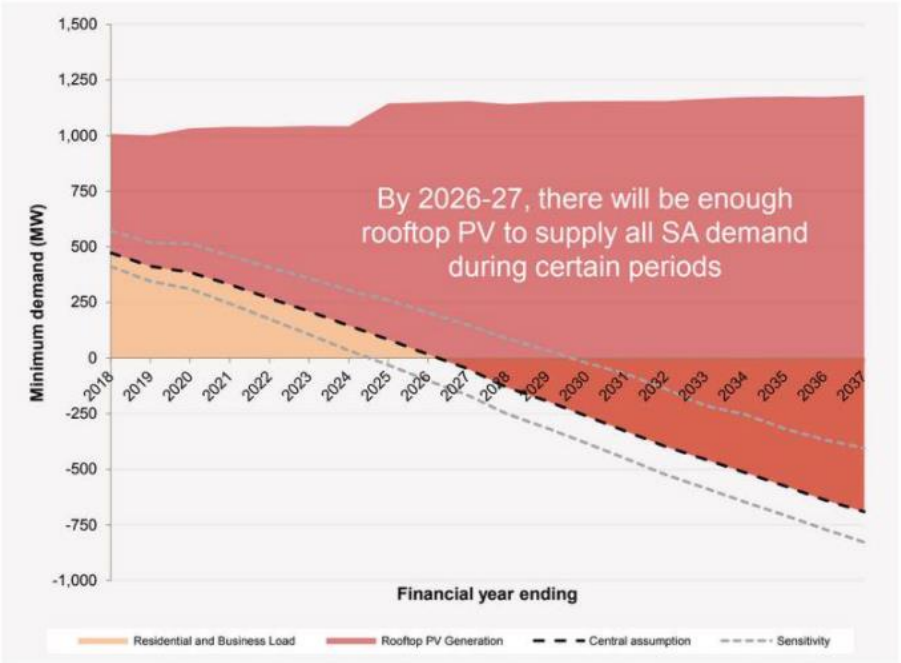


N. Stringer et.al, APSRC2017

Security implications

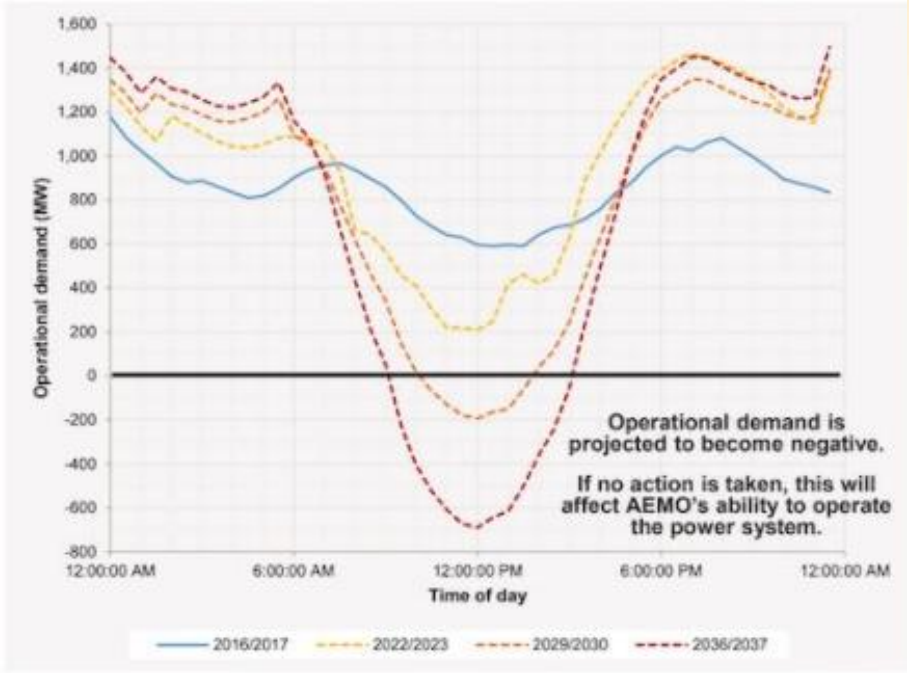
- Australia's PV capacity is projected to reach to 20GW by 2030
- Majority of them being rooftop with no visibility/centralised control by SCADA
- This will introduce challenges to energy security due to the intermittent nature of renewables

AEMO's forecast for South Australia:



AEMO's projections for demand and rooftop PV growth, in the weak economic growth scenario.

Operational Demand in South Australia:



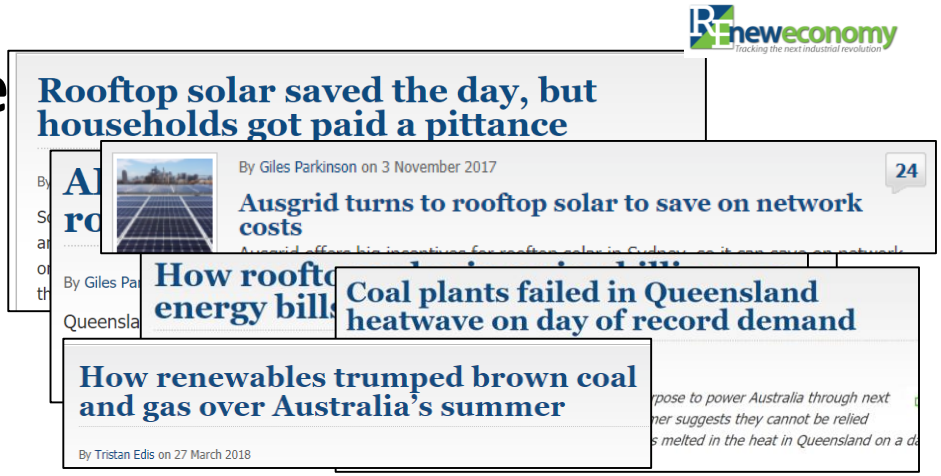
Reneweconomy.com.au, 8 Dec 2017
J. Riesz, APSRC 2017

What happened in SA on 28 Sep 2016?

- Tornadoes with **wind** speed of 190-260 km/h, 16000+ lightning strikes
- Three transmission lines failed, series of events and voltage excursions; some windfarms not configured for ongoing multiple low voltage ride through and eventually tripped
- Loss of generation overloaded interconnector which then tripped
- State isolated and available generation unable to stabilise frequency => state-wide blackout,

What didn't happen in summe

On 10th Feb 2017, when two 500MW coal units and multiple gas peaking plants failed during a heatwave, NSW blackout likely avoided by contribution of wind and rooftop solar's (500MW) contribution at most critical time.



What happened *after* the SA blackout..

Emerging challenges with high penetrations and fast growth of RE in Australia and politicisation of the blackout has hastened a range of measures to deal with it:

- AEMO Future Power System Security focus
  - Low voltage ride through settings for generators
  - More conservative dispatch of local generation resources under extreme weather conditions.
- Finkel Review
  - New security obligations on networks
  - New rules for minimum synchronous (gas) generation requirement
  - Fixing ride-through settings on wind farms
- SA government's Energy plan, including procurement of batteries
- Federal government's announcement of Snowy Hydro
- ARENA/CEFC support for complementary technologies that provide flexibility like batteries, DR and wind farms that can provide FCAS

*Major power system event such as the SA blackout will almost always be the result of **a number** of things going wrong!*

What learned from the blackout

- Batteries can be built fast and are very flexible
- Market operators should require appropriate settings for inverters to deal with fault conditions
- The min gas requirements proved to be unnecessarily high & curtailing wind have been wound back a bit already – care should be taken
- Need for new technical connection requirements for new generation with different operational characteristics

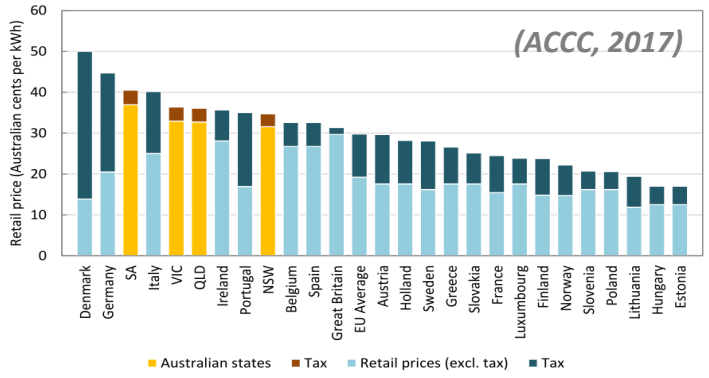
Beyond renewables..

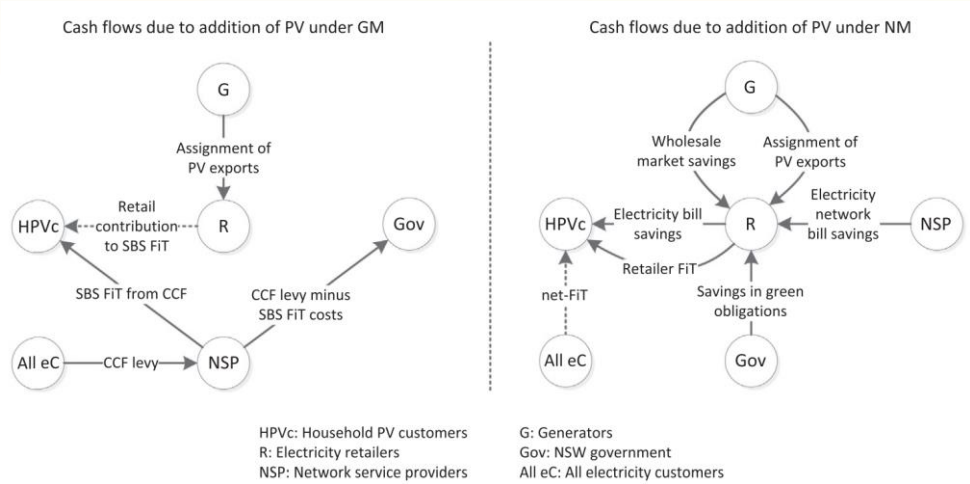
- Aging and increasingly unreliable thermal plant
- A long stringy network
- More extreme weather events
- Market design – need for thoughtful and appropriate policy, market design and regulatory improvements rather than politicising the renewables..

Revenue implications for network businesses, retailers and generators

- Residential PV changes the traditional cash flow between customer, retailer, generator, and networks and it may:
  - reduce network and retailer "revenue" from households with PV, and
  - also reduce network "costs" as it avoids augmentation and replacement cost

Figure 1.9: Comparison of residential electricity prices (before and after tax) (Australian cents per kWh) (May 2017 prices in Australia, 2015 prices in European countries)[62]





S. Oliva et al. 2016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