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Some lessons from distributed PV integration into the Australian National Electricity Market

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GIVAR workshop – Lessons from recent SIR Analysis

Yokohama, Japan

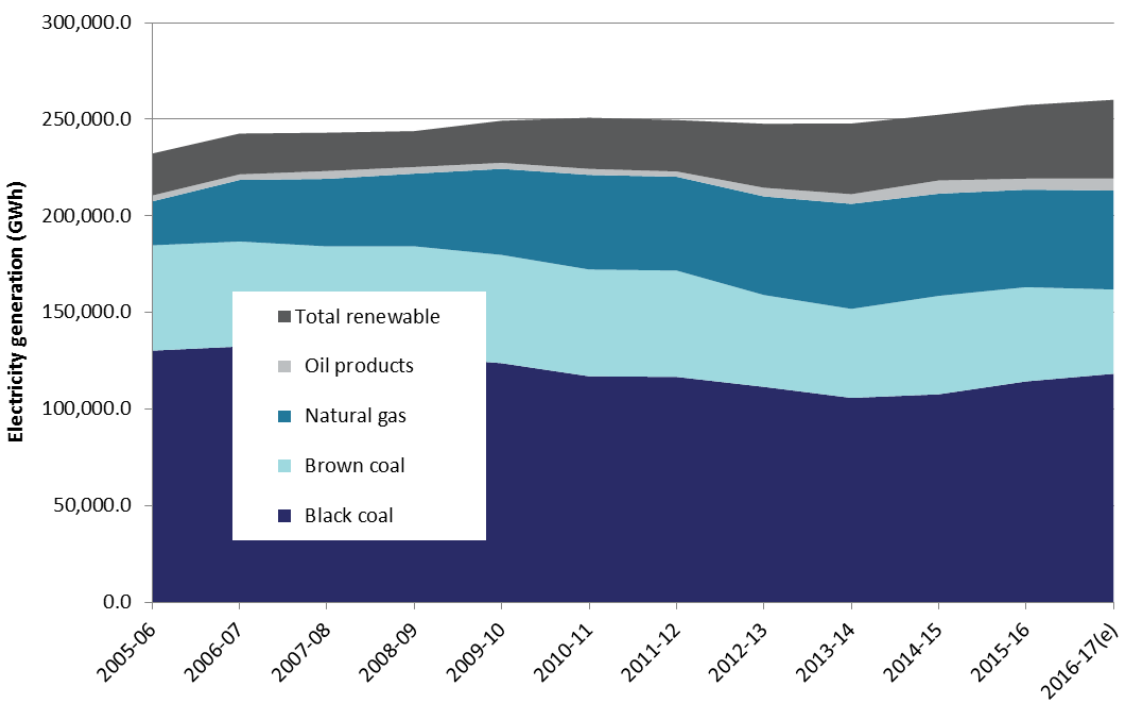
21 June 2018

Key messages

- Australia a leading jurisdiction for distributed PV deployment, and hence integration lessons
- Some seemingly manageable technical challenges in the LV network including voltage, but management not just PV issue
- A growing appreciation of security challenges with distributed PV during major power system 'events'
- Economics – marginal energy + network value declines with higher PV penetrations, as with all generation technologies
- 'follow the money' - commercial impacts of PV deployment on key industry participants, especially networks, highlighting limitations of present retail market arrangements
- Recent growth in Australian utility PV highlighting the complex economics, wider context of PV's future – large, small or all PV? Also the role of new technologies including Energy Storage, DR

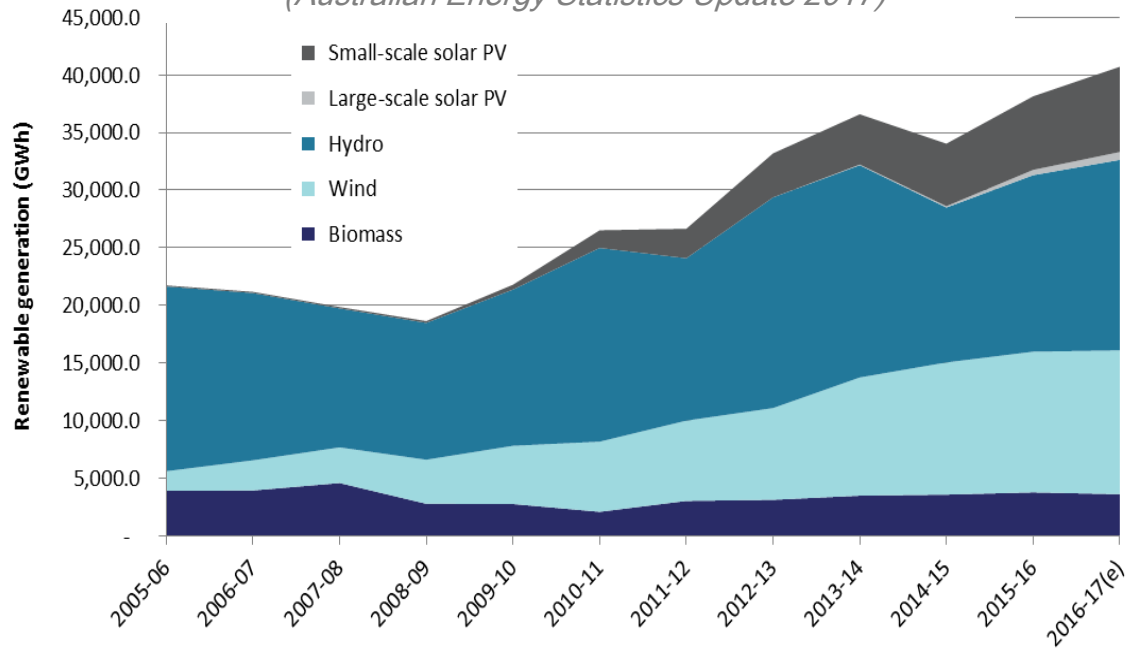
Distributed PV still modest contributor to Australian electricity generation, and even renewable generation

…but more significant impacts than might be expected for such a modest penetration



Australia's electricity generation mix 2006 - 2017

(Australian Energy Statistics Update 2017)



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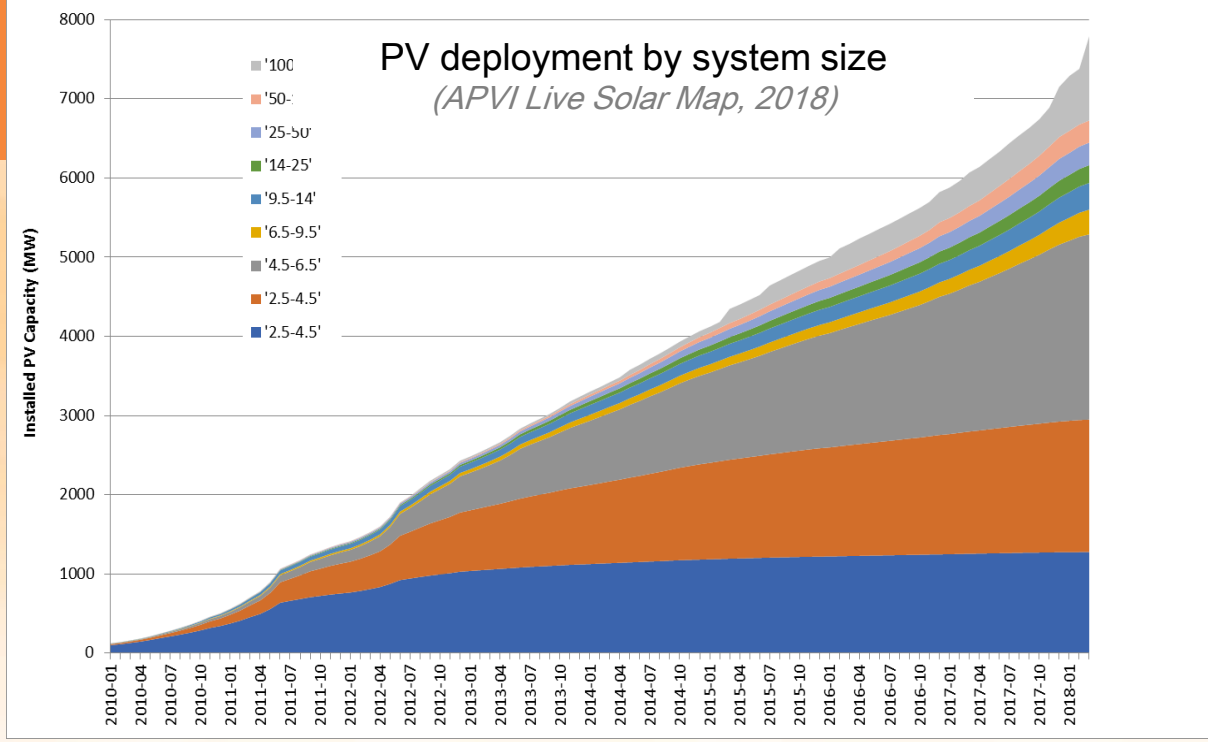
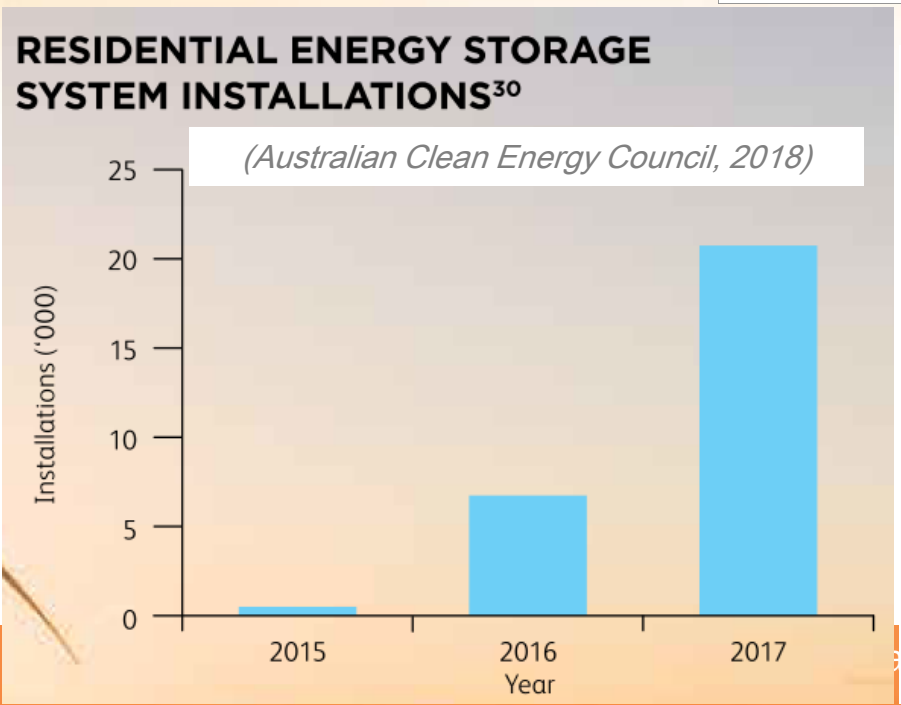
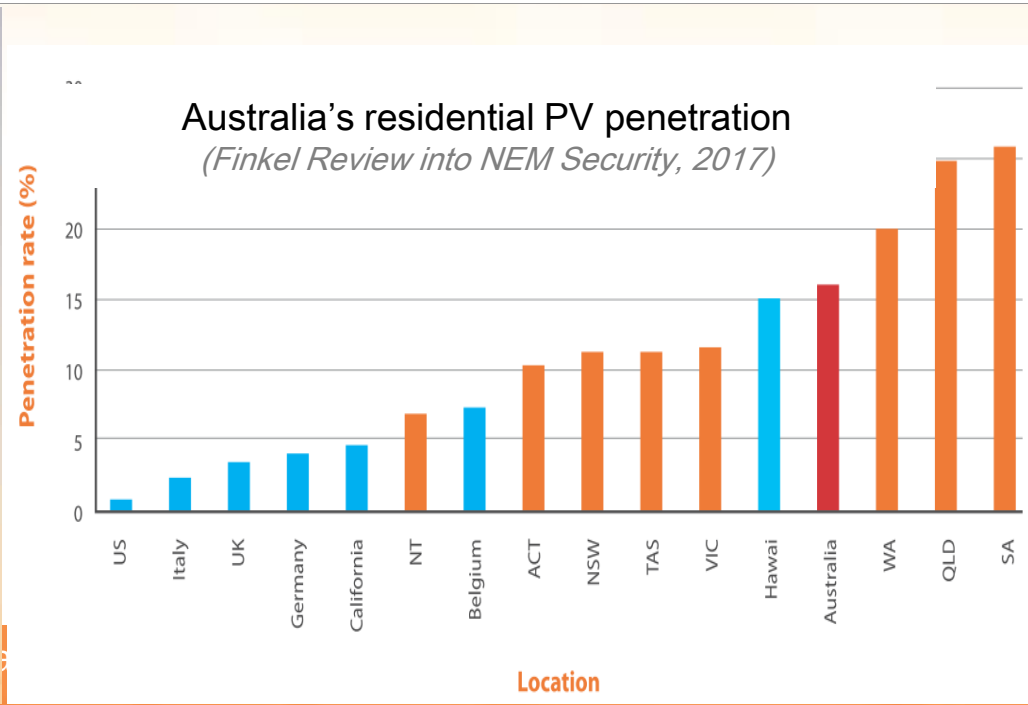
..but growing

- Over 80% is ‘rooftop’ PV
- World leading residential PV penetration
- ~15% new Residential PV includes energy storage







.. and now significant proportion of installed capacity

- Utility PV also now taking off, some old coal departing

NEM generation capacity – existing, committed, proposed
(AEMO Generation Mix webpage, 2018)

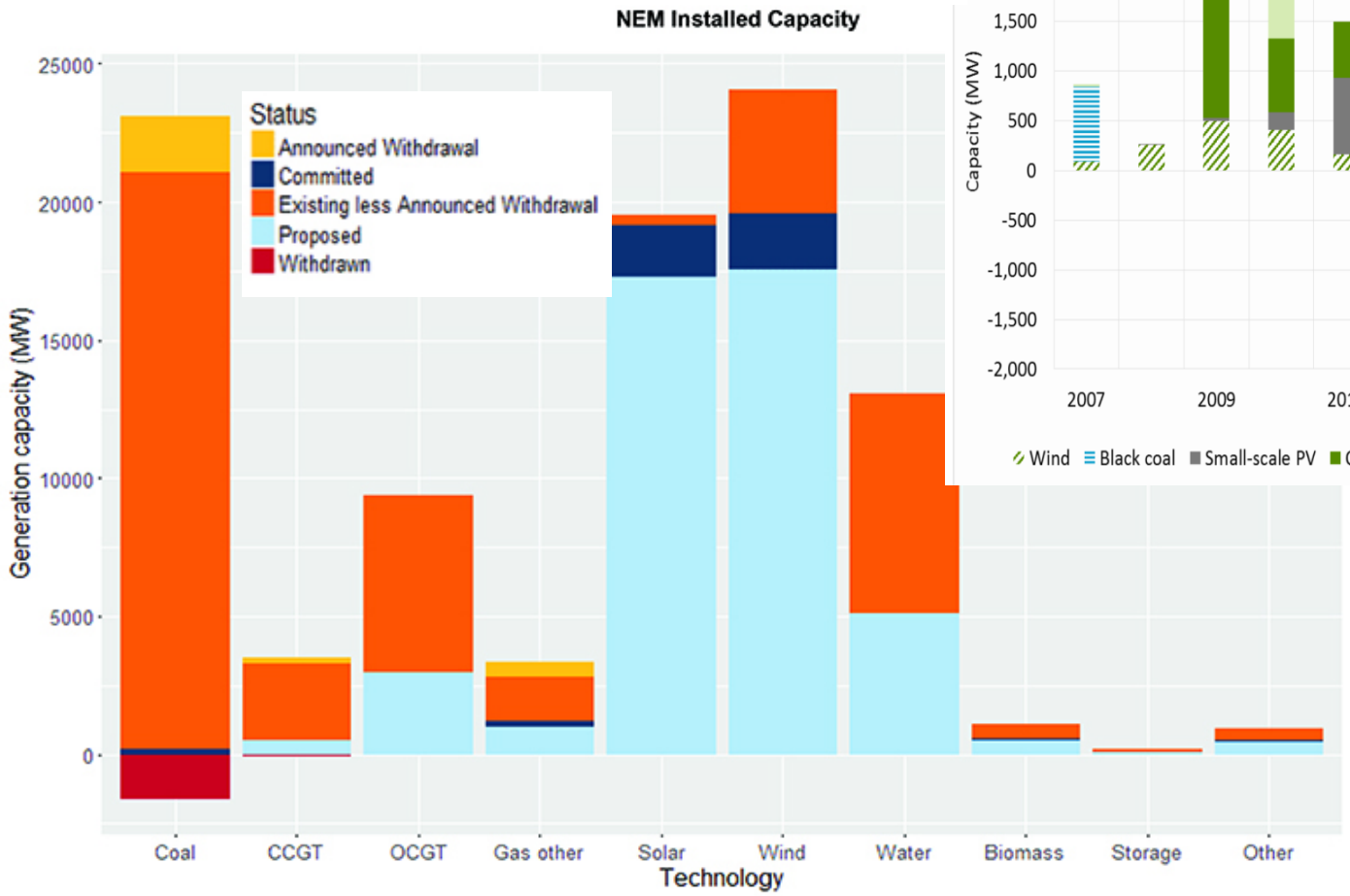
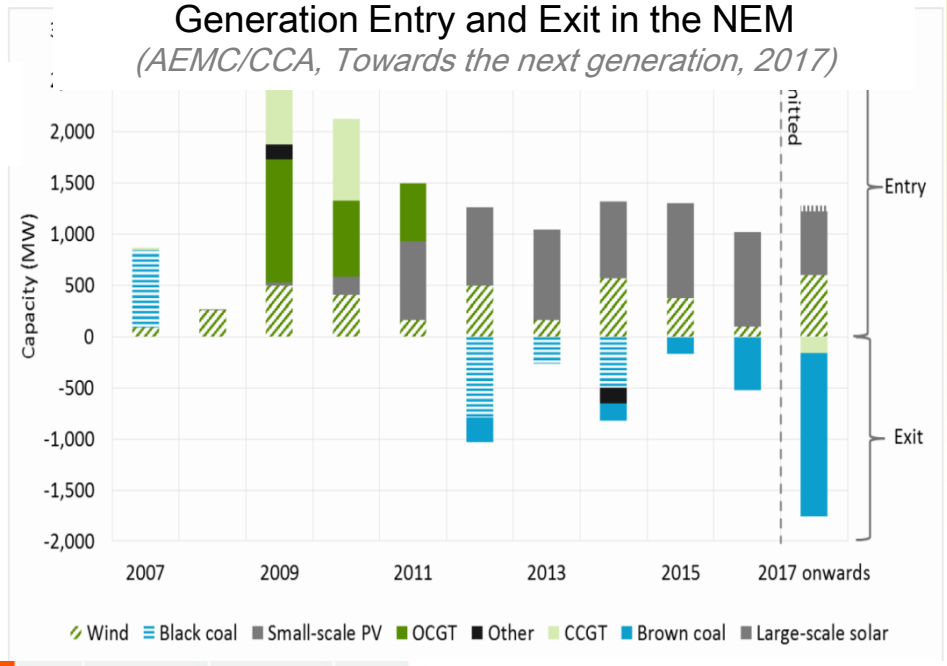
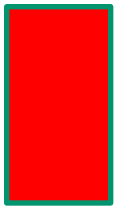


FIGURE 3: ENTRY AND EXIT OF GENERATION CAPACITY IN THE NEM SINCE 2007

Generation Entry and Exit in the NEM
(AEMC/CCA, Towards the next generation, 2017)

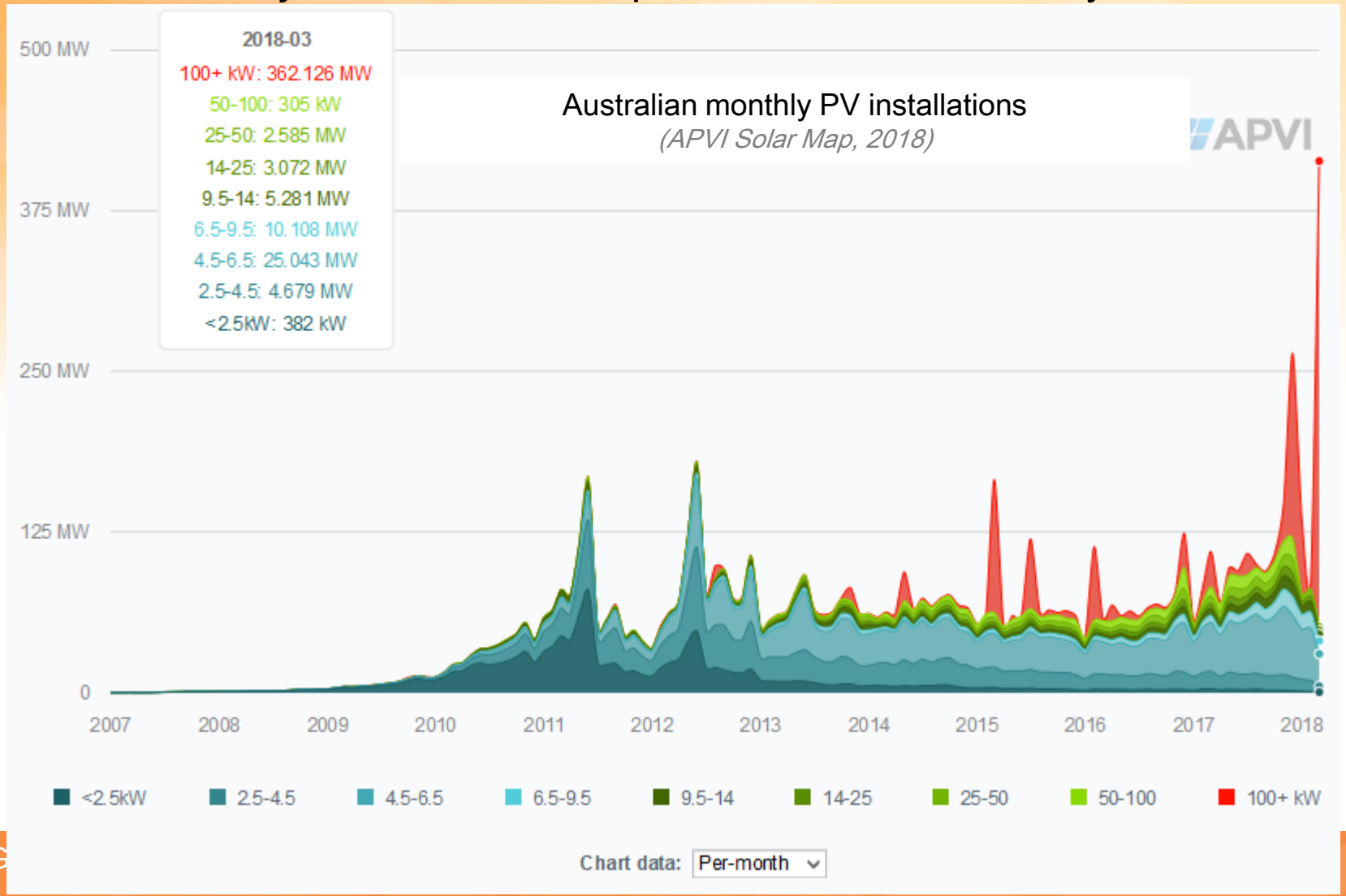




Approximate capacity of rooftop PV

Distributed PV installation rates steady

With some early FiT cutoff date ‘spikes’, more recent utility PV installations



Plausible scenarios for PV and storage see more coming

… with potential implications including low residual demand for utility plant at key times

Figure 1: Projected installed capacity of rooftop PV and distributed battery storage in the NEM

(AEMO / ENA, 2018)

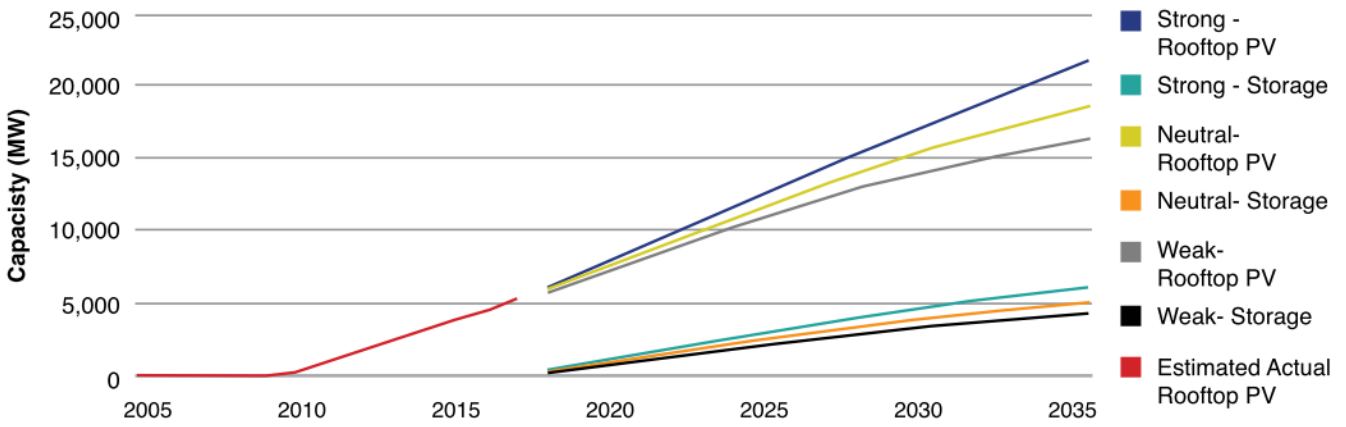
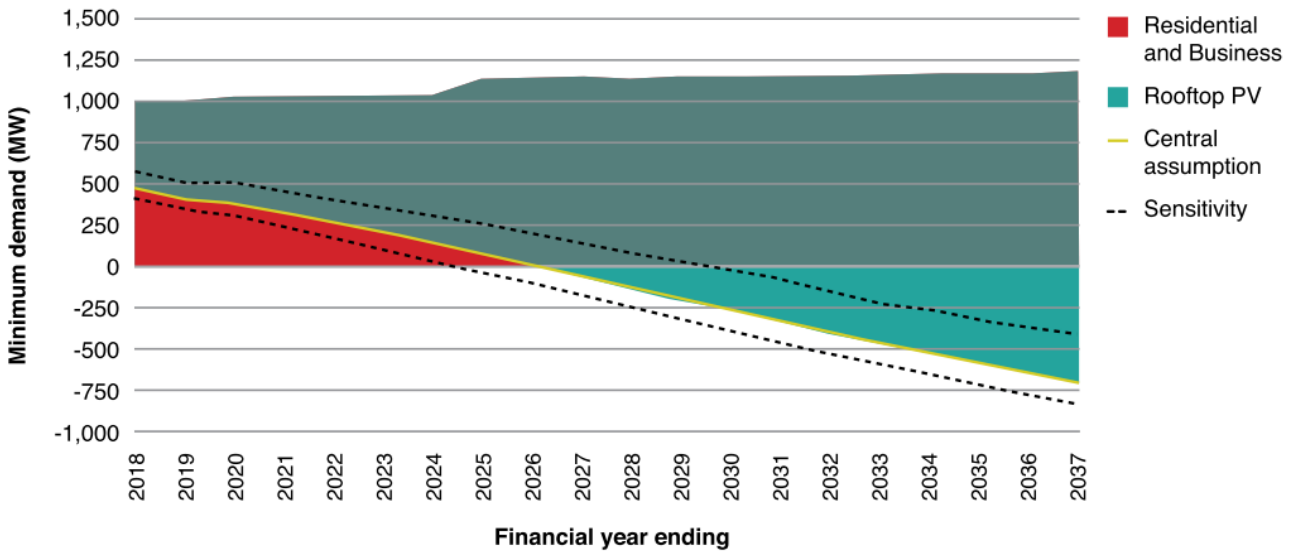
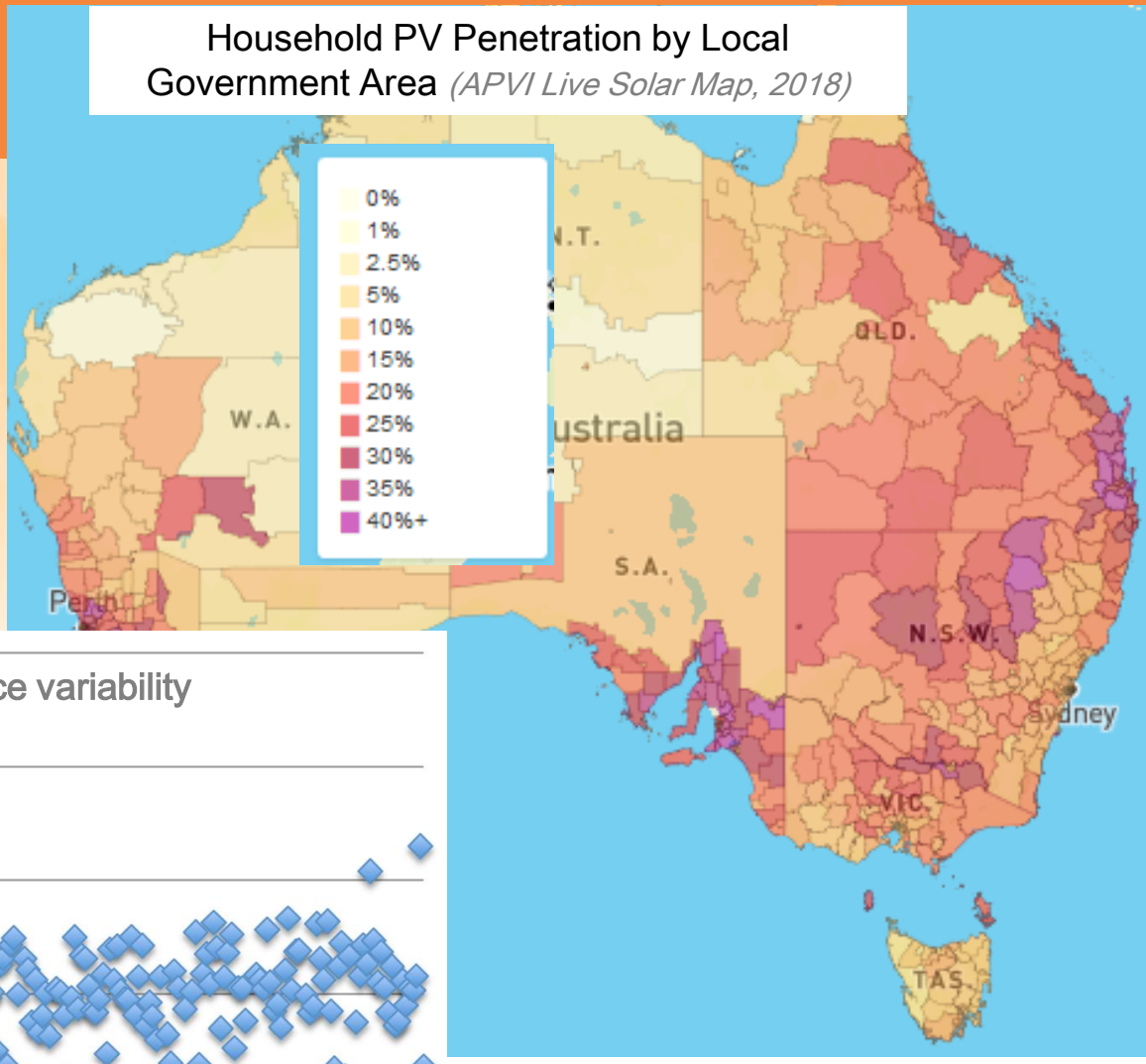


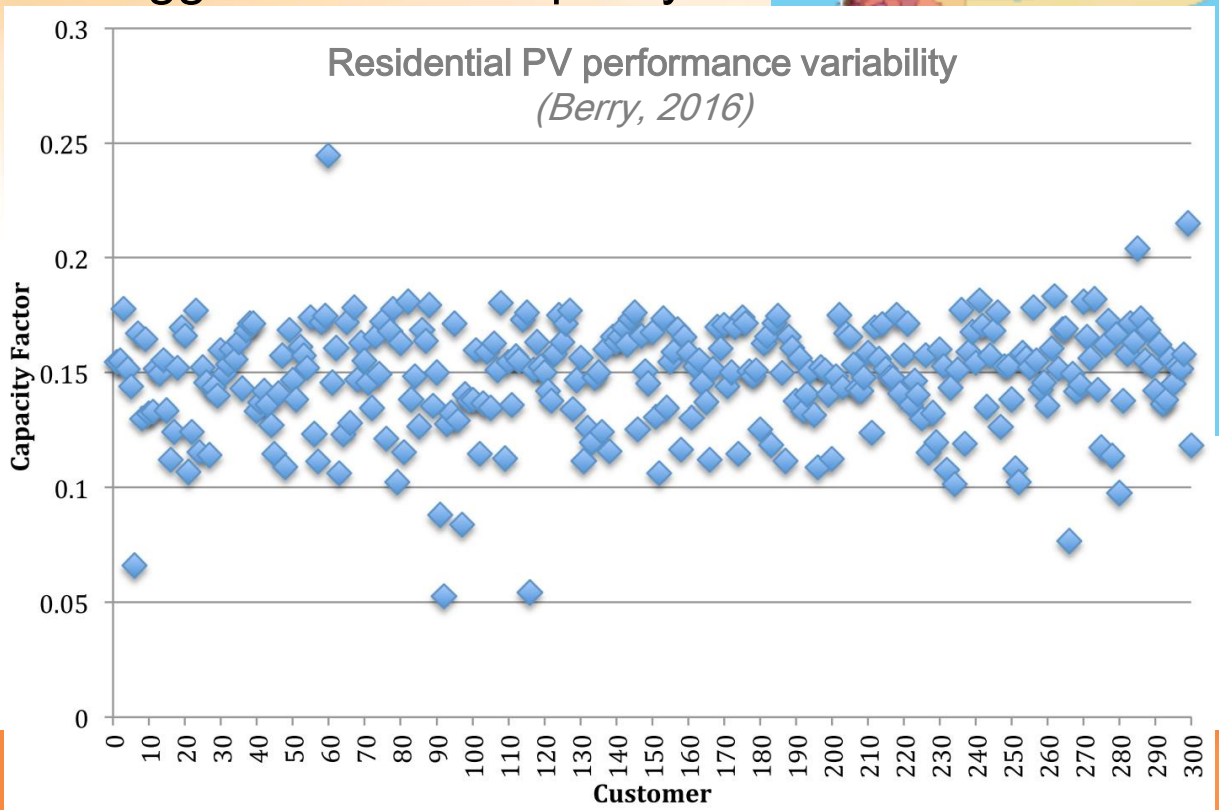
Figure 6: AEMO minimum demand forecast for South Australia



Some technical connection issues

- PV penetrations quite varied across Dx network
- Mixed PV performance suggests variable ‘quality’

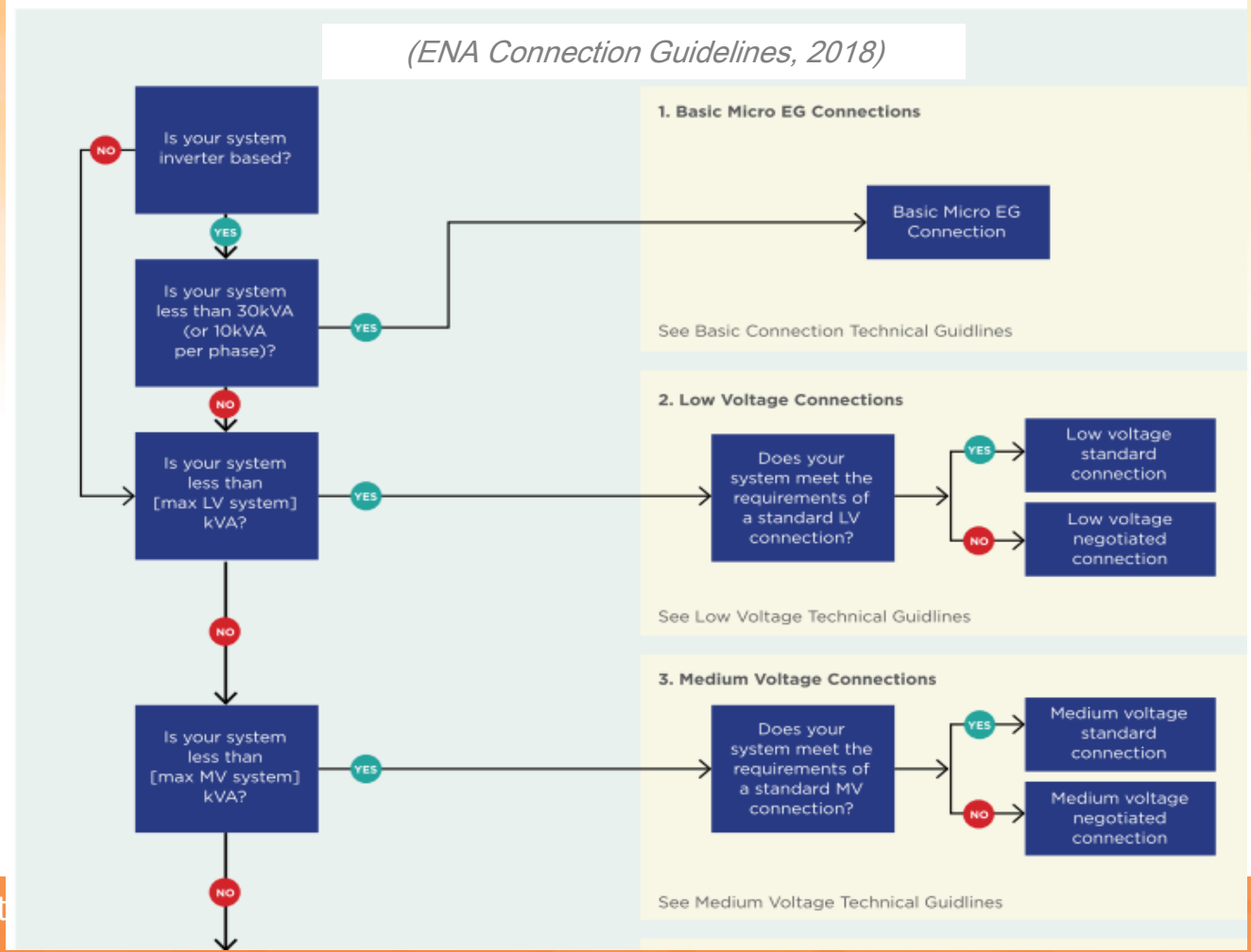




Connection process – impacts vs transaction costs

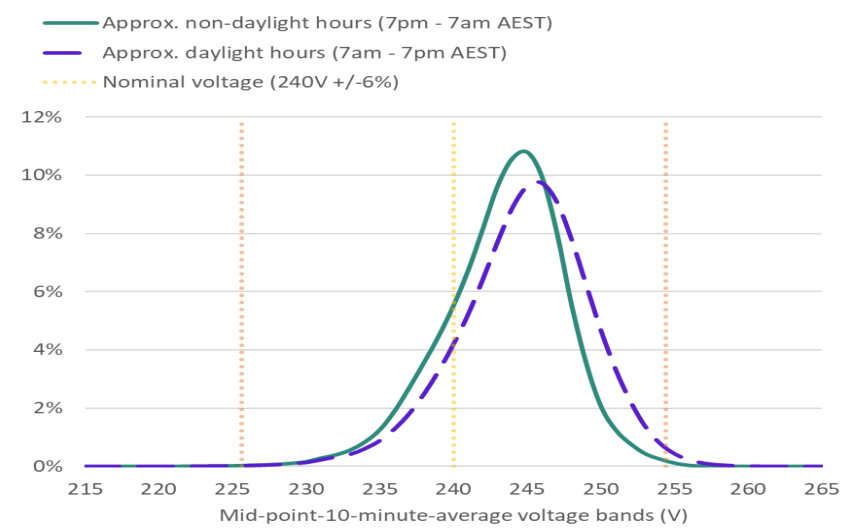
- Less demanding for small PV but cumulative small impacts big
- Coherence between treatment of gen, storage + load impacts?

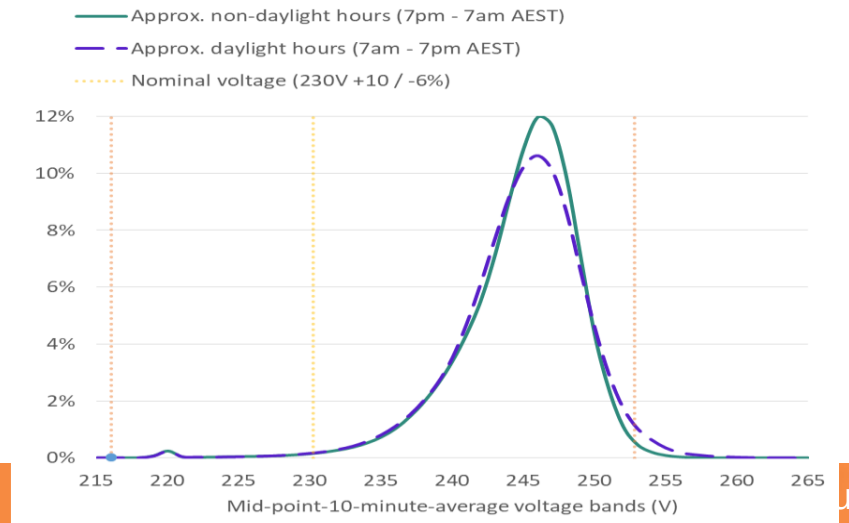
(ENA Connection Guidelines, 2018)

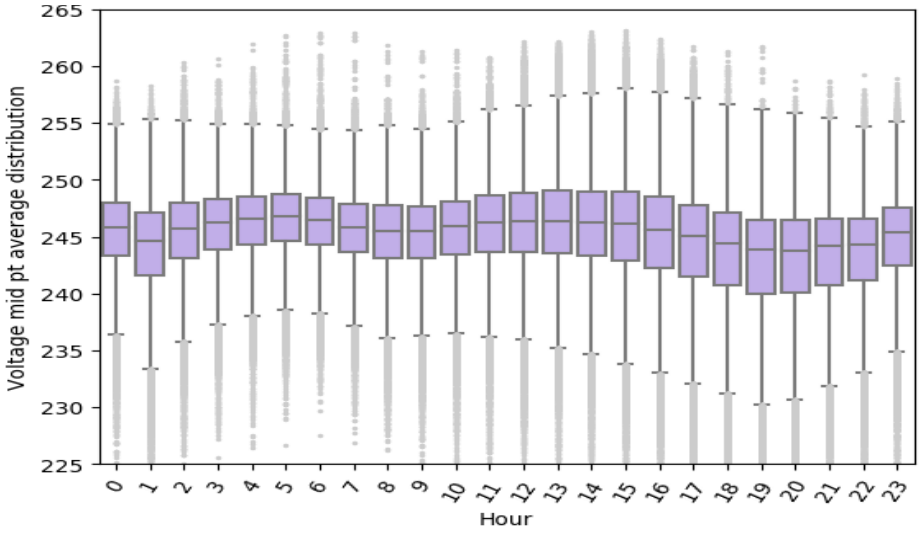


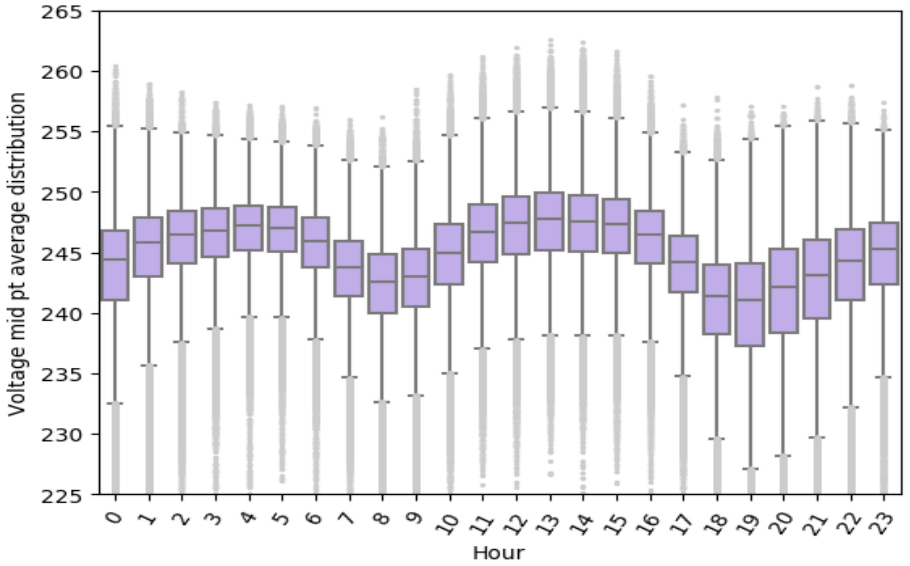
Voltage a key issue … but shared outcome

Queensland and South Australia LV network voltage *(Solar Analytics data - Stringer, APSRC, 2018)*









uptake in

Power system security implications

- Distributed PV now a significant power system level contributor to total generation at key times, certainly in SA
- Falls outside AEMO SCADA and dispatch
- Has proven valuable during extreme heat peak demand
- But poorly understood behaviour during major disturbances

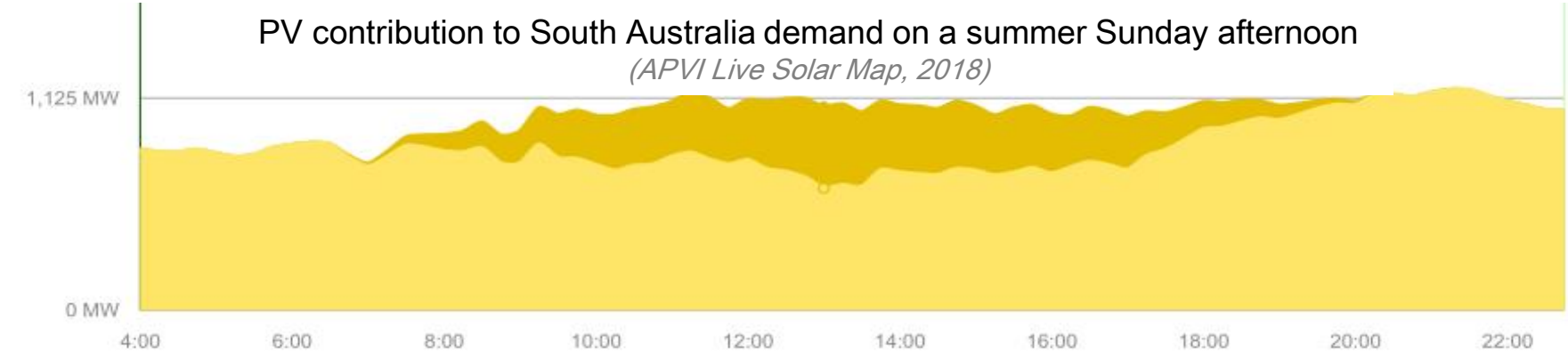
AEMO points to rooftop solar's critical role in "remarkable" heat event

By Giles Parkinson on 1 March 2018

Queensland has nearly 2GW of rooftop solar installed across the state -– more capacity than any of its coal generators – and the value of that resource has been highlighted by an Australian Energy Market Operator assessment of a recent heatwave that hit the state.

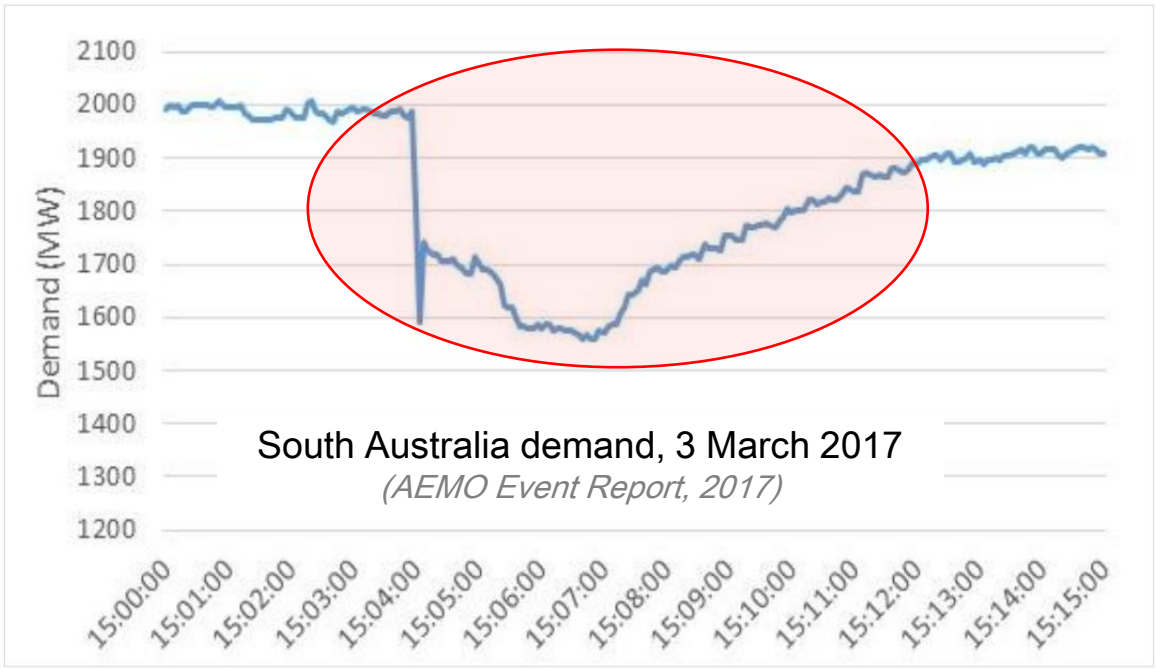
PV contribution to South Australia demand on a summer Sunday afternoon

(APVI Live Solar Map, 2018)



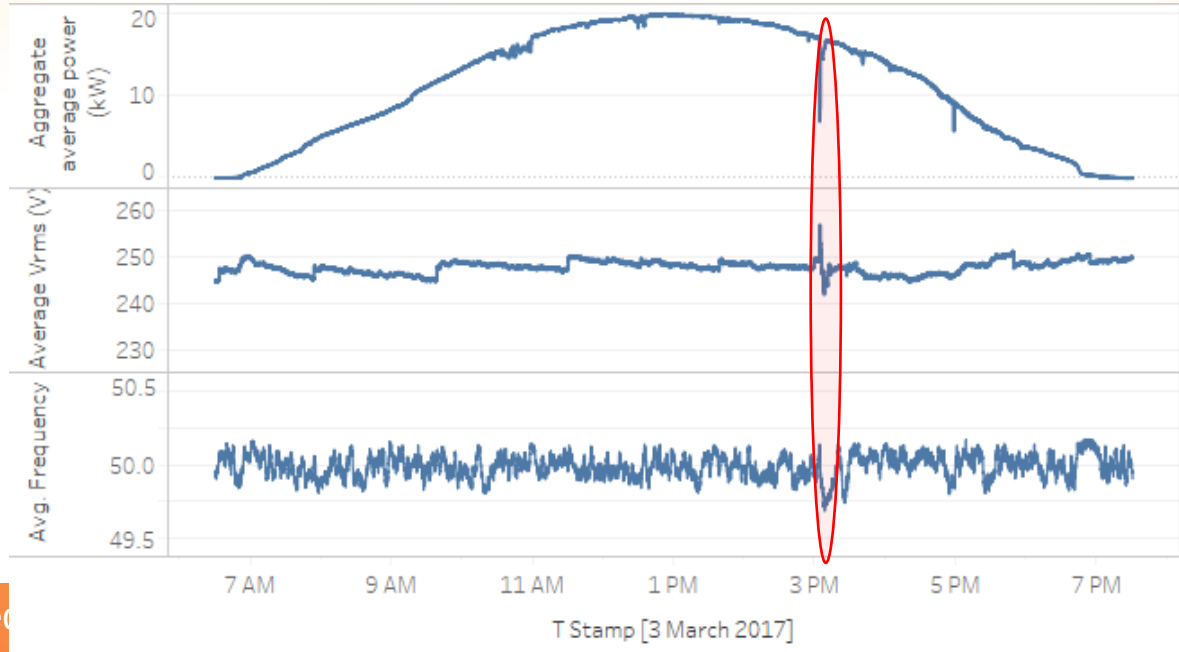
Distributed PV response to a major power system ‘event’

- Catastrophic CVT failure in switchyard leads to faults + other issues, major generation loss in SA
- Major voltage disturbance all the way to LV network, load ‘shake off’, distributed PV ‘shake off’
- Response of distributed PV varied, from ride-through to complete disconnection



South Australia demand, 3 March 2017
(AEMO Event Report, 2017)

Distributed PV response – sample of *Solar Analytics* monitored systems
(Stringer et al, AEMC submission, 2018)



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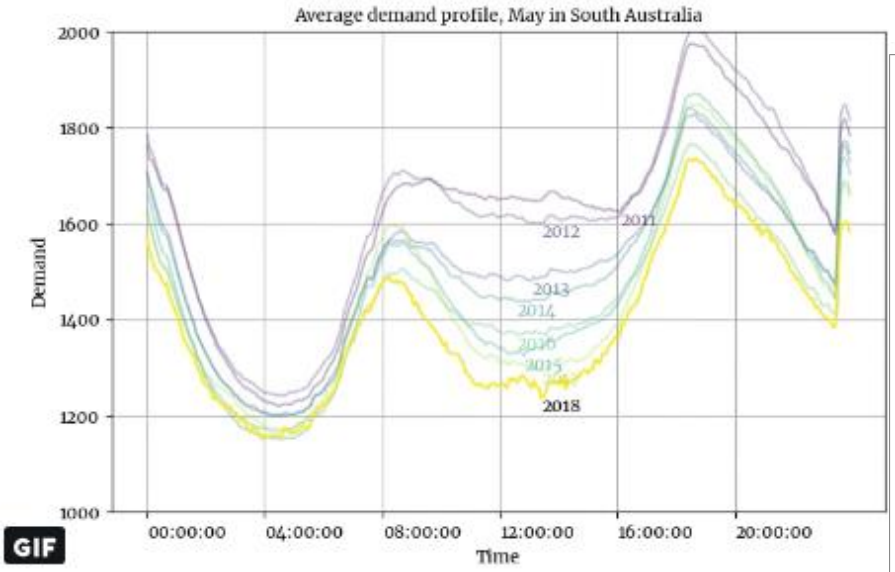
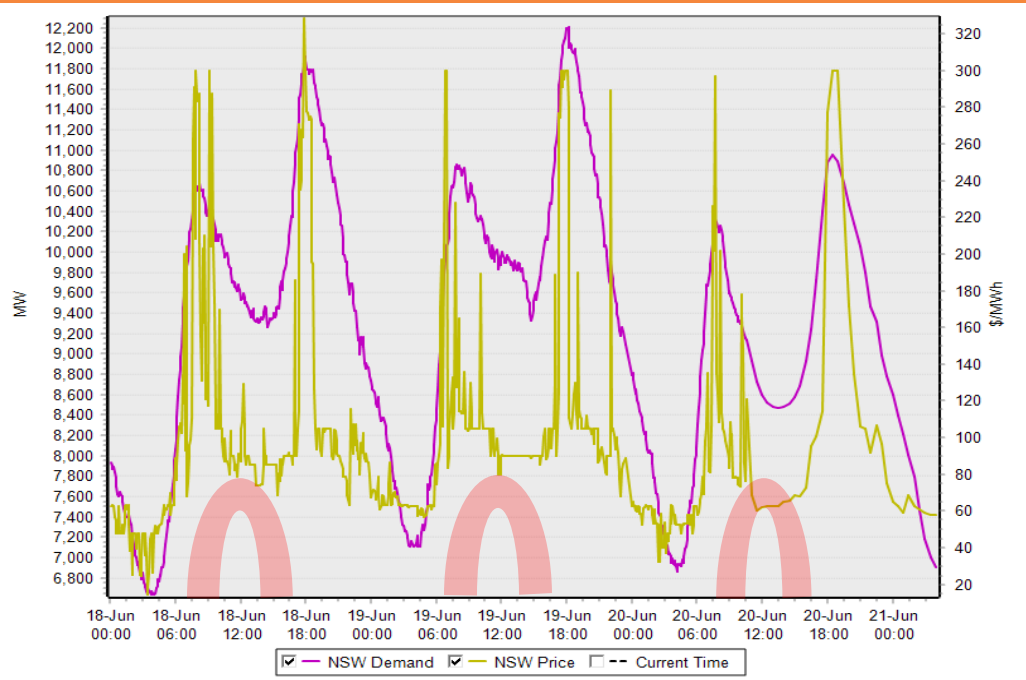
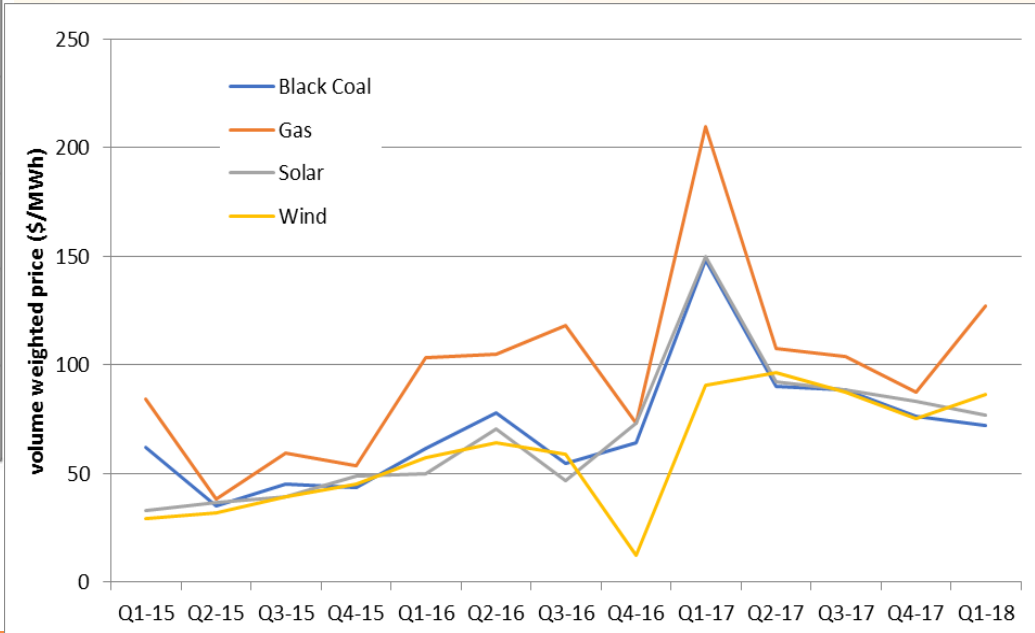
PV economics

- *marginal energy value declines with growing penetrations, as expected*

South Australia's changing demand profile
(https://mobile.twitter.com/dylanjmcconnell/status/995571185139105792/photo/1)



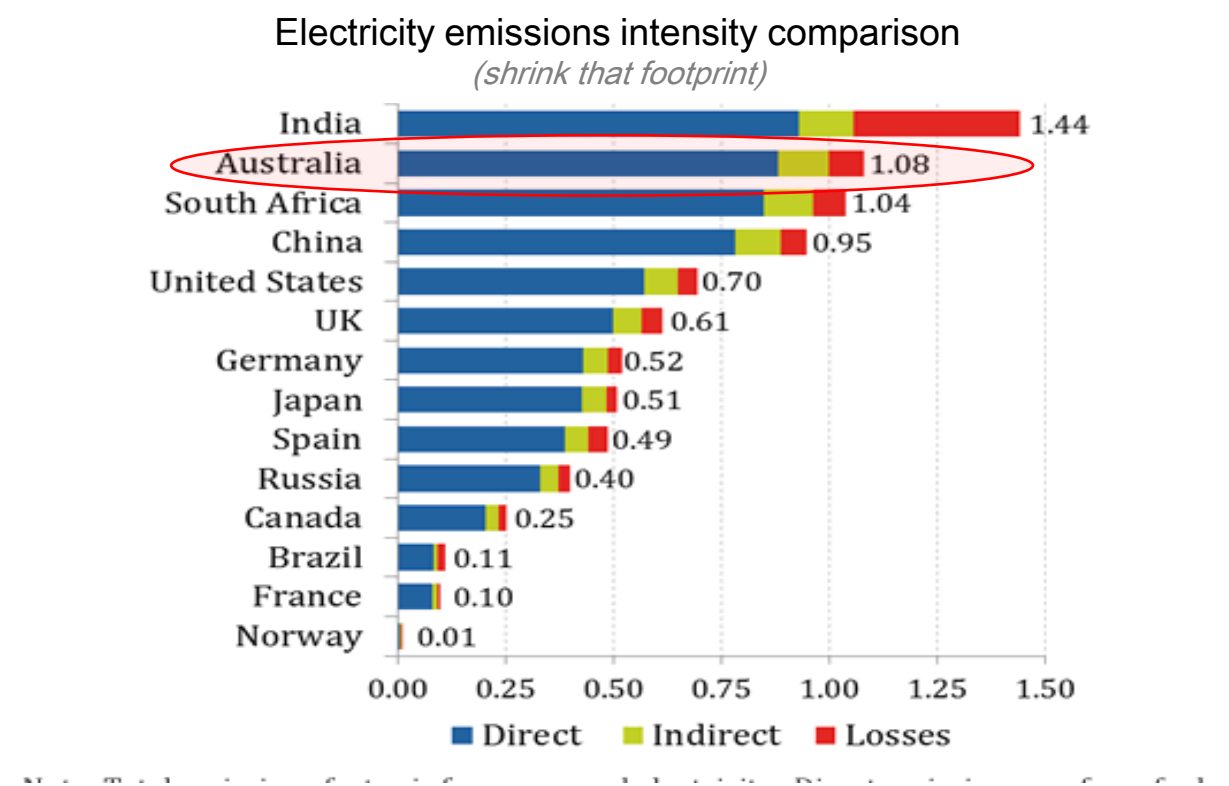




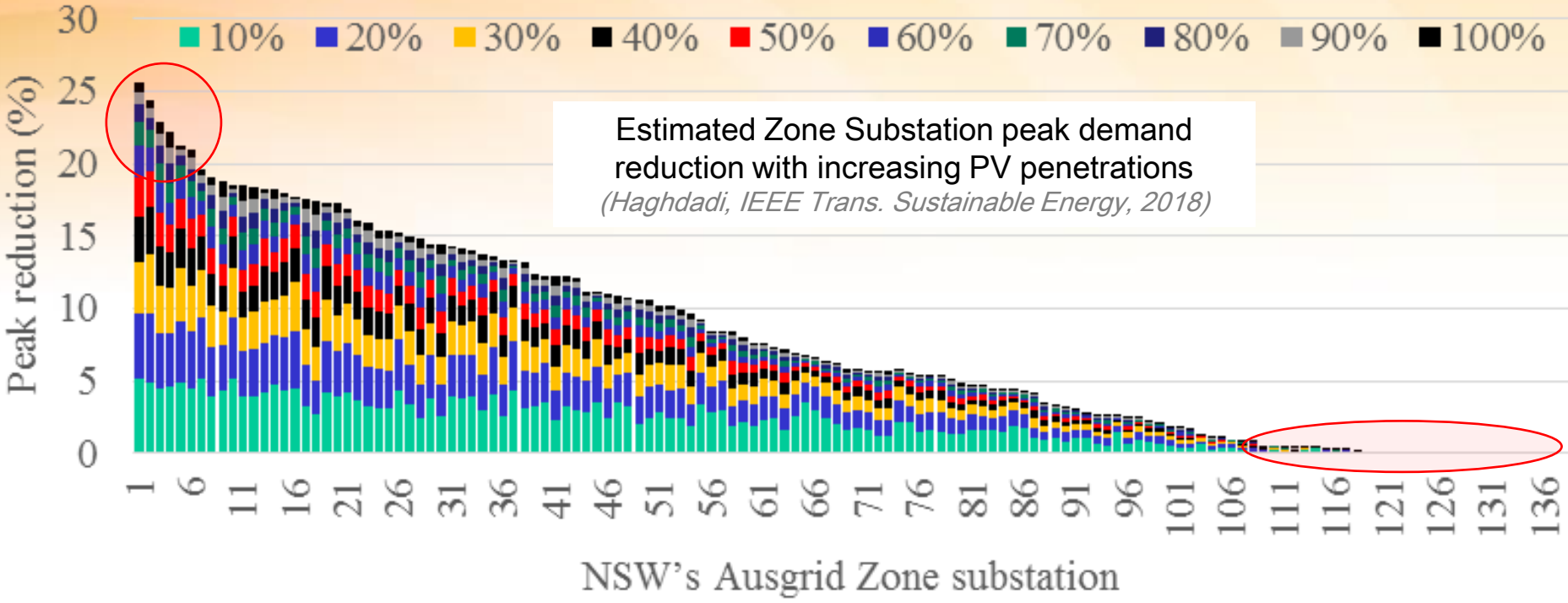
Can expect falling daytime hours price premium as 'residual' daytime demand due to distributed PV

PV economics

– environmental value increasing with growing appreciation of climate risks, lack of Australian progress to date



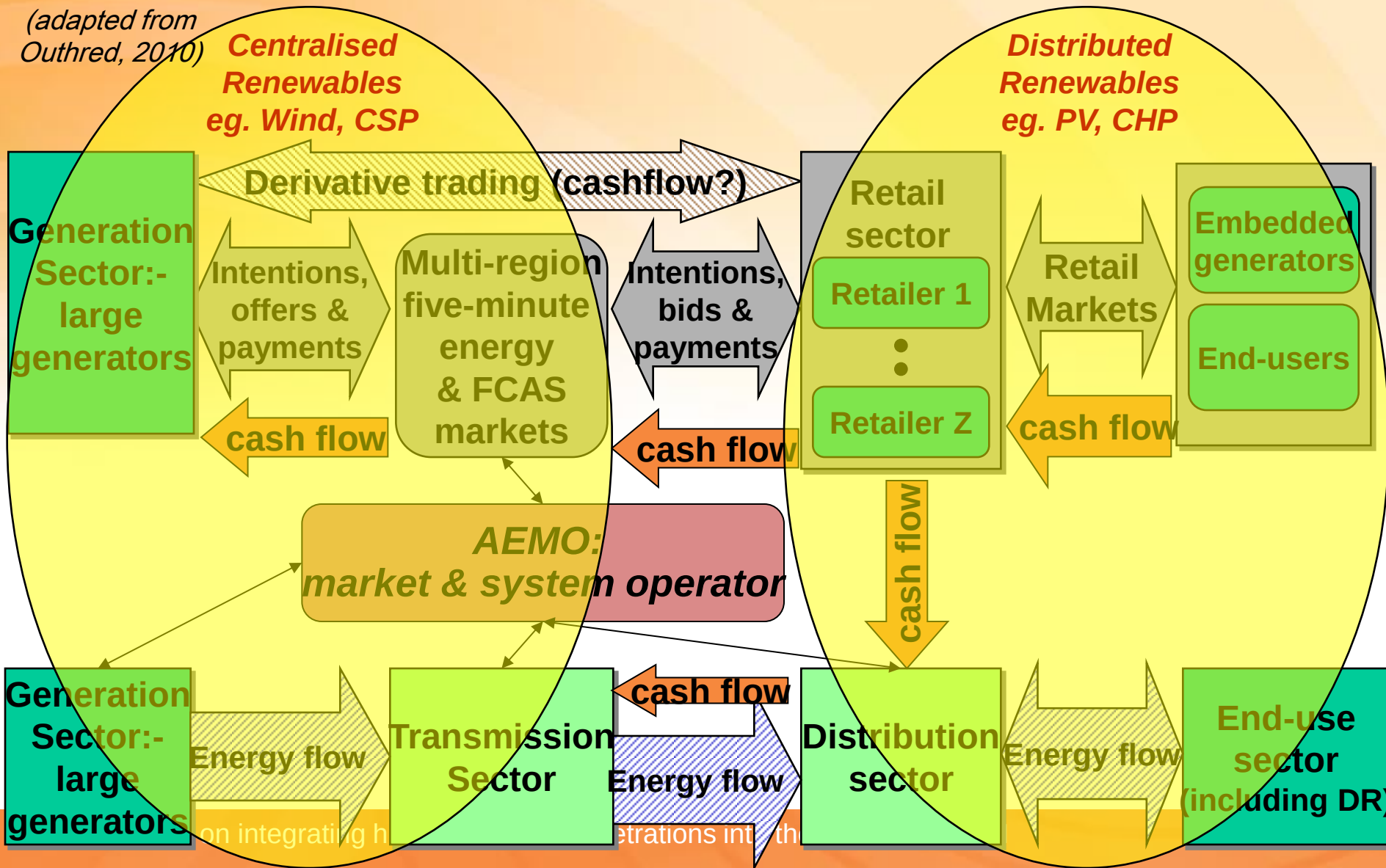
PV economics – network cost / value complex, highly context specific



Estimated Zone Substation peak demand reduction with increasing PV penetrations
(Haghdadi, IEEE Trans. Sustainable Energy, 2018)

Two market 'worlds' for PV integration

(adapted from Outhred, 2010)



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Commercial perspectives for retail ‘consumers’

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]

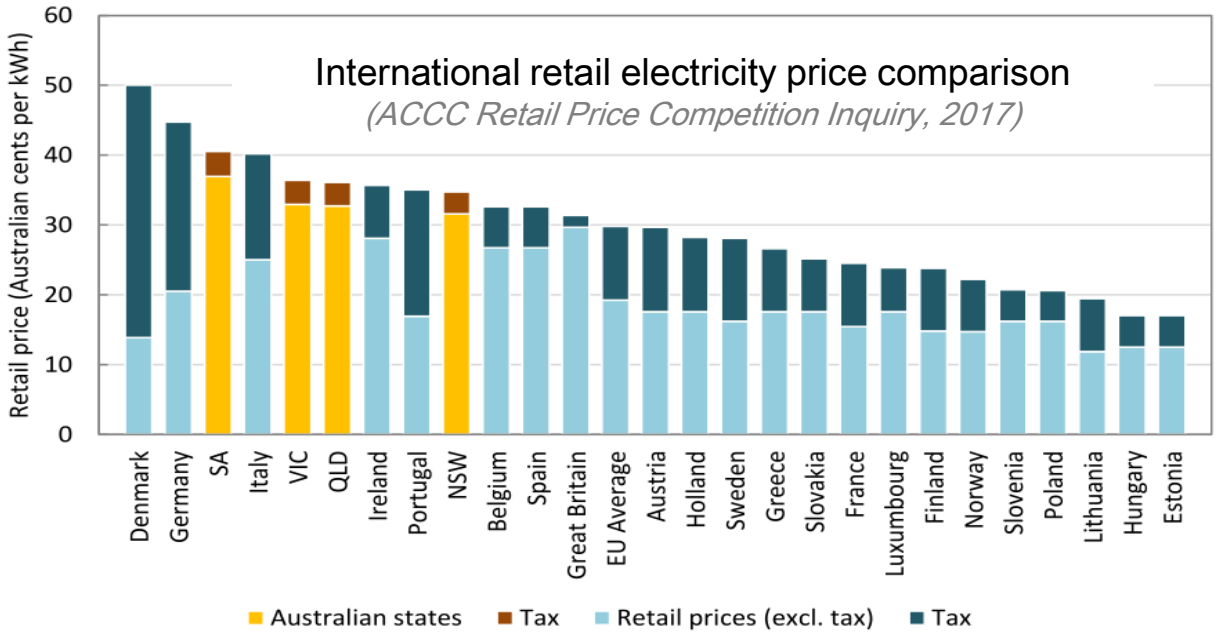
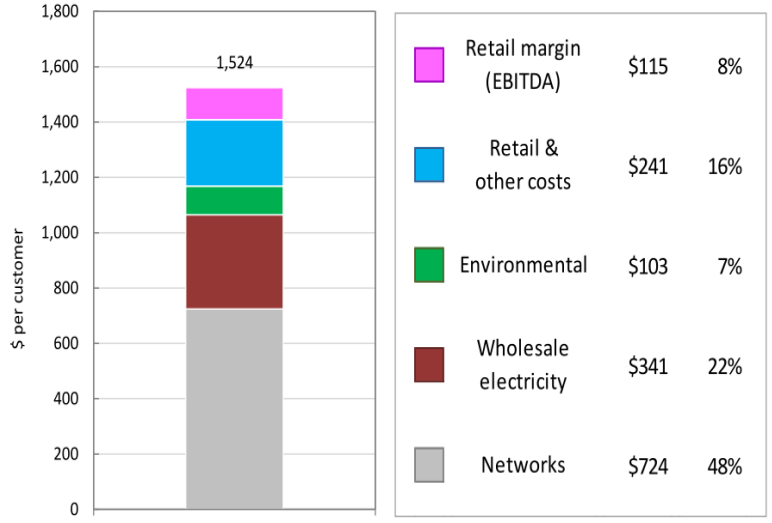


Figure 3.6: Household energy price index

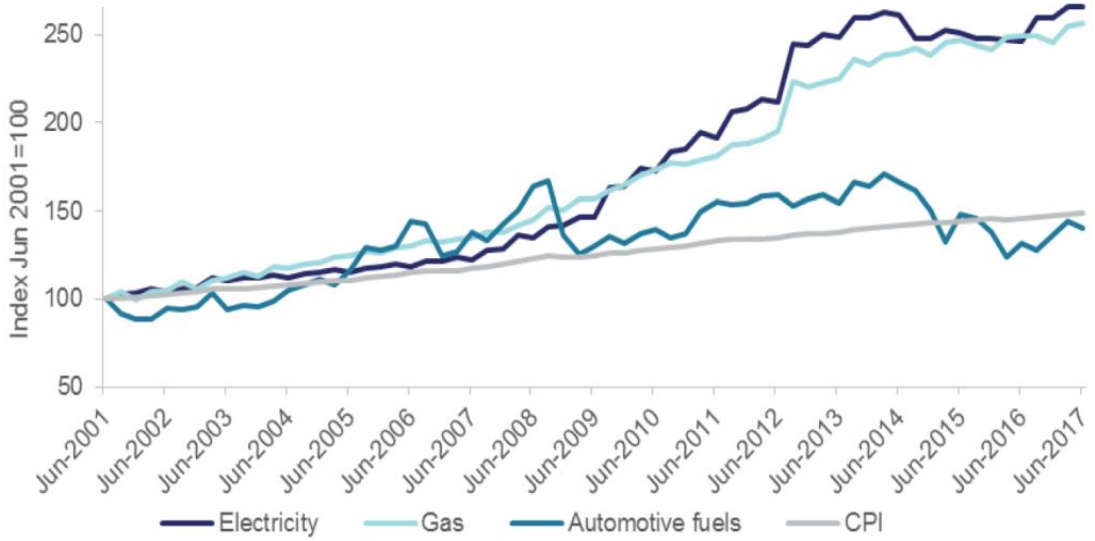
Figure 2.1: Components of an average residential customer bill across the NEM (excluding Tasmania) (2015/16, $ per customer,) excluding GST



Source: ACCC analysis based on retailers' data. This figure does not include data for Tasmania.[77]

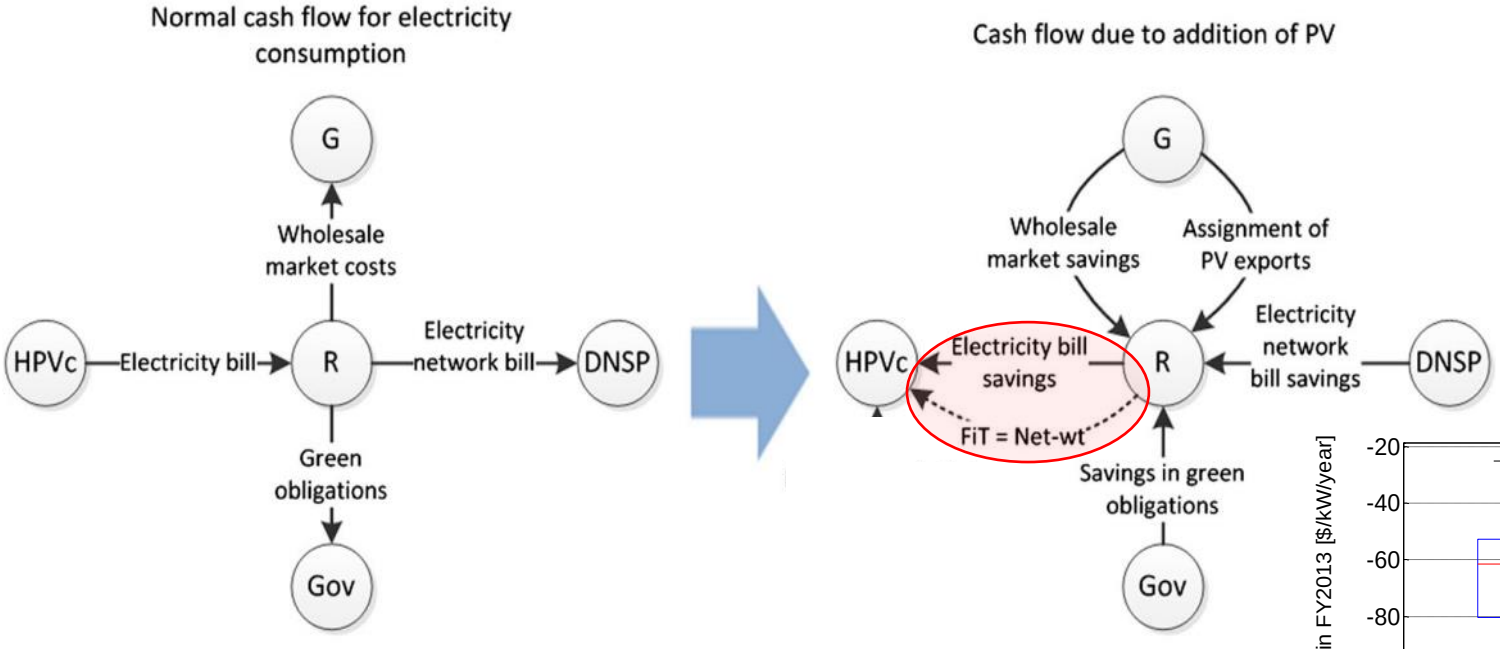
Australian residential energy prices index

(Australian Energy Statistics Update 2017)



How is this impacting incumbents?

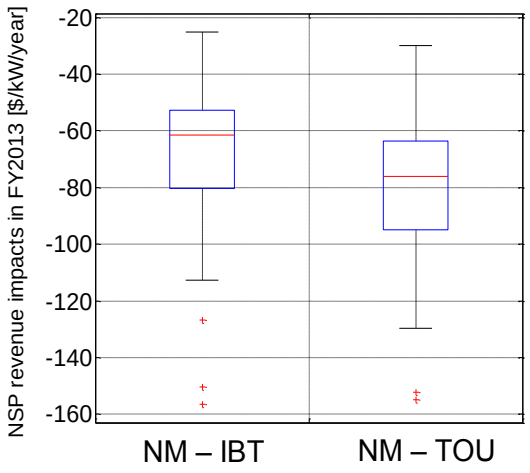
follow the money, particularly falling N/W revenues from net-metered consumers with PV, soon perhaps also battery systems



(Oliva et al, 2015)

Revenue loss by Dx utilities with Net FiT

(Oliva et al, 20160)



A new direction for network tariffs

Australian Energy Market Commission

AEMC

Home | Australia's Energy Market | Energy Rules | Market Reviews & Advice

Home > News > New rules for cost-reflective network prices

New rules for cost-reflective network prices

27 November 2014

The National Electricity Rules will be changed from 1 December 2014 to require regulated network companies to structure their prices to better reflect the consumption choices of individual consumers.

Under these changes, network prices will reflect the costs of providing the electricity to consumers with different patterns of consumption.

The new rules follow extensive consultation over the past year, and take into account submissions received when the draft rules were released in August.

AEMC Chairman John Pierce said the prices we pay for electricity would actively respond to the different ways people choose to use it under these new rules.

"These changes put consumers at the centre of future decision-making about energy," he said.

"By having prices that reflect the costs of different patterns of consumption, we are giving consumers clearer choices as we develop a more efficient, incentive-based network regulation framework.

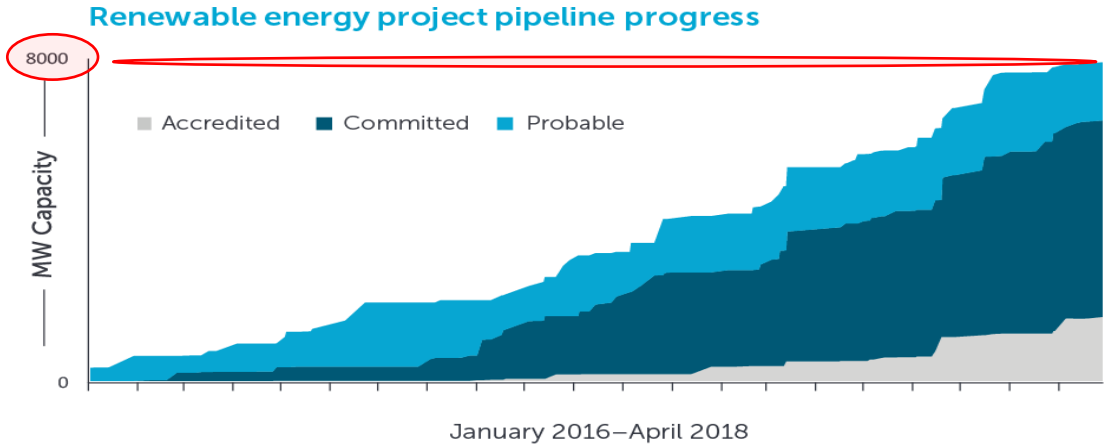
Will new 'cost-reflective' tariffs efforts help?

- Which costs – past, present or future?
  - Future costs and benefits are key for efficiently driving transformation
  - Past costs the key incumbent network consideration – hence interest in raising fixed tariff component (¢/day) while reducing volume ¢/kWh
  - *…which will then reduce the 'value' of consumer participation with PV, but also value of participation via energy efficiency, and DR*
- What of transition?
  - Metering capabilities
  - Social expectations, hence political realities
- What of integration into broader end-user industry interface?
  - Does it matter if N/W tariffs aren't mirrored in retail tariffs?
  - Why accept some cross subsidies – eg. city vs country – but not others that actually support energy transition?
  - *Do we really want to reward consumer engagement or maintain BAU?*

Other relevant developments

- Utility PV and wind deployment growing rapidly, potentially this may continue
  PV – large, small or all?
- Growing concerns with old thermal plant reliability
- New technologies + business models can assist in monitoring, managing PV impacts

(Clean Energy Regulator, 2018)



(https://reneweconomy.com.au/demand-response-disrupting-australias-ancillary-services-markets-)

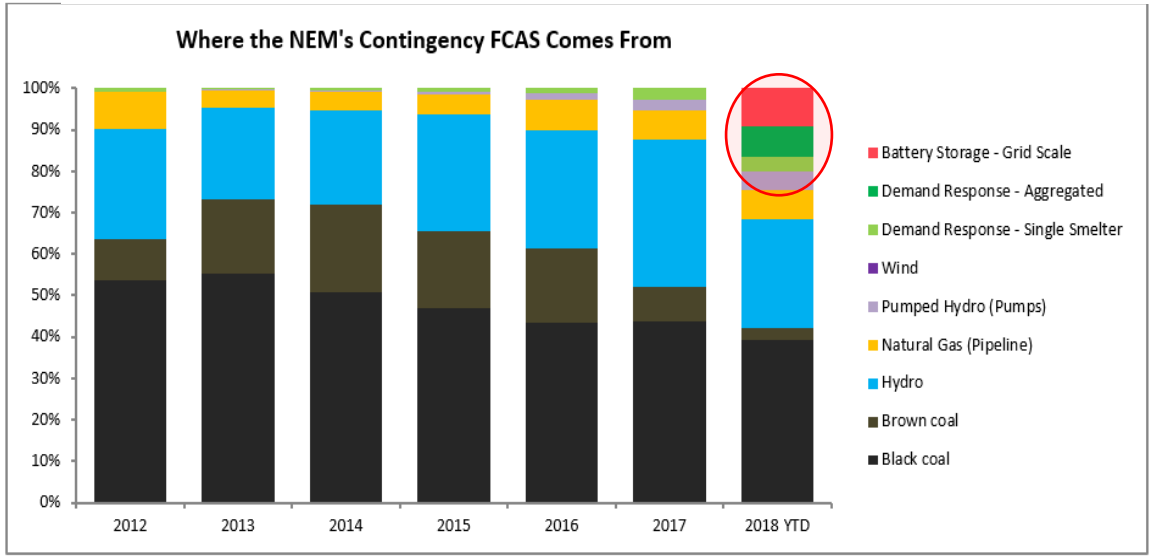


Chart data: *Sum of R6, R60, R5 FCAS |Enabled MWh (NB: not 'energy supplied') by technology type*
Calendar years | 2017 to 30 Sep (pre EnerNOC + Hornsdale PR) | 2018 to 31 May

Possible ‘coordination’ paths forward

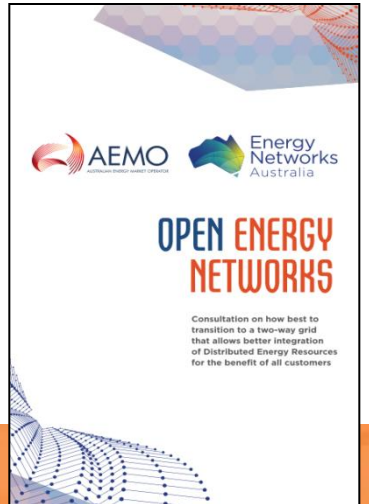
How to get greater coherence between utility scale / wholesale market *and* distributed resources investment and operation?

Single Integrated Platform (SIP) - The single platform model envisages a unitary point of entry to the entirety of the NEM and WEM. Under this option, the platform would be an extension of the wholesale market. AEMO would provide the platform as part of its market and system responsibilities and along with the individual distribution utilities will develop a single integrated platform that will use a set of agreed standard interfaces to support the participation in the integrated multi-directional market by retailers, aggregators, and VPP platform companies. The SIP will then simultaneously solve local security constraints and support wholesale market entry. Under this configuration, access to the platform will be a one-stop shop that provides market participants the opportunity to participate anywhere in the NEM or WEM without having to develop separate systems or tools to integrate with the various individual distribution platforms. Network businesses will be linked into the platform, with distribution business providing information on local constraints to AEMO. AEMO would consider this information and economically dispatch these resources alongside other resources (transmission connected load, large scale generation etc.).

Two Step Tiered Regulated Platforms - A second alternative is a model where there is a layered distribution level platform interface operated by the local distribution network and an interface between the distribution network‘s platform and AEMO. Under this design, individual distribution networks can design interfaces that best meet their system requirements. Participants would then need to communicate directly with the distribution level platform for the local constraint issues and the distribution network would optimise these resources against local network constraints based on bids from the aggregators servicing the area.

Distribution networks would provide an aggregated view per the transmission connection point. AEMO would take this information and consider the overall system security and economic dispatch.

Independent DSO - A third option, that is a variant of the second, is for an independent party – a DSO that is separate from AEMO and the distribution utility. Under this model the independent DSO would work with the distribution utility to optimise the dispatch of the DER based upon local system constraints that are provided by the network business, provide the aggregated bids to AEMO for incorporation into the larger dispatch. This option will be more complex than the others and may be significantly more costly.



Key messages

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- Some seemingly manageable technical challenges in the LV network including voltage, but management not just PV issue
- Relatively recent appreciation of security challenges with distributed PV during major power system 'events'
- Economics – marginal energy + network value declines with higher PV penetrations, as with all generation technologies
- 'follow the money' - commercial impacts of PV deployment on key industry participants, especially networks, highlighting limitations of present retail market arrangements
- Recent growth in Australian utility PV highlighting the complex economics, wider context of PV's future – large, small or all PV? Also the role of new technologies including Energy Storage, DR

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Thank you… and *questions*

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