



Centre for Energy and  
Environmental Markets

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# Possible Australian Energy Futures – *legacy, technology, market and policy drivers*

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# Energy - past

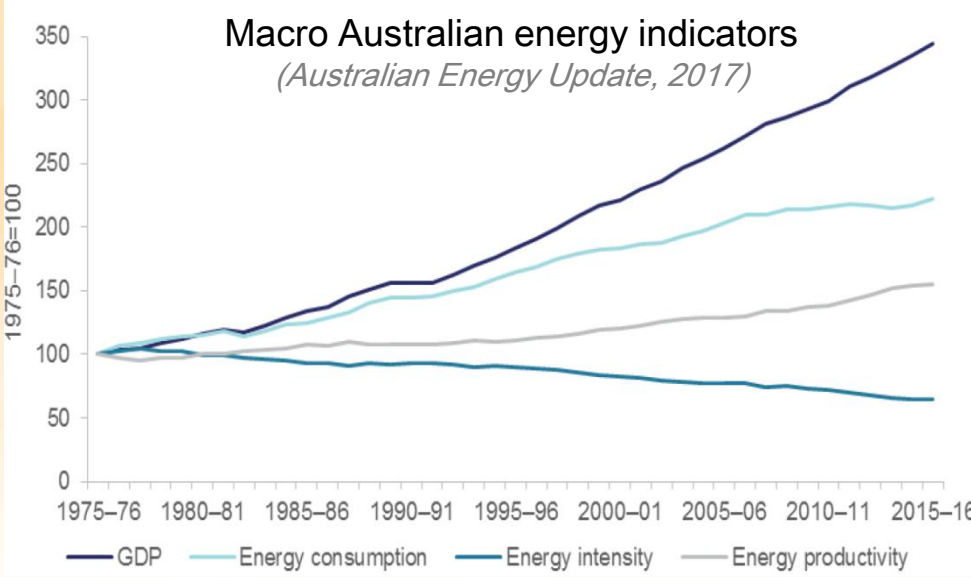
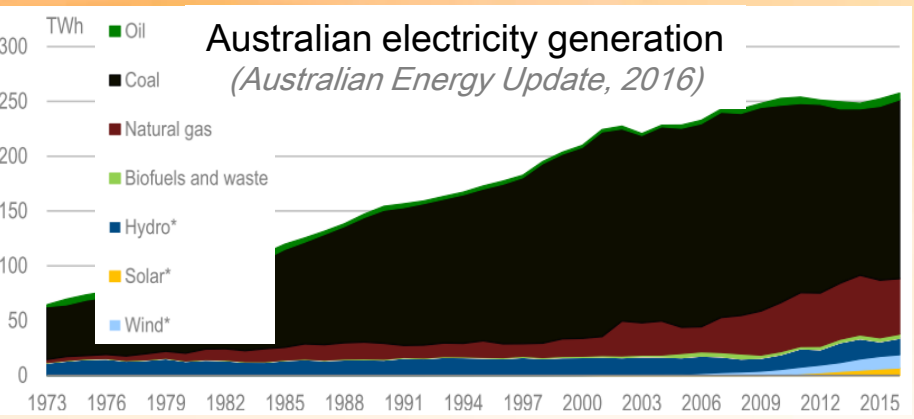
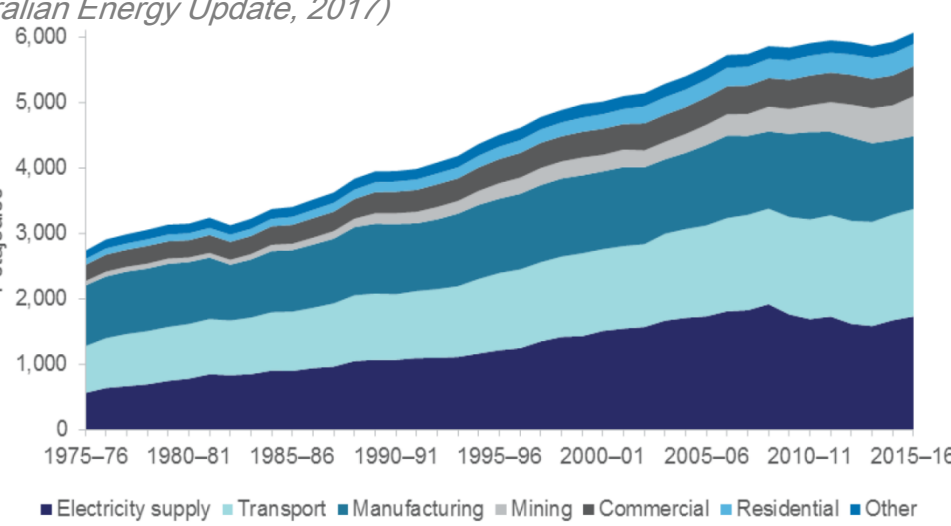
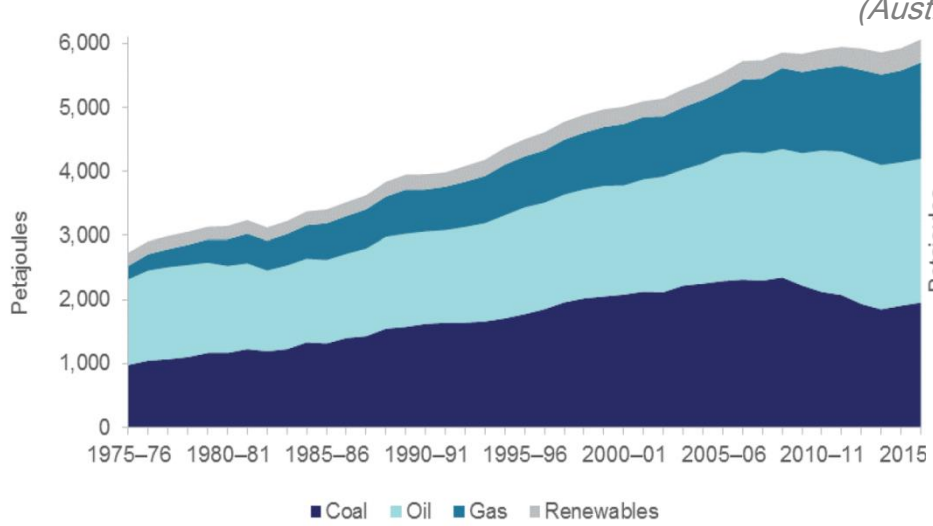


Figure 3.2: Australian energy consumption, by fuel type Australian primary energy consumption by fuel and consumption sector (Australian Energy Update, 2017)





# Past to present

*“Many of us who keenly observe the energy sector can take a pretty good guess at what our next big challenges are”*

Senior Australia Federal Minister, 2014

- Some Federal Government White paper predictions
  - **2004:** missed Coal Seam Gas takeoff, East Coast LNG export, falling demand, lower costs & growing uptake of wind
  - **2012:** missed East Coast LNG market impacts, falling demand, growing residential PV uptake
  - **2015:** missed climate change, wholesale price rises, success of wind and utility PV, growing security challenges

■ *Highlighting need for a becoming modesty about our ability to predict, let alone manage future challenges*

## A NATIONAL STRATEGY TO DELIVER PROSPERITY, SECURITY AND SUSTAINABILITY

To achieve energy prosperity, security and sustainability, the Government has in place policies to:

- attract investment in the efficient distribution of energy for the benefit of all Australians
- deliver a prosperous economy while maintaining Australia's role in global efforts to reduce greenhouse gas emissions
- encourage development of cleaner, more efficient energy sources, Australia's energy future
- develop effective and efficient energy markets, including energy, where and when it is needed
- minimise disruptions to energy supply, and ensure that when disruptions occur, they are managed effectively
- establish an efficient energy tax base, including resource rent taxes to offshore projects
- ensure Australia uses its energy wisely.

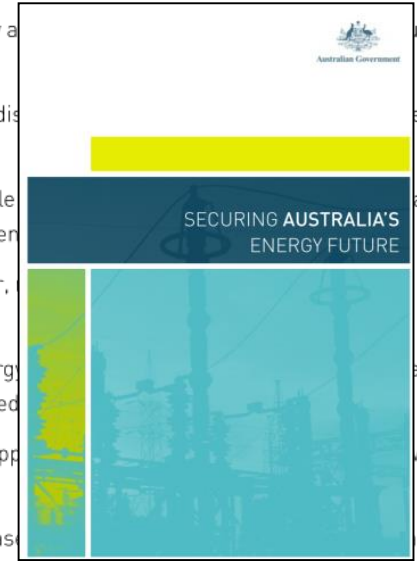
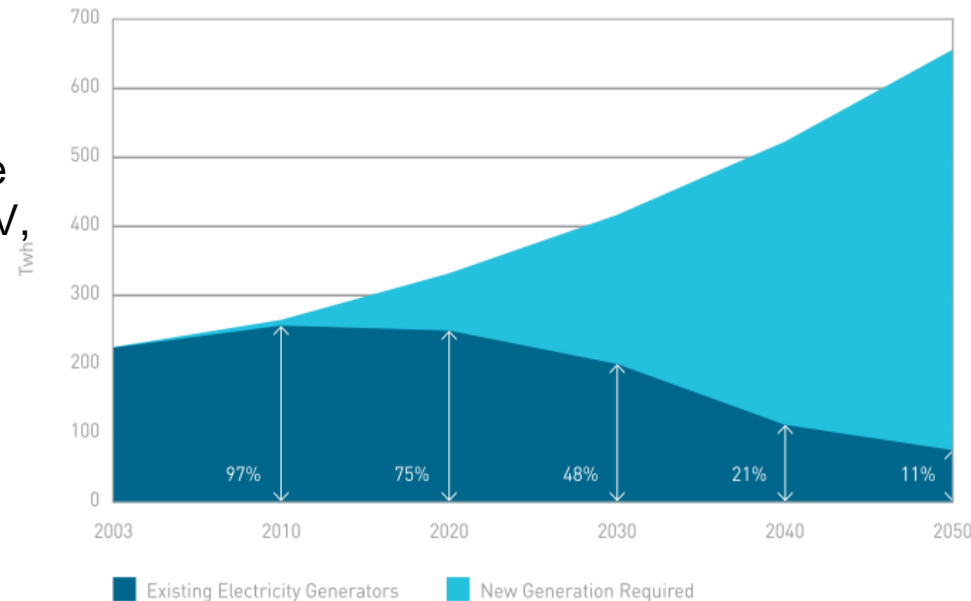


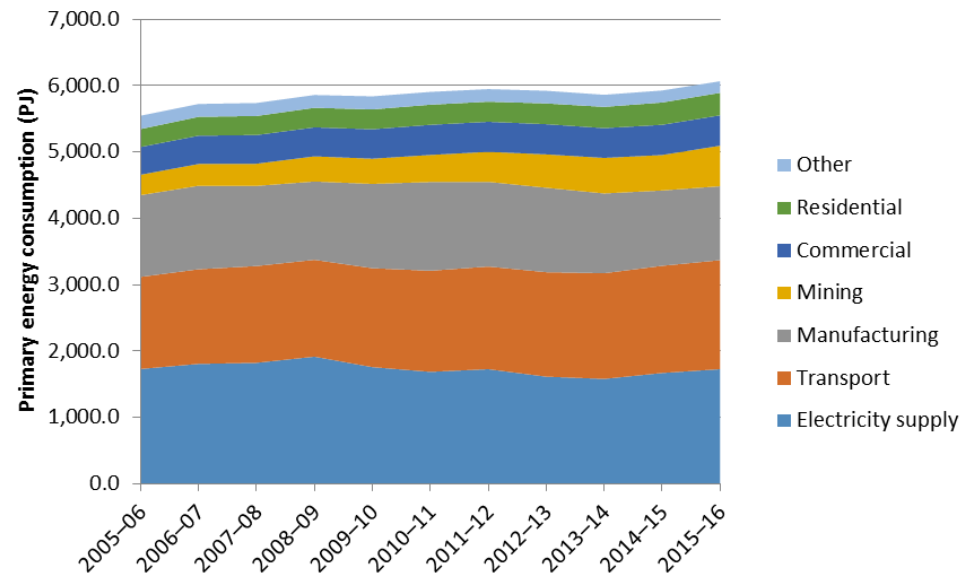
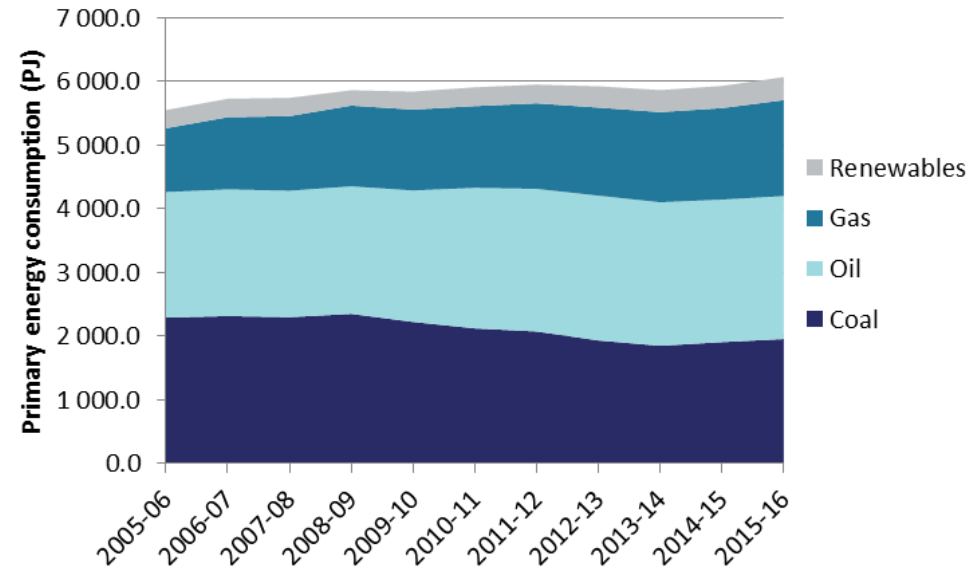
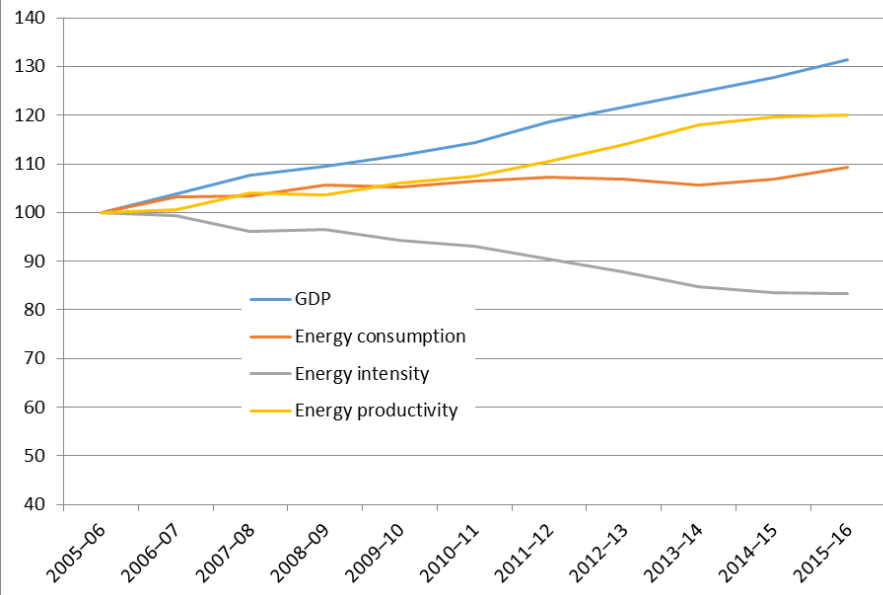
Figure 3: Demand/Supply balance for electricity—Medium electricity demand scenario



# Energy - present

- Significant 'inertia' but some emerging trends

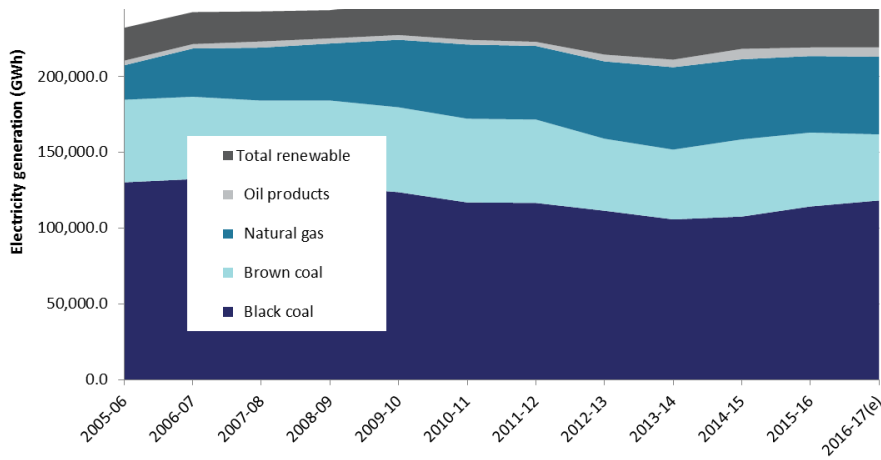
Key Australian energy statistics and indicators  
(Australian Energy Statistics Update 2017)



# Particularly in electricity

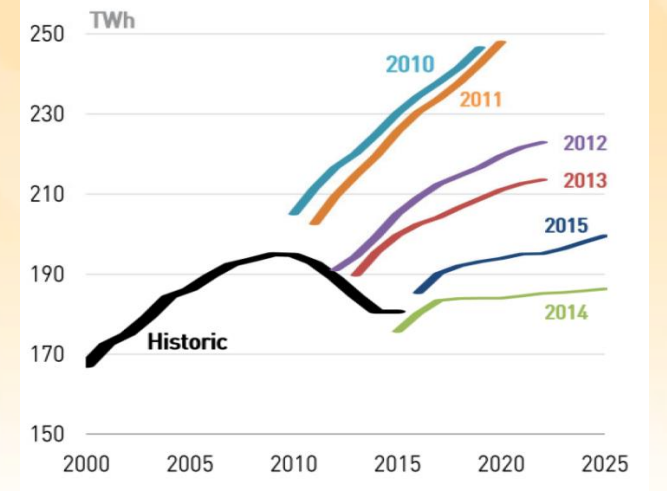
Australia's electricity generation mix 2006 - 2017

(Australian Energy Statistics Update 2017)



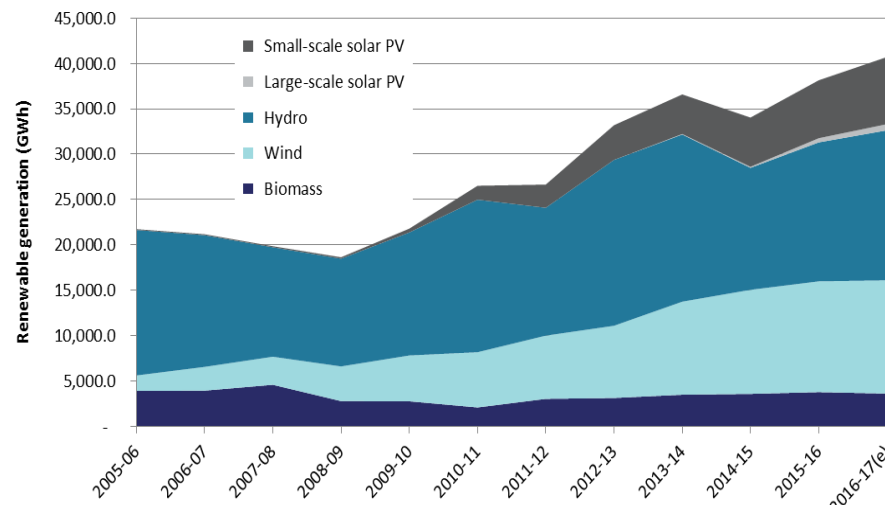
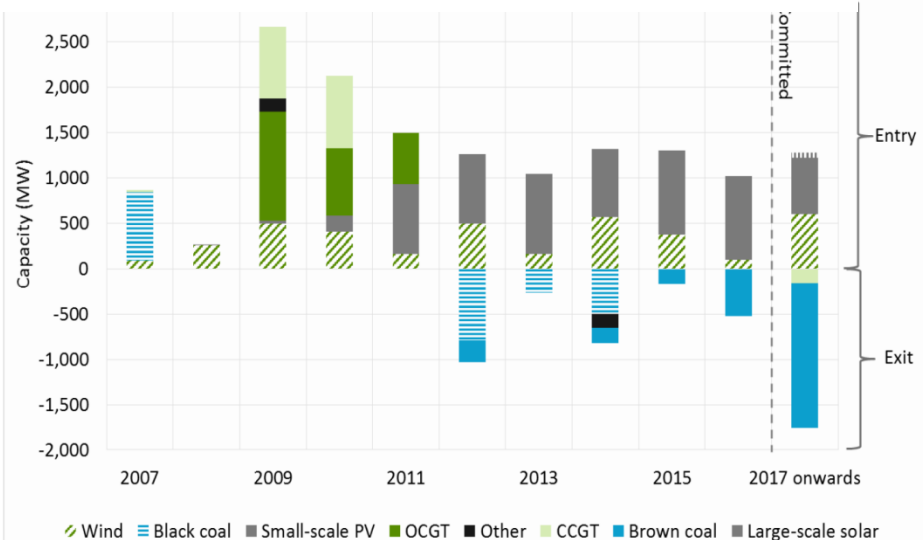
Electricity demand forecasts by AEMO and actual consumption 2000 - 2015

(BZE Renewable Energy Superpower, 2012)



Generation Entry and Exit in the NEM

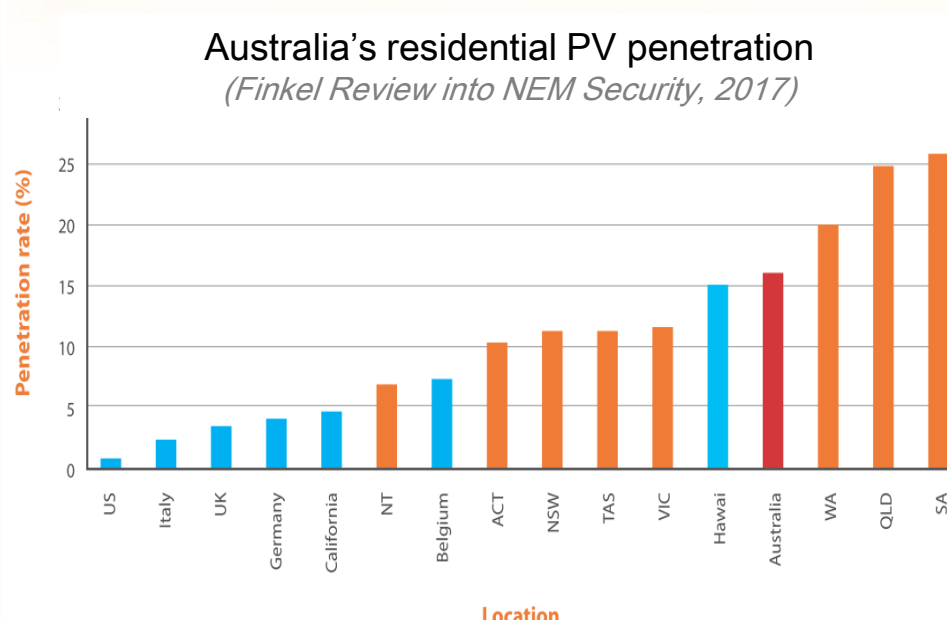
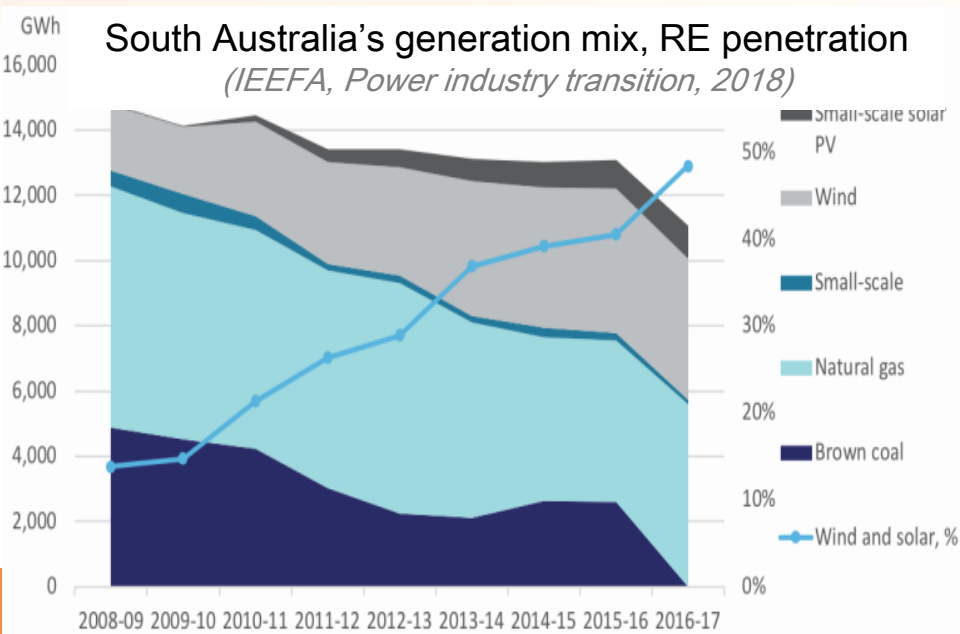
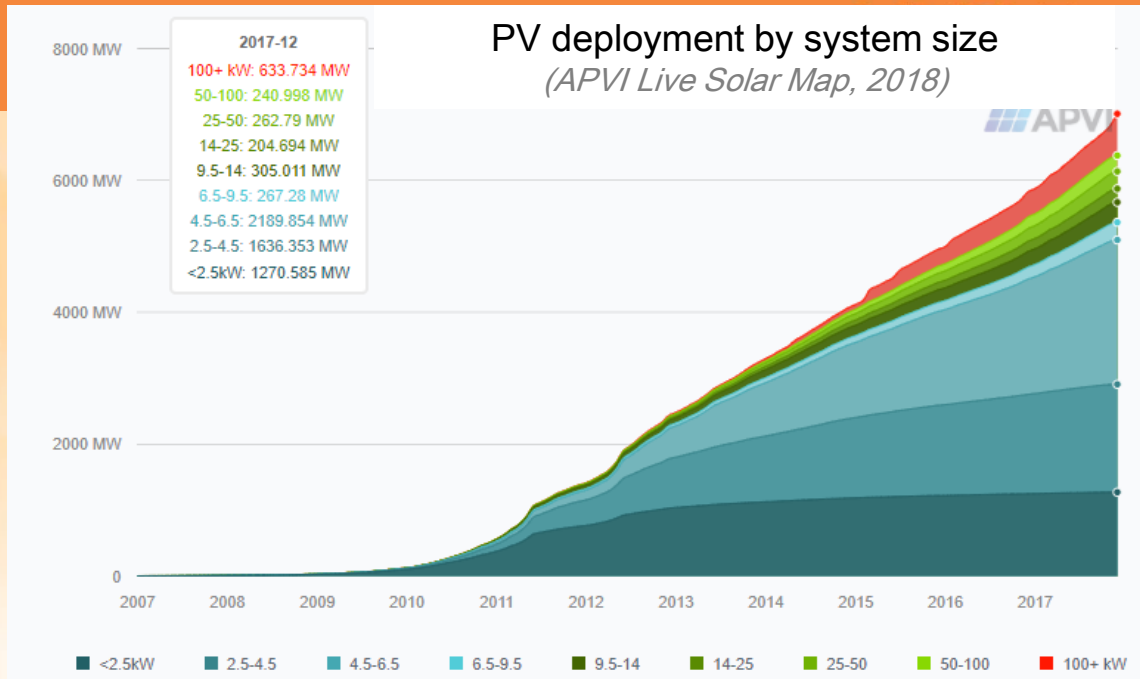
(AEMC/CCA, Towards the next generation, 2017)





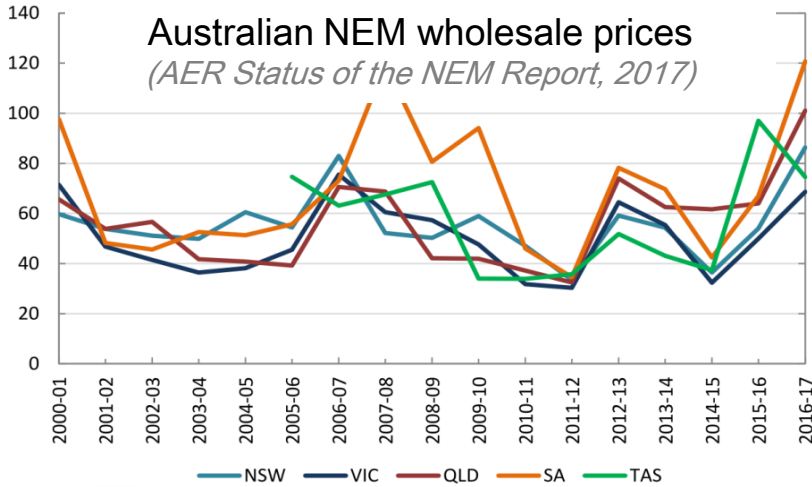
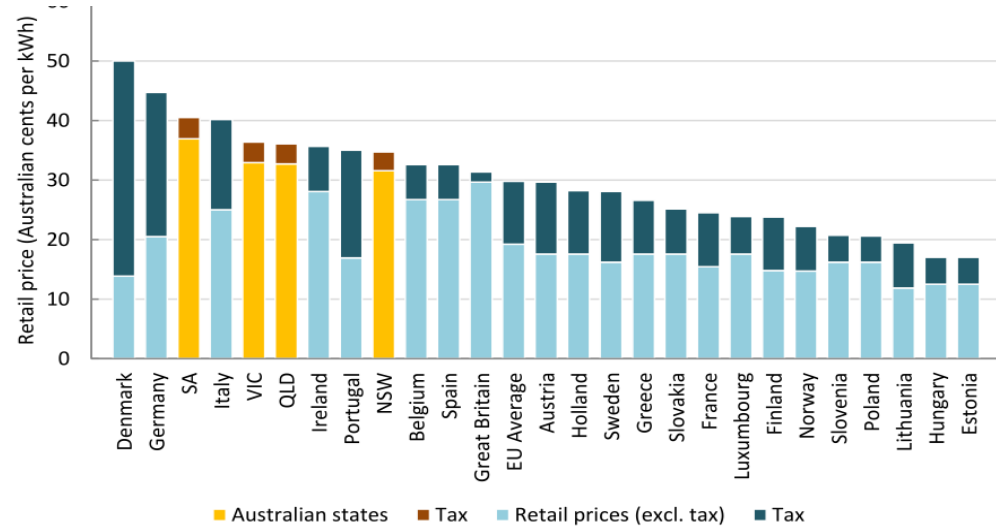
# ..with surprises

- World leading residential PV penetration
- South Australia a world leading jurisdiction for integrating high variable renewables penetrations

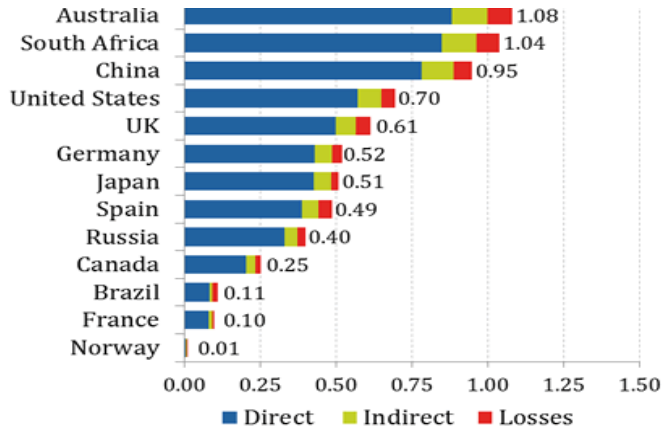


# ..including high wholesale & retail prices, and emissions, & some security concerns

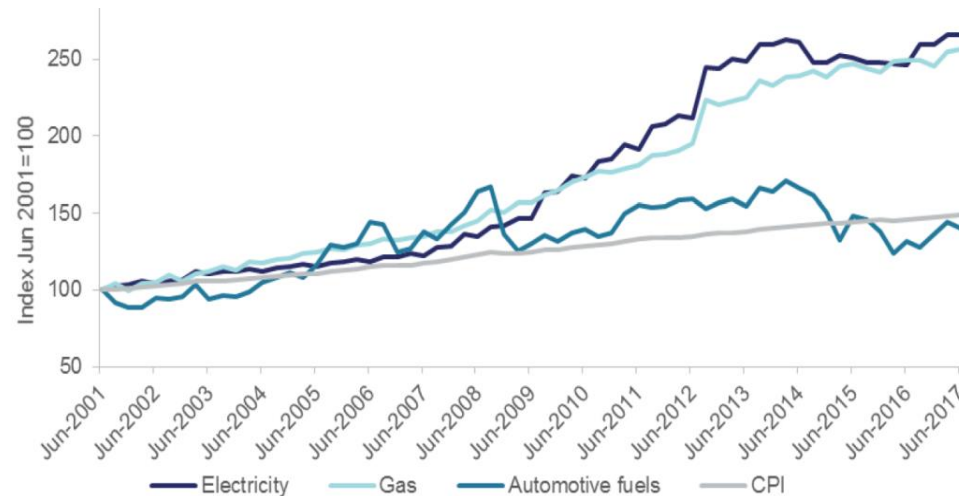
## International retail electricity price comparison (ACCC Retail Price Competition Inquiry, 2017)



## Electricity emissions intensity comparison (shrink that footprint)



## Australian residential energy prices index (Australian Energy Statistics Update 2017)



# Other possible reasons

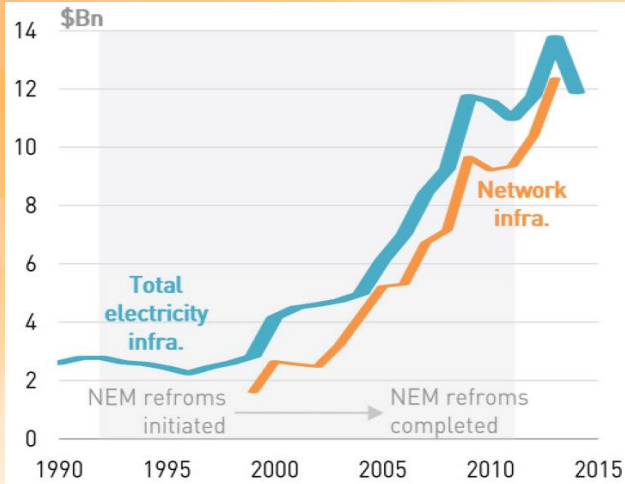
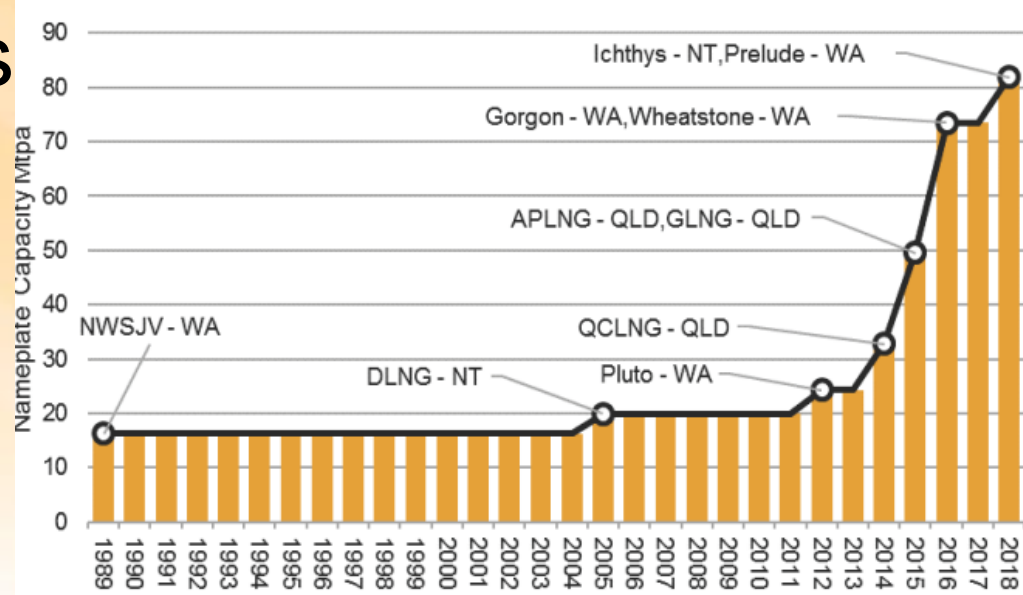
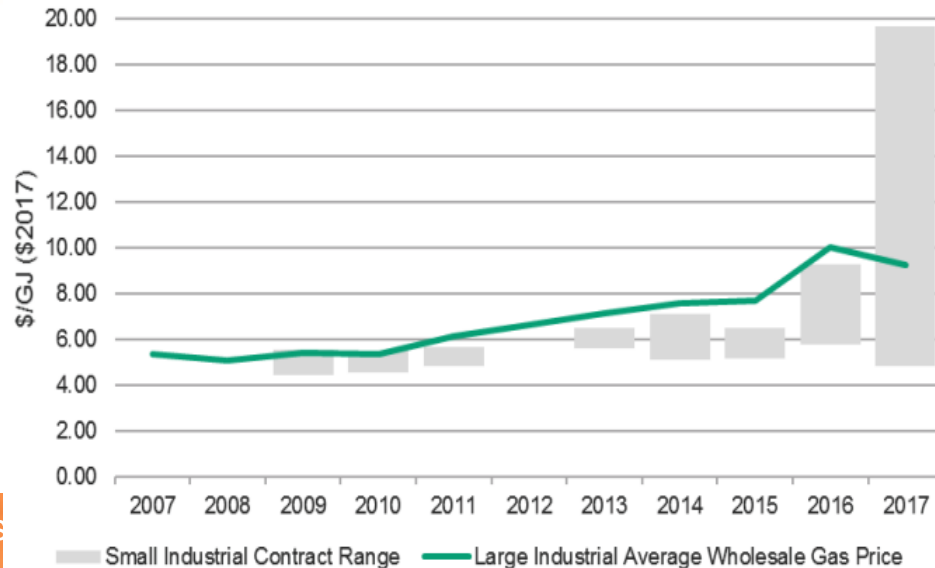
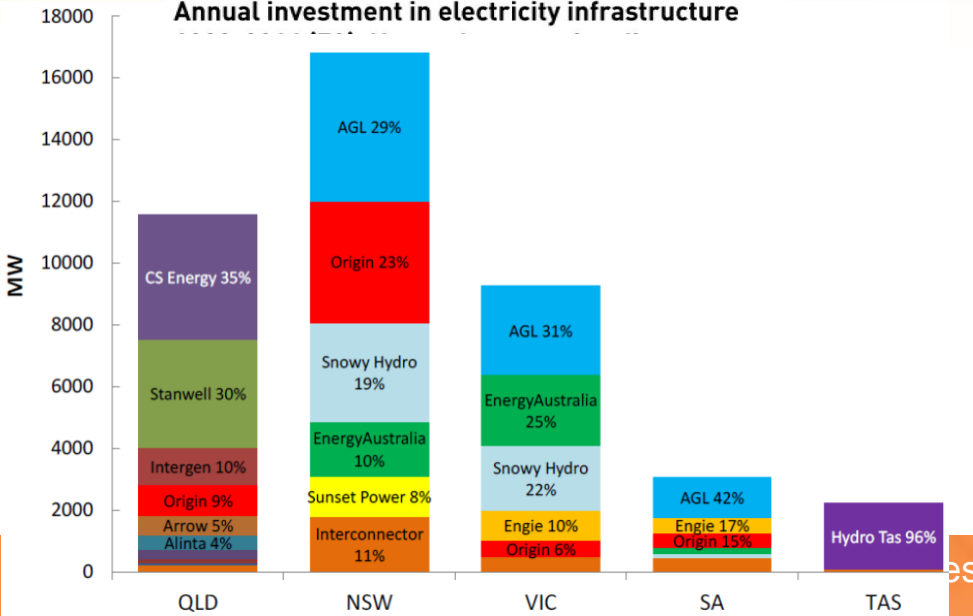


FIGURE 38



## Annual investment in electricity infrastructure





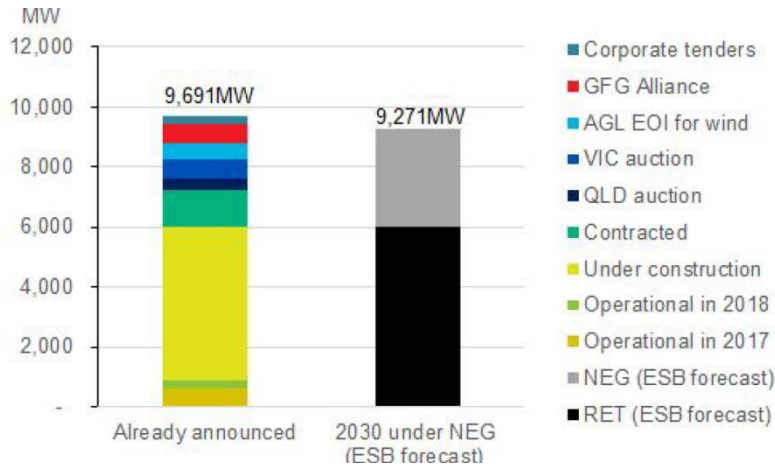


# Energy futures

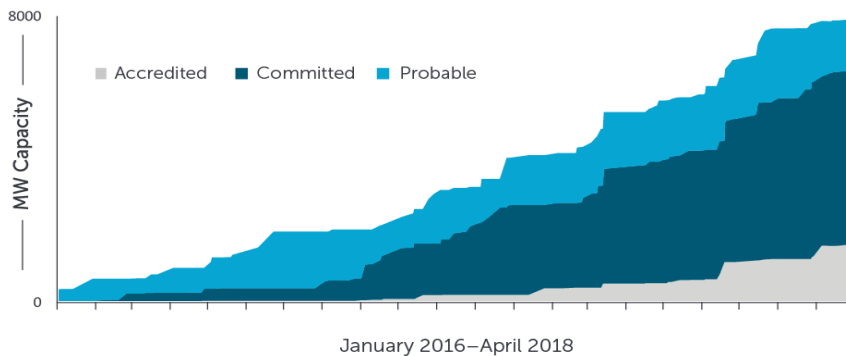
## — committed, expected

### Committed, likely renewables build, pipeline

(Green Energy Markets REI and Clean Energy Regulator)



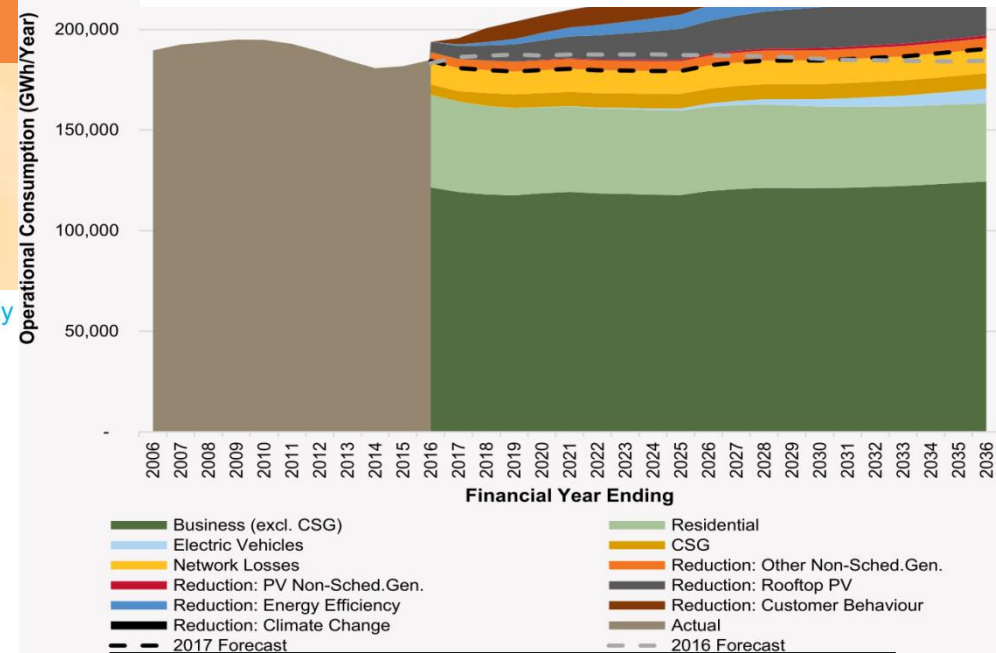
### Renewable energy project pipeline progress



by

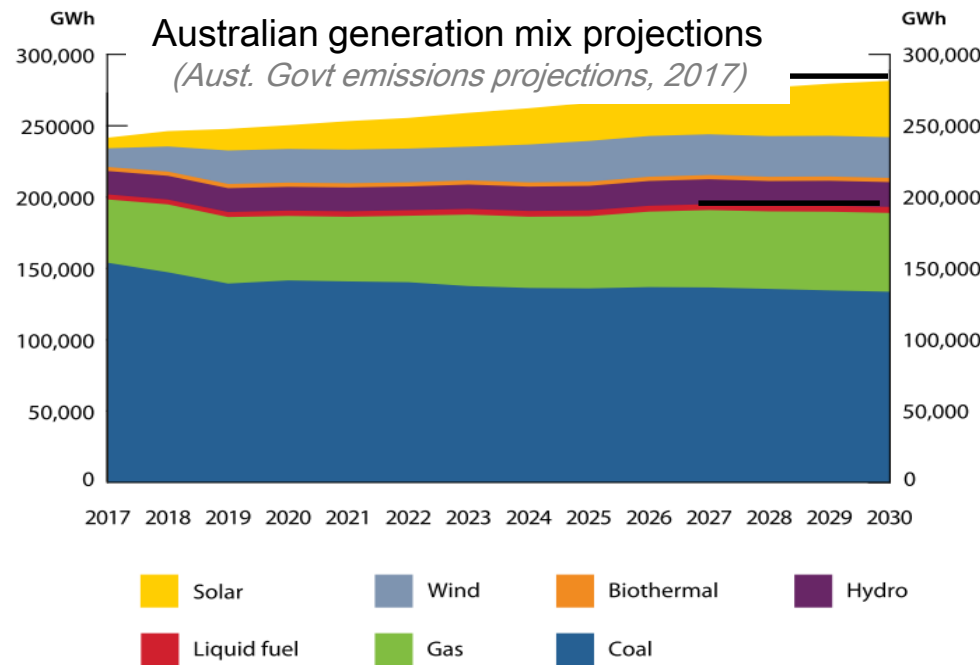
## AEMO 'central' demand forecast to 2036

(Electricity Forecast Insights, 2017)



## Australian generation mix projections

(Aust. Govt emissions projections, 2017)

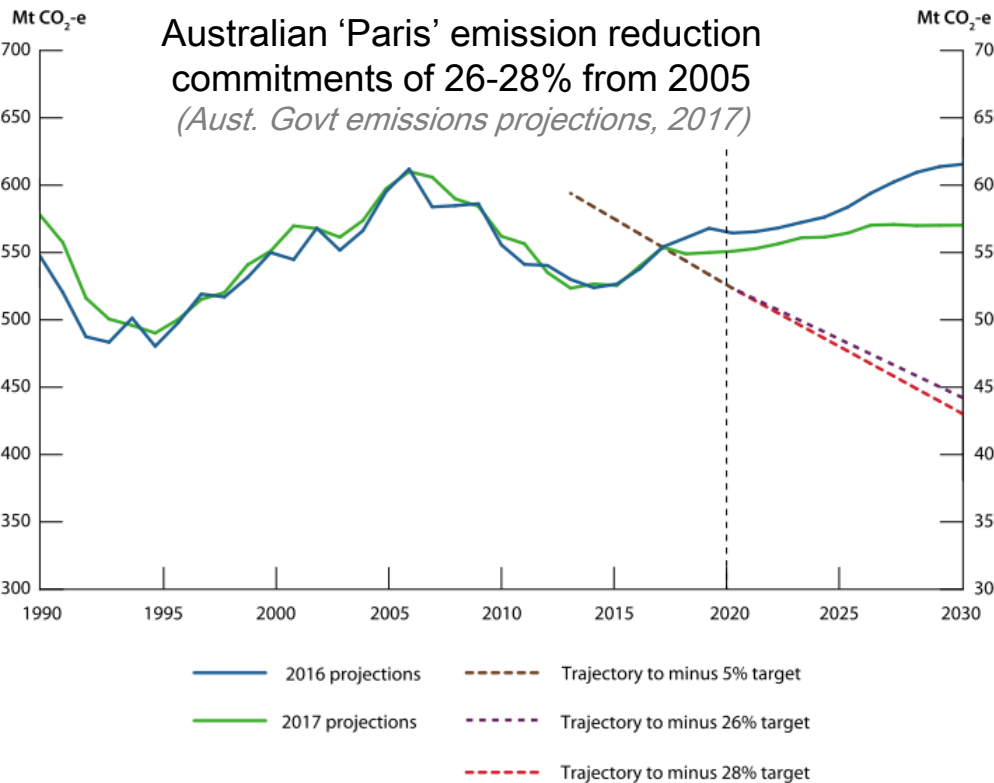


# Present policy settings

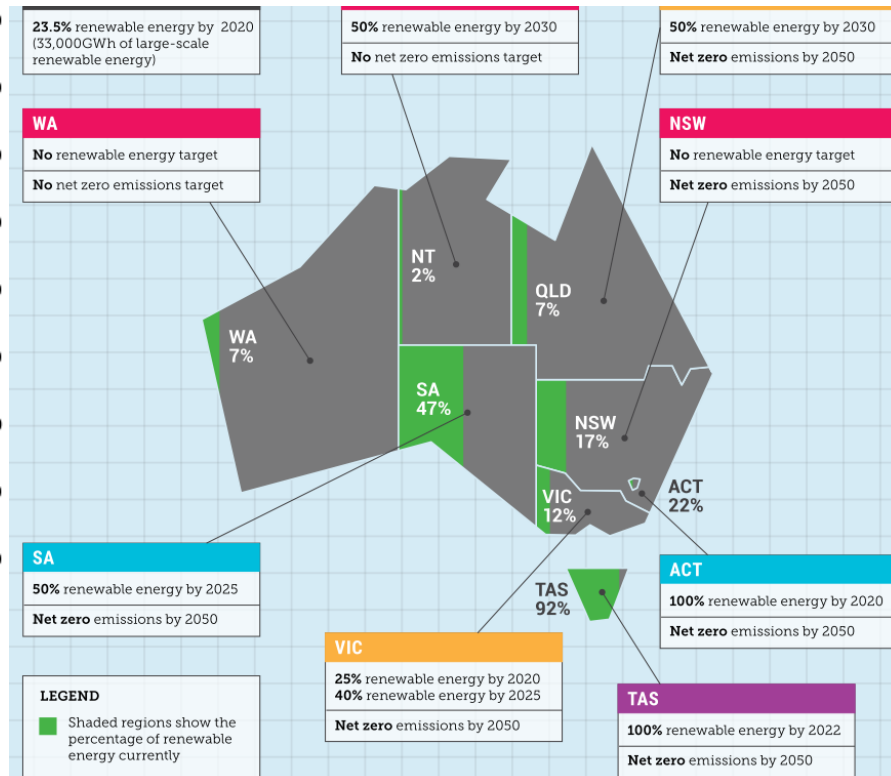
## APEC relevant policy objectives (*APERC Sixth Outlook*)

Table 1.3 • Summary of major energy policy drivers by APEC economy

<b>Australia</b>	Increase energy productivity by 40% between 2015 and 2030; renewables target of 33 TWh by 2020.
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## Australian State Government renewables and 'aspirational' emission reduction targets (Climate Council, 2017)



# National Energy Productivity Plan (NEPP)

Improving Australia's energy productivity means *more value* from the energy we consume.

$$\text{Energy productivity} = \frac{\text{economic output (GDP)}}{\text{energy used (PJ primary)}}$$



## WHY improve energy productivity?



Boosting *competitiveness* and growth



Helping families and business manage their energy *costs*



Reducing greenhouse gas *emissions*



## WHAT are our goals?

**40%**  
IMPROVEMENT BY 2030



## HOW will we get there?

Encouraging smarter *choices* through

- efficient incentives
- empowering consumers
- helping business compete

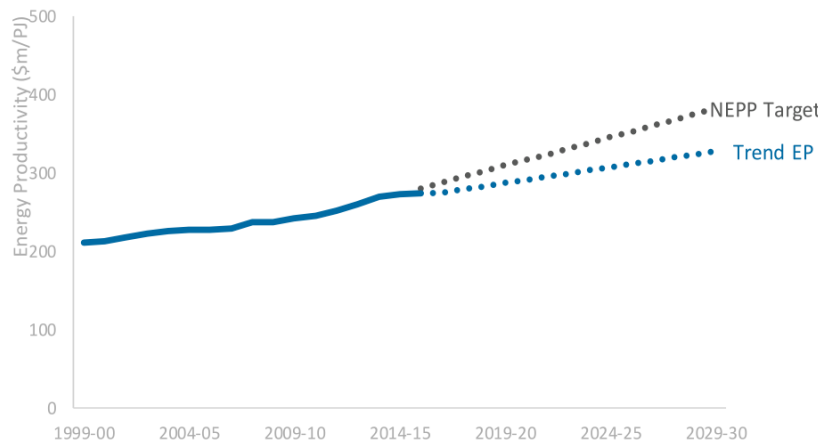


Promoting better energy *services* through

- innovation support
- competitive modern markets
- consumer protections

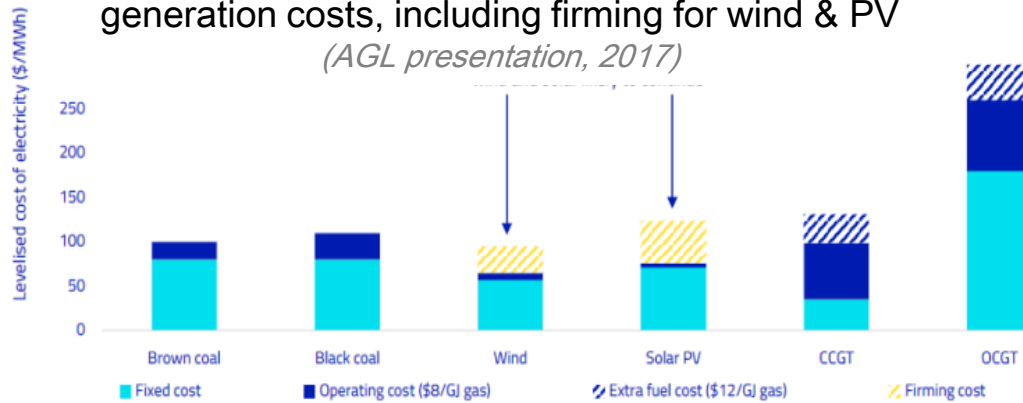


Figure 7: Australian trend energy productivity and the 40 per cent NEPP target, \$million/PJ, 1999–00 to 2029–30



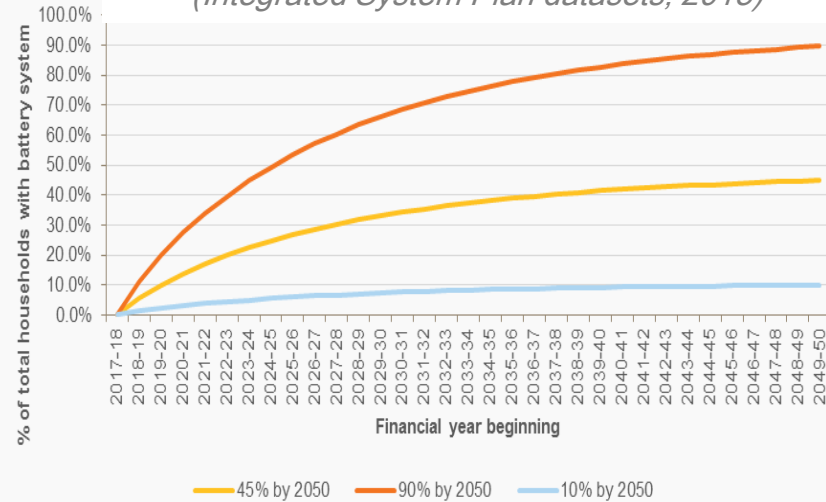
# Technology, market drivers, uncertainties

Australia's largest utility estimates of current generation costs, including firming for wind & PV  
(AGL presentation, 2017)

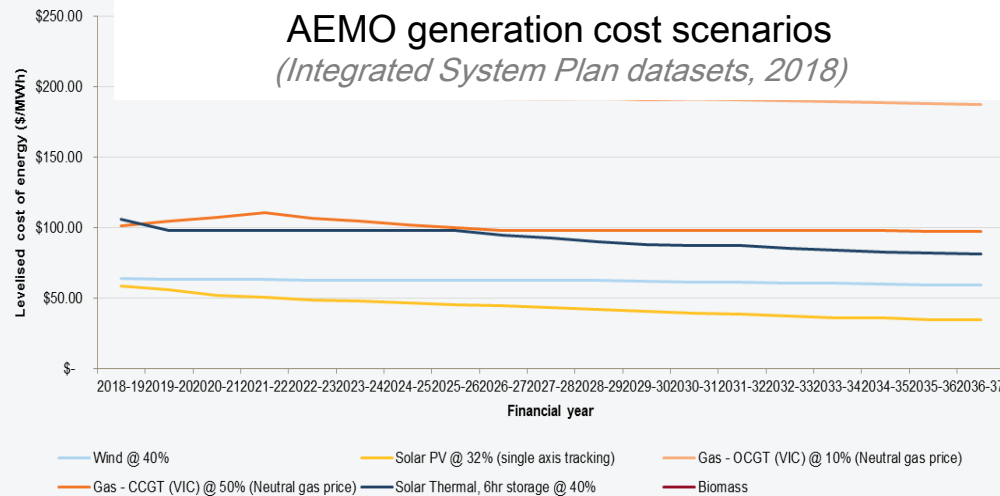


Source: AGL estimates; assumes capacity factors of 40% for wind, 25% for solar, 75% for CCGT and 10% for OCGT; heat rates of 8 for CCGT and 10 for OCGT.

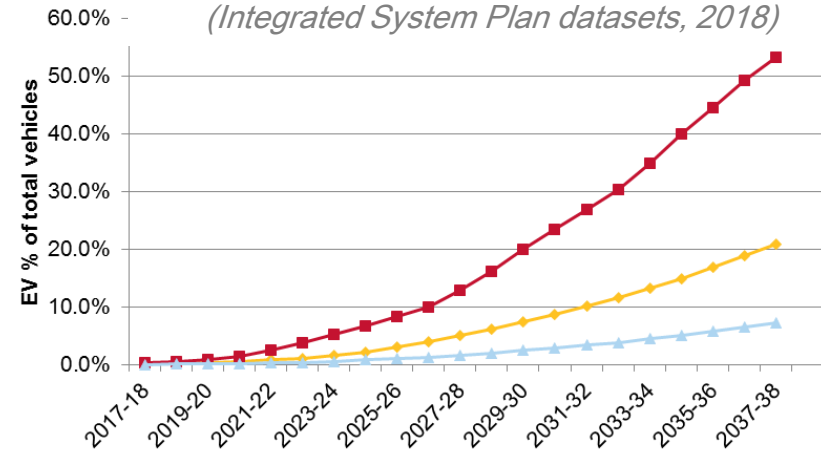
AEMO battery system uptake scenarios  
(Integrated System Plan datasets, 2018)



AEMO generation cost scenarios  
(Integrated System Plan datasets, 2018)



AEMO EV uptake scenarios  
(Integrated System Plan datasets, 2018)

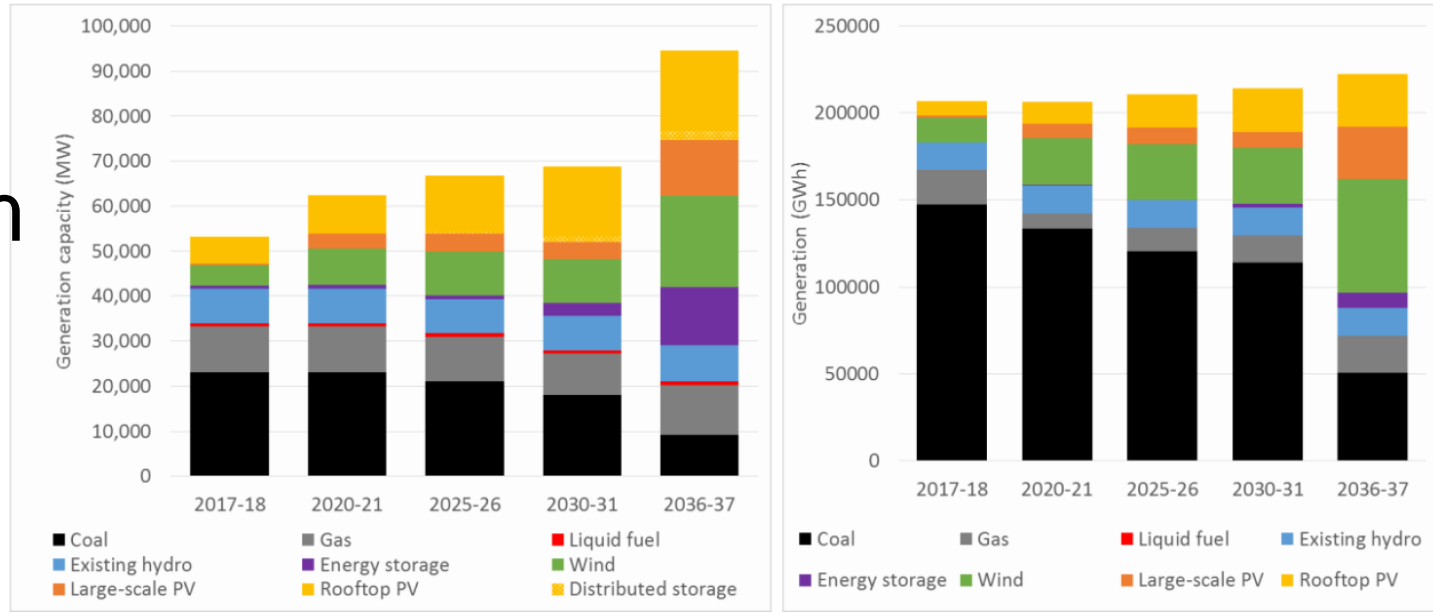




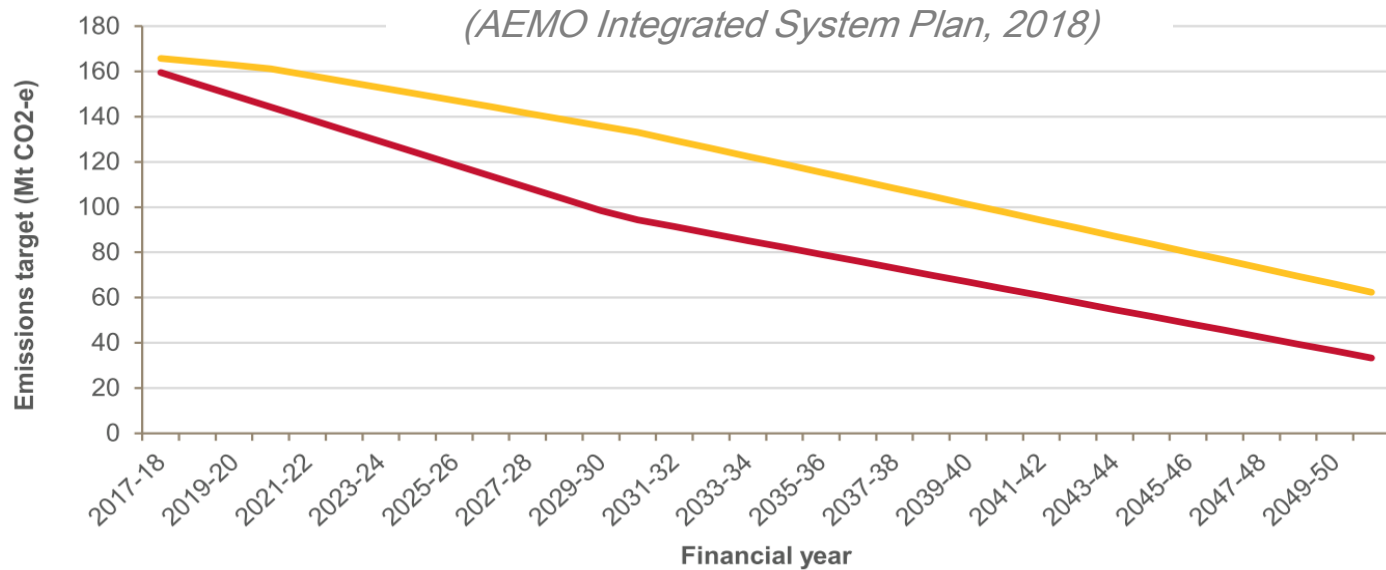
# Longer-term scenarios

Wide, growing range that can choose from

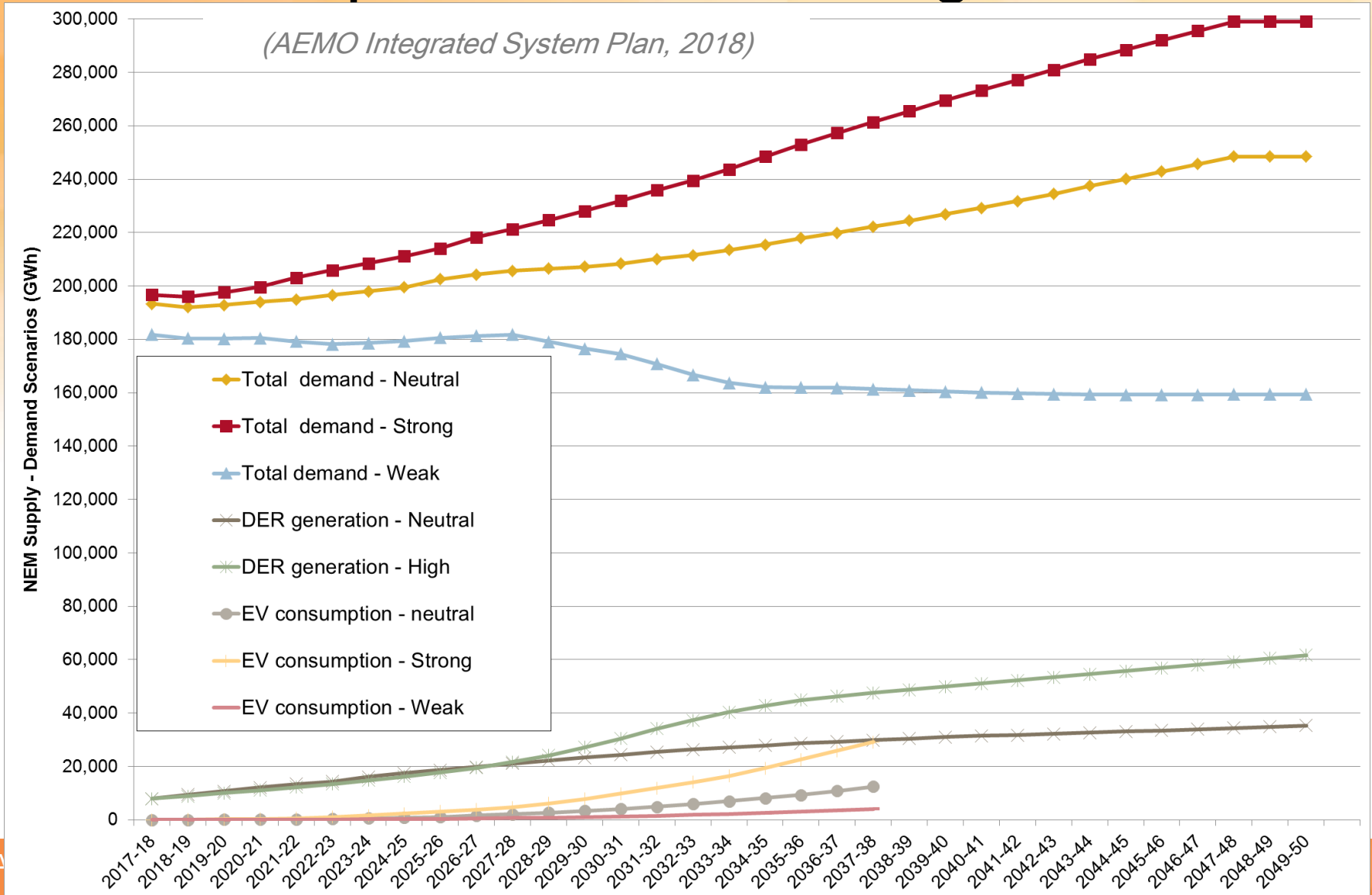
**Figure 9 Preliminary projections of NEM generation capacity (left) and generation output (right), Neutral scenario**



**Figure 5 Proposed NEM emissions reduction trajectories to be examined in ISP scenarios**



# Scenario space is broadening



# New scenario approaches

Some scenarios for Australia's energy future, ...and their risks  
(CSIRO Low Emission Technology Roadmap, 2017)

	1 Pathway 1: Energy productivity plus	2 Pathway 2: Variable renewable energy	3 Pathway 3: Dispatchable power	4 Pathway 4: Unconstrained
Buildings, industry and transport	Ambitious energy productivity improvements	Business as usual energy productivity improvements		Ambitious energy productivity improvements
New build electricity generation	Existing low emissions technologies: wind, solar PV (45% limit) plus gas	Cheap, mature, low emissions generation: mainly wind and solar PV plus enabling technologies e.g. batteries pumped hydro	Hydrogen for transport and export	
			Wind and solar (45% limit) plus low emissions, dispatchable generation: <ul style="list-style-type: none"> <li>Concentrating solar thermal with storage</li> <li>High efficiency, low emissions fossil fuels with carbon capture and storage</li> <li>Nuclear</li> <li>Geothermal</li> </ul>	All low emissions technologies allowed, with no limit on wind and solar PV
Fugitive emissions	Uptake of cost-effective technologies			

	Pathways				
	Description	1 Pathway 1: Energy productivity plus	2 Pathway 2: Variable renewable energy (VRE)	3 Pathway 3: Dispatchable power	4 Pathway 4: Unconstrained
Technology, commercial and market risk	<p><b>Technology risk:</b> Technology needs development to overcome technical challenges or to bring down costs</p> <p><b>Commercial risk:</b> Technology not commercially mature in Aus. hence costs not well understood</p> <p><b>Market risk:</b> Revenue generated over the lifetime of the asset is uncertain</p>		Technological challenge to transform the electricity grid to support VRE at high share with acceptable security and reliability, with uncertain cost of transformation	Market risk with large, long lead time projects given uncertain demand  Technology and commercial risk with HELE, CCS, CST, geothermal and nuclear	As per P2
Social licence risk	Technology may face opposition from local community, broader community or specific groups e.g. environmental groups	High reliance on expansion of domestic gas for electricity generation	Social licence risk with wind power	Social licence risk with new build coal, CCS, nuclear and with expansion of domestic gas for electricity generation	Social licence risk with gas and CCS
Stakeholder coordination risk	Deploying the technology depends on coordination or behaviour change of a large number of individuals or groups	Relies on behaviour change by millions of energy users	Transformation of the grid to support high share of VRE requires overcoming regulatory and cultural challenges	Investor coordination typically required for large capital projects	As per P1 and P2

Timeframe in which risk becomes significant  
■ Before 2020    ■ 2020–2030    ■ After 2030

# Summary – Australia's energy sector

- **Past – *trend is destiny***
  - Projections have largely proved reasonable for domestic energy supply and demand - high infrastructure 'inertia' but also 'settings'
  - However, past decade suggests significant future change and increasing inadequacies of projections and 'expert' predictions
- **Present – *new players, high uncertainties***
  - Demand growth uncertainties – user energy efficiency, price response
  - Renewables deployment; both consumer driven distributed, utility scale
  - Old coal plant exit with no future build, yet Q of gas competitiveness
- **Future – *challenges, options & possible outcomes broadening***
  - Renewables appear increasingly competitive, regardless of policy but raising growing integration challenges
  - Demand likely to depend on industry, building, transport electrification
  - Energy efficiency options still improving but remains the 'hard' win win





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