



Collaboration on Energy and  
Environmental Markets



UNSW  
SYDNEY



# Is the Australian National Electricity Market *'fit for purpose'* in delivering clean energy transition

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*Asia Pacific Solar Research  
Conference APSRC'21*

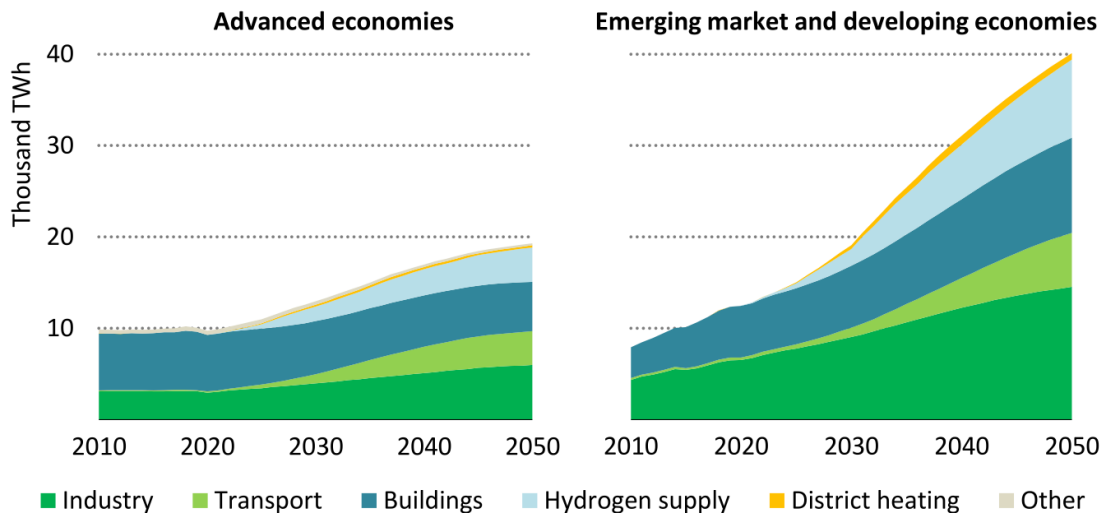
*UNSW Sydney, December 2021*

# Clean energy transition?

- Global electricity sector has **the** key role in clean energy transition
  - Electrification of many currently non-electricity energy sectors
  - Powered almost entirely by renewables



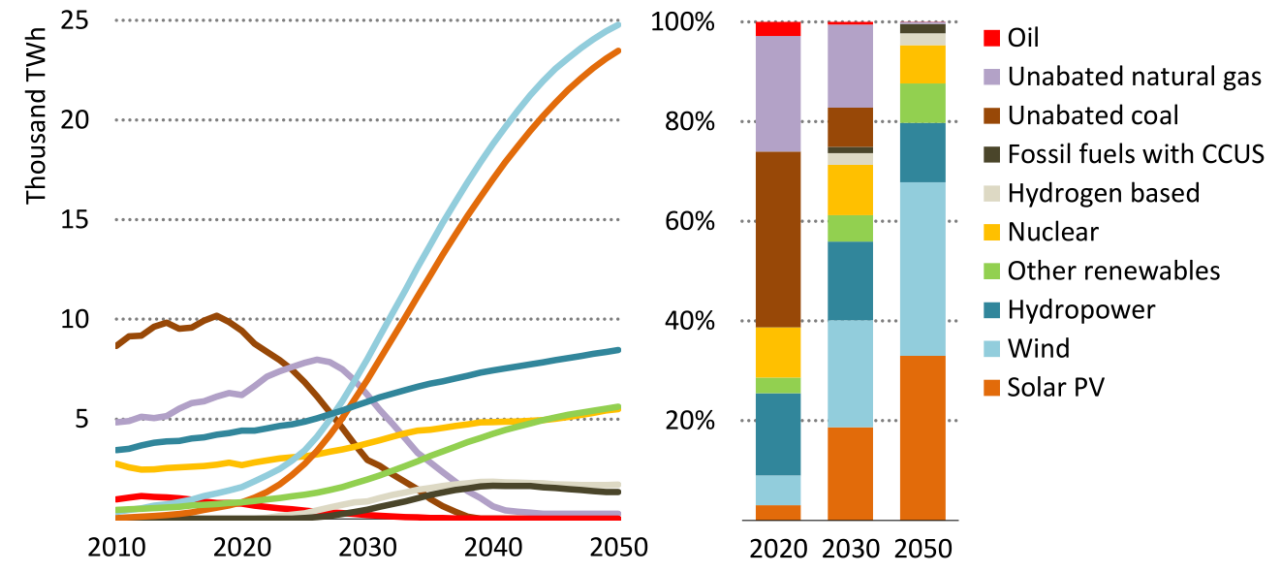
**Figure 3.9** ▷ Electricity demand by sector and regional grouping in the NZE



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Electrification of end-uses and hydrogen production raise electricity demand worldwide, with a further boost to expand services in emerging market and developing economies

**Figure 3.10** ▷ Global electricity generation by source in the NZE

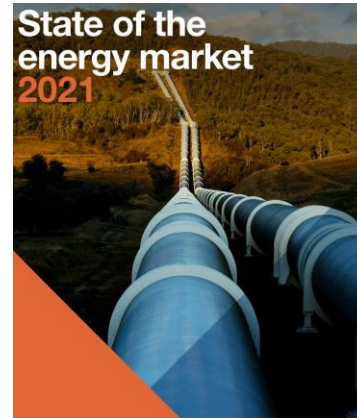


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Solar and wind power race ahead, raising the share of renewables in total generation from 29% in 2020 to nearly 90% in 2050, complemented by nuclear, hydrogen and CCUS

# Is this the NEM?

...or the Eastern Australian interconnected power system?



Participating jurisdictions	Qld, NSW, Vic, SA, Tas, ACT
NEM regions	Qld, NSW, Vic, SA, Tas
NEM installed capacity (including rooftop solar) <sup>1</sup>	67,046 MW
Number of large generating units	295
Number of customers <sup>2</sup>	10.2 million
NEM turnover 2020	\$10.9 billion
Total electricity consumption 2020 <sup>3</sup>	190.1 TWh
National maximum demand 2020 <sup>4</sup>	35,043

Electricity generation in the National Electricity Market

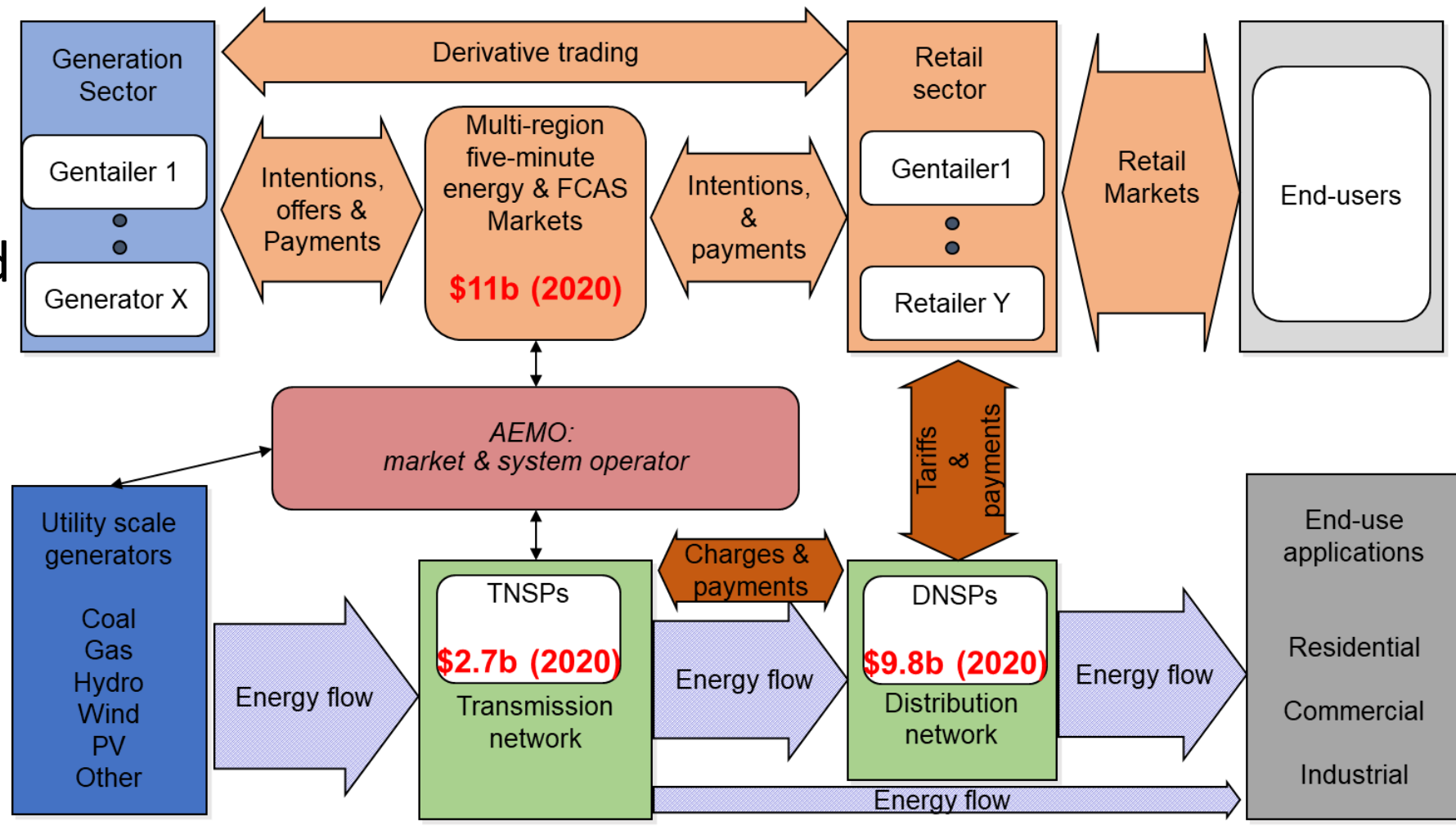


# Is this the NEM?

Wholesale, retail and derivative markets

..however, around half the \$\$ goes to regulated monopoly networks

...and many consumers have little engagement with market beyond 'paying their bills'



(adapted from Outhred, The Australian National Electricity Market, 2010)



# And what is the NEM's purpose?

Still a trilemma given low cost renewables?

**If yes**, then choose any two? (*as NEM NEO does*)

**Or instead** balance a complex set of trade-offs between these objectives

## Balancing the 'Energy Trilemma'

### Energy Security

The effective management of primary energy supply from domestic and external sources, the reliability of energy infrastructure, and the ability of energy providers to meet current and future demand.

### Energy Equity

Accessibility and affordability of energy supply across the population.

### Environmental Sustainability

Encompasses the achievement of supply and demand-side energy efficiencies and the development of energy supply from renewable and other low-carbon sources.



ENERGY SECURITY

*"To promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to –*

- *price, quality, safety, reliability, and security of supply of electricity; and*
- *the reliability, safety and security of the national electricity system."*

National Electricity Law (Schedule to the National Electricity (South Australia) Act 1996), s.7



ENERGY EQUITY



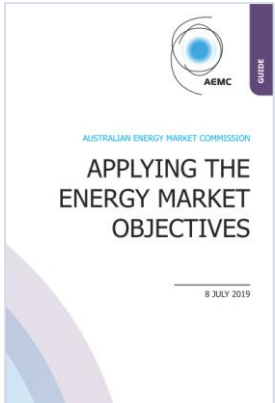
ENVIRONMENTAL SUSTAINABILITY

# AEMC and its consideration of a future 'liveable planet'

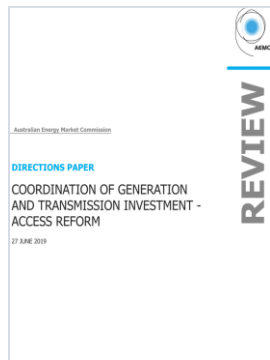
- AEMC currently argues for climate change consideration in rule changes with regard to mitigation or adaptation risk
- ... but perhaps a stronger case on strict 'efficiency' grounds

## Commission decision-making and climate change risks

The Commission makes its decisions on rule changes with reference to the national energy objectives. These objectives do not specifically require the Commission to have regard to the long-term interests of consumers with respect to climate change or the environment. Instead, the national energy objectives direct the Commission to consider the achievement of economic efficiency in the long-term interests of consumers with respect to specified matters, being the price, quality, safety, reliability and security of the supply of energy or energy services. However, in order to make decisions that meet the national energy objectives, the Commission considers whether its decisions are robust to any impacts on price, quality, safety, reliability and security of supply of energy or energy services, if these matters are impacted by mitigation or adaptation risk that manifests due to the issue of climate change.



A key aim of any transmission access regime should be to provide appropriate price signals to new generators such that they make operational decisions that efficiently reflect the costs of generating and transporting to consumers. Efficiency is promoted when prices reflect the marginal cost of the provision of a particular product or service, as well as any positive or negative externalities. At times of transmission congestion, the Commission considers that dynamic regional pricing should send the right incentives to generators in order to improve the prospect of the lowest cost combination of generation being dispatched.



# Is the NEM currently 'fit for purpose'? – the ESB view..

- NEM should be judged on whether it can deliver affordable, secure and 'reliable and low emissions' electricity services
- Identify remaining key affordability and security challenges despite progress
- Ok with what is still 'world worst practice' emissions intensity?
- And are they confusing market 'means' with desired ends – a 'good' market delivering poor outcomes?



## The Health of the National Electricity Market

2020  
Energy Security Board

Volume 1: The ESB Health of the NEM Report

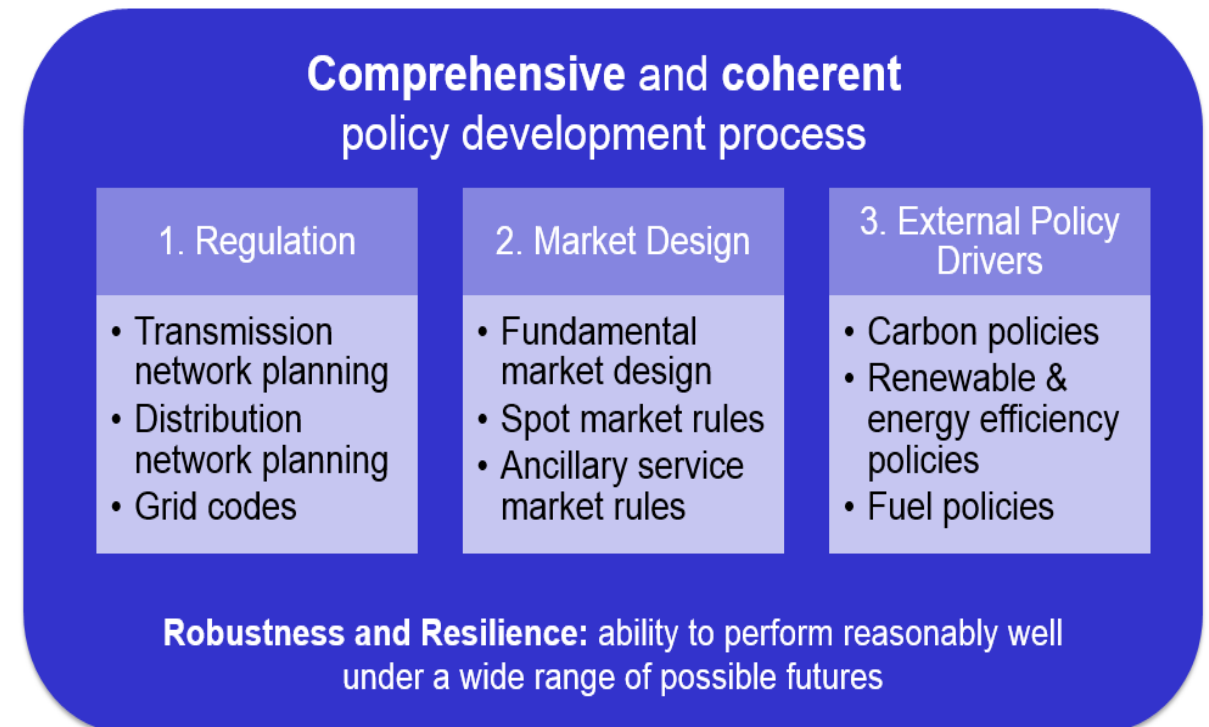
The Energy Security Board has five members:  
Kerry Schott AO Independent Chair  
David Swift Independent Deputy Chair  
Clare Savage Chair of the Australian Energy Regulator  
Merryn York Chairman of the Australian Energy Market Commission (Acting)  
Audrey Zibelman CEO of the Australian Energy Market Operator

	2020 Ratings		Last Year's Ratings	
	Current status	Outlook	Current status	Outlook
Affordable energy and satisfied consumers	Moderate-Critical	Moderate	Moderate-Critical	Moderate
Secure electricity and gas system	Critical	Moderate-Critical	Critical	Critical
Reliable and low emissions electricity and gas supply	Moderate	Moderate	Critical	Moderate
Effective development of open and competitive markets	Good	Good-Moderate	Moderate	Good-Moderate
Efficient and timely investment in networks	Good-Moderate	Moderate	Moderate-Critical	Moderate
Strong but agile governance	Moderate	Moderate	Moderate	Moderate

# Another framing for assessing whether NEM 'fit for purpose'

- Secure economically efficient and low emission **operation** with growing, eventually extremely high, renewable penetrations – particularly wind and solar
- Robust, assured delivery of the **investment** in zero emission generation and associated enabling technologies that completely decarbonises the electricity sector within two decades
- Facilitating the high **societal consensus** required to deliver assured clean energy transition

Suitably flexible, comprehensive and coherent on the *means* to these ends

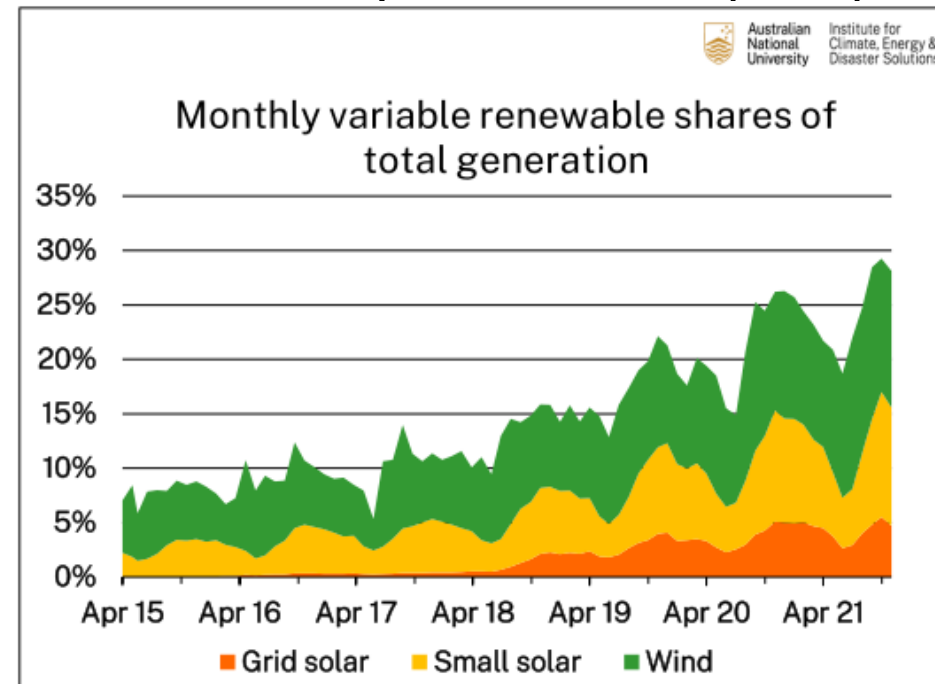
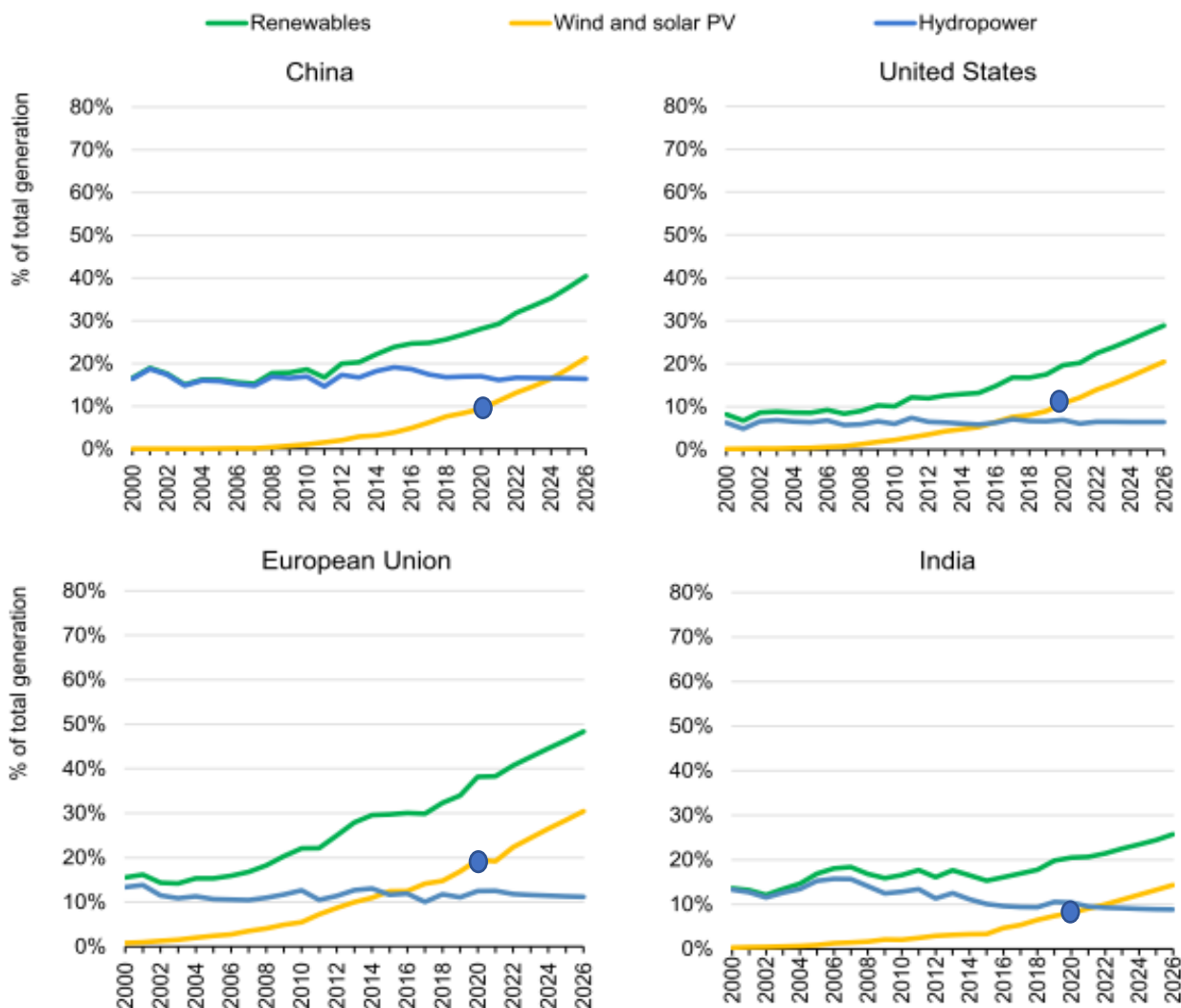




# NEM 'fit for purpose' operationally?

NEM now operating at the leading edge of GW grid wind and solar penetrations (25%)

Figure 1.10 Share of wind, solar PV, hydropower and all renewables in total electricity generation, 2000-2026



Renewables  
2021  
Analysis and forecast to 2026

Energy transition

# NEM 'fit for purpose' operationally?

However, some significant market impacts including in 'security directions', FCAS costs and RE curtailment

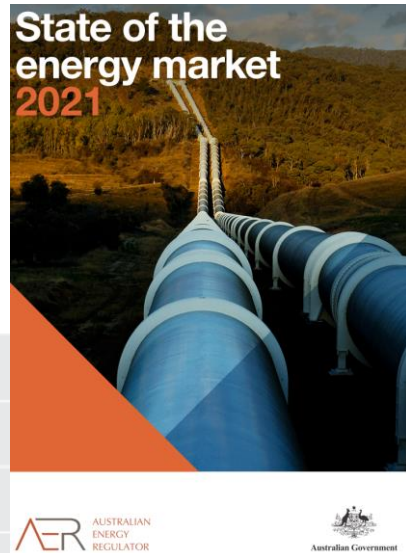


Figure 1.15 Frequency control ancillary service costs

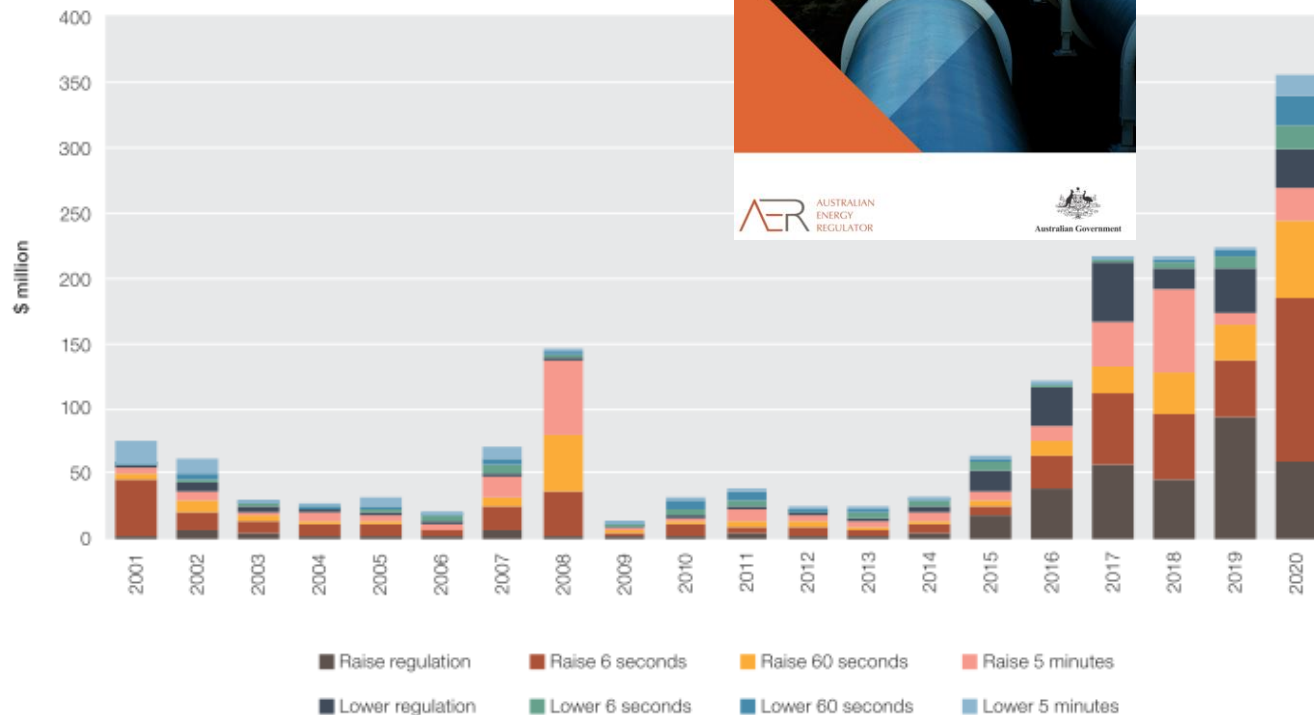
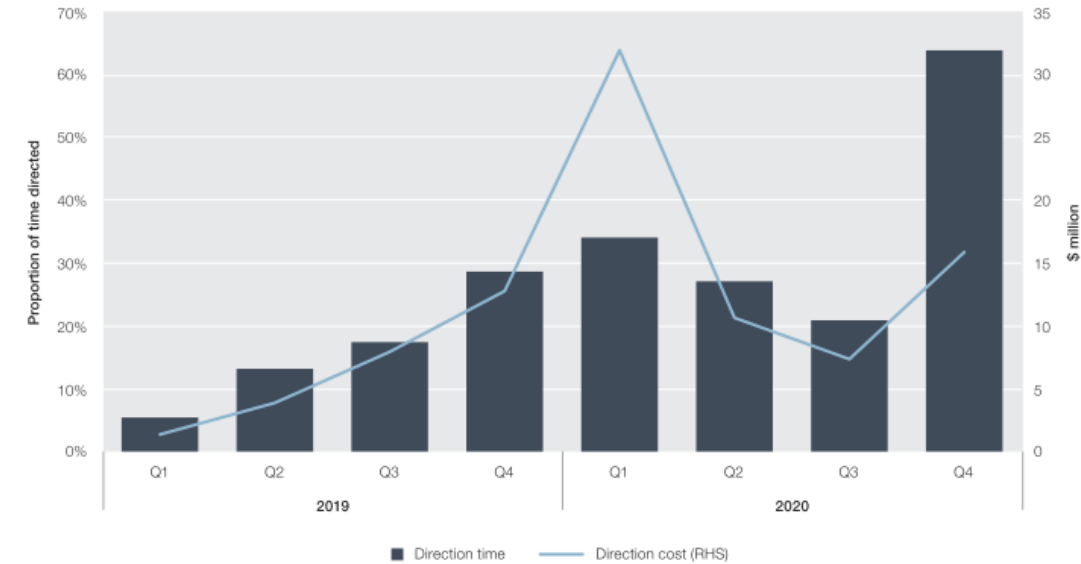
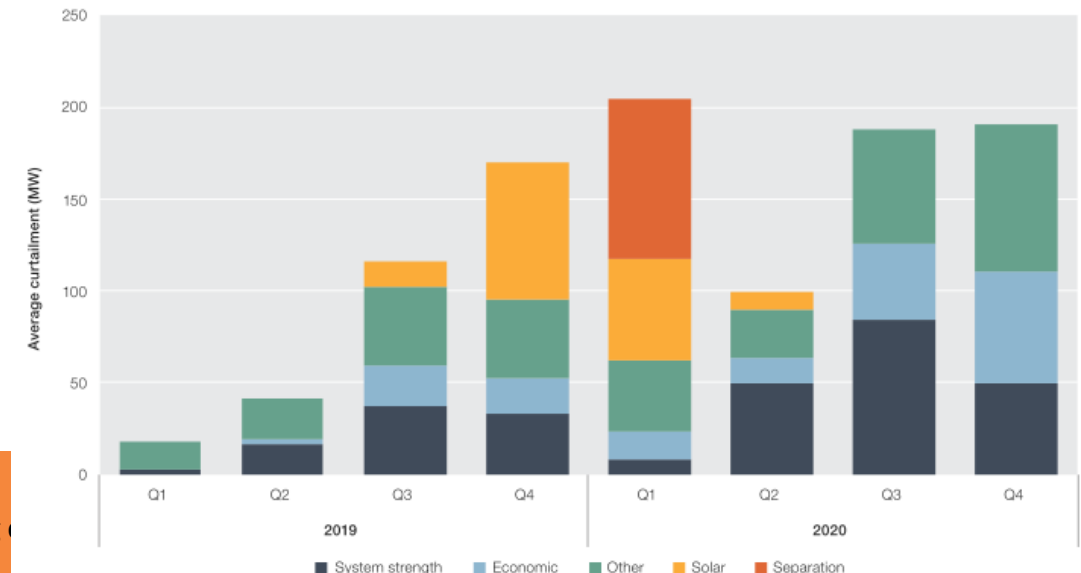


Figure 1.12 System security directions



Source: AEMO, Quarterly energy dynamics Q4 2020, February 2021.

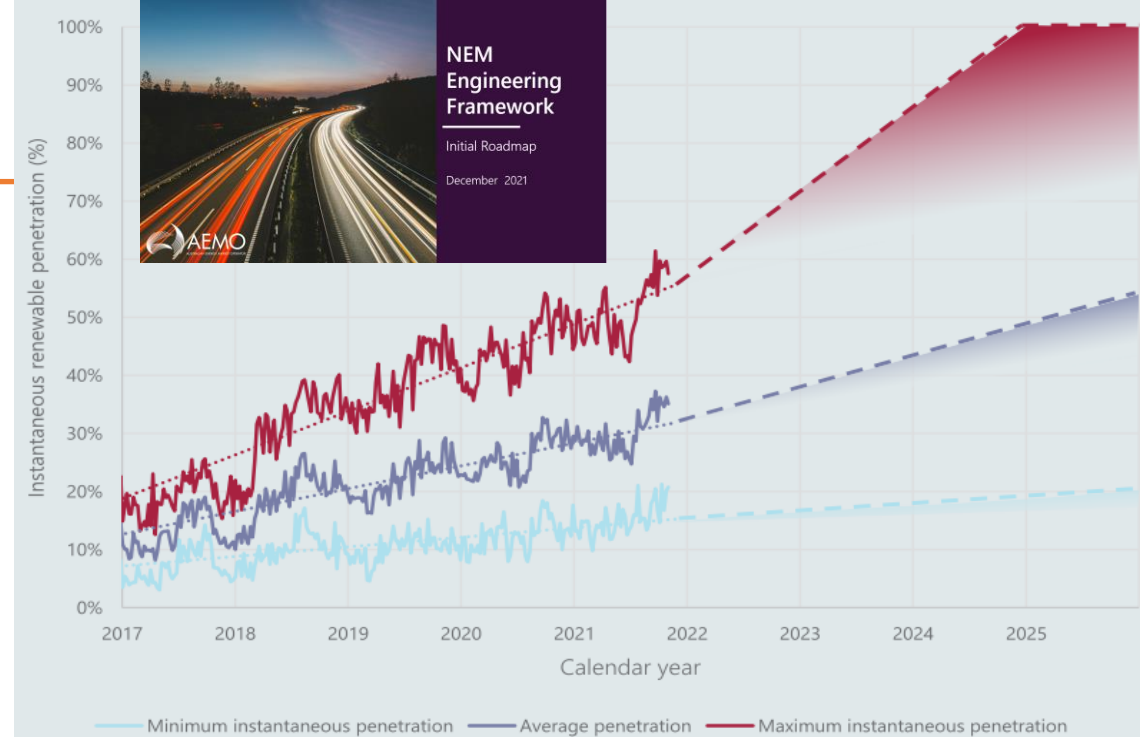
Figure 1.13 Curtailment of renewable generation



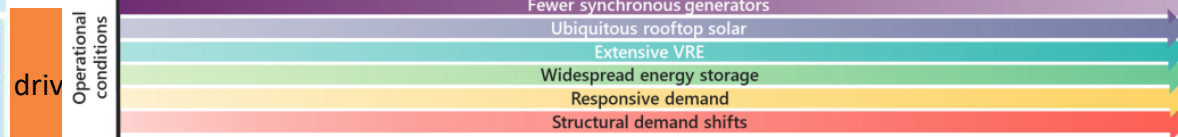
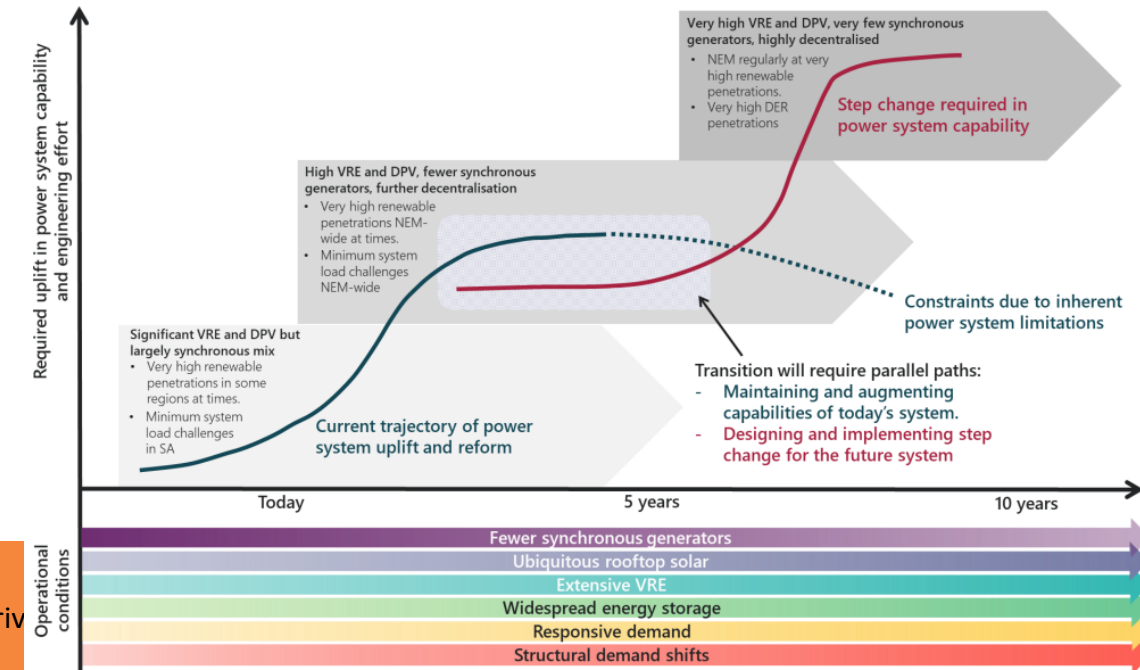
driving

# NEM 'fit for purpose' operationally?

ESB/AEMC Essential Systems Services (ESS) program of work rolling out  
 .. yet challenges are only growing  
 .. and DERs need to be integrated into arrangements



System req'ts	Drivers	Reforms	Expected 'on the ground' timing	Next milestone
Frequency control and inertia	Controlling frequency around 50Hz under normal conditions	Primary frequency response – mandated obligation and enhancements	Interim arrangements in place Enduring arrangements in place from sunset (2023)	AEMC rule change draft determination Sept 2021
	Managing frequency under lower inertia conditions	Fast frequency response – new ancillary service  Inertia spot market	Implementation of new markets 2023  The potential gains from introducing a co-optimised spot market for inertia will be kept under review as the power system evolves. Inertia spot market could be triggered by approaching minimum inertia levels, increased structured procurement and scheduling for inertia, expanded technical knowledge, and learnings from the WEM.	Revised Market Ancillary Services Specification by Dec 2022.
Ramping / Operating reserves	Managing higher levels of variability and uncertainty across dispatch intervals	Ramping / operating reserves – co-optimised market	2025 if rule change were immediate implementation	draft determination
System strength and Power system security	Maintaining power system security and avoiding uneconomic constraints with reduced synchronous generation	Stability of inverter-based resources  Complementing longer-term with shorter-term structured proc.  Scheduling resources for structured procurement	Longer-term structured procurement and network development for fault levels / system strength  System Security Mechanism (SSM) – structured procurement in operational timeframe + tool for scheduling system configurations  Unit Commitment for Security (UCS) – scheduling resources under structured procurement	Pro-active TNSP-led procurement from 2022, with solution  As soon as possible – 2025 determination (2025).  Scheduling mechanism structured procurement place by 2025.
	Co-optimisation	Improving efficiency and co-ordination of dispatch	Further unbundling of services  Integrated Energy and Services Ahead Market	Further unbundling could be triggered by technical understanding enabling further disaggregation of specific services and capabilities.  Integrated ahead market could be triggered by learnings from experience developed through WDR and operational structured procurement and DSP and DER integration





# Has the NEM ever been 'fit for purpose' for investment?

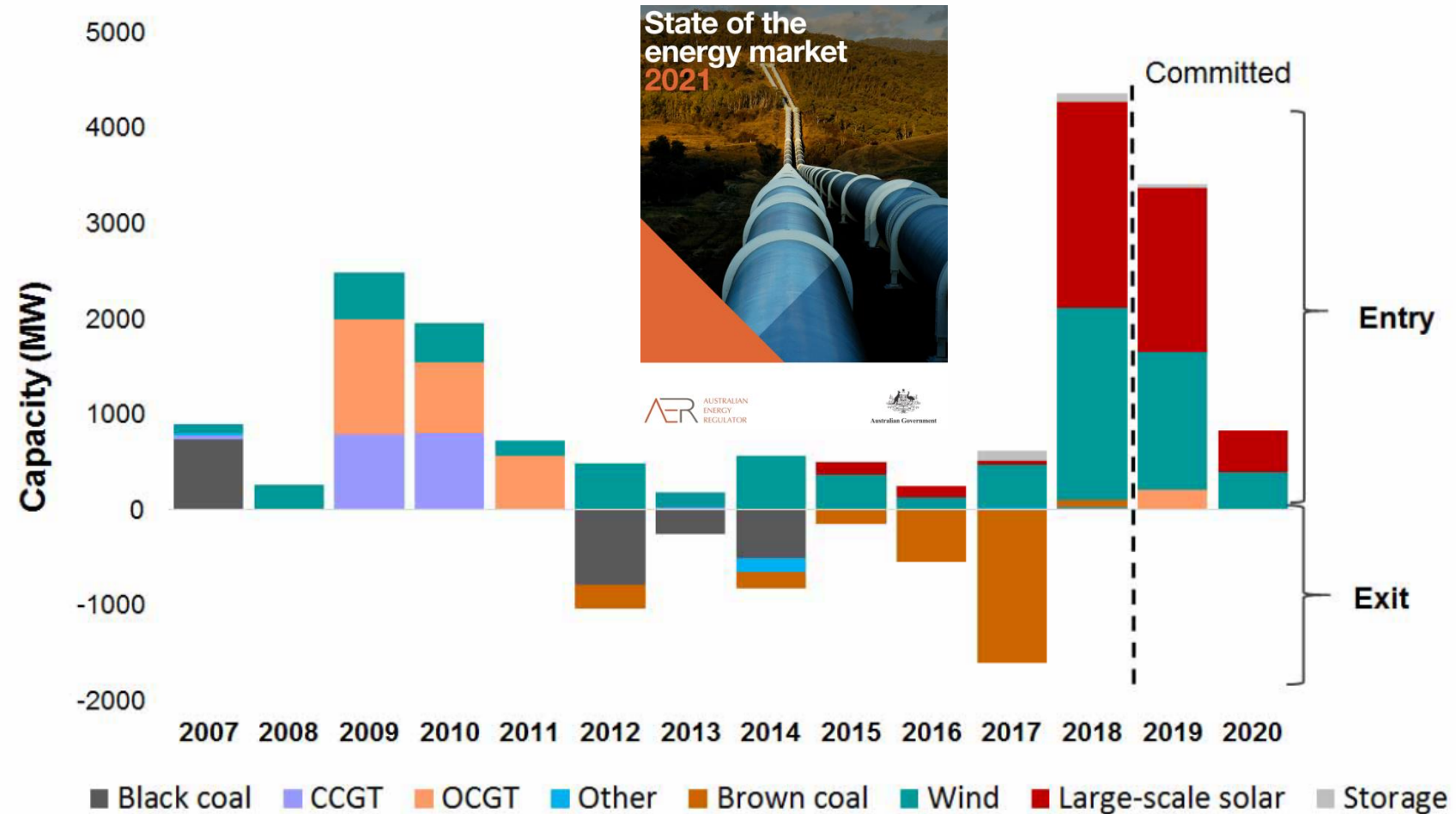
Mid 2000's coal investment by QLD state government corporations

Late 2000s CCGT supported by QLD 13% Gas Scheme, NSW GGAS, bipartisan support for a national carbon price

Wind and solar driven by Federal Government MRET, now State schemes

**Market driven?** OCGTs, some recent renewables (Corporate PPAs), and those coal plant exits

Figure 1: Entry and exit of generation capacity in the NEM, 2007 to 2020



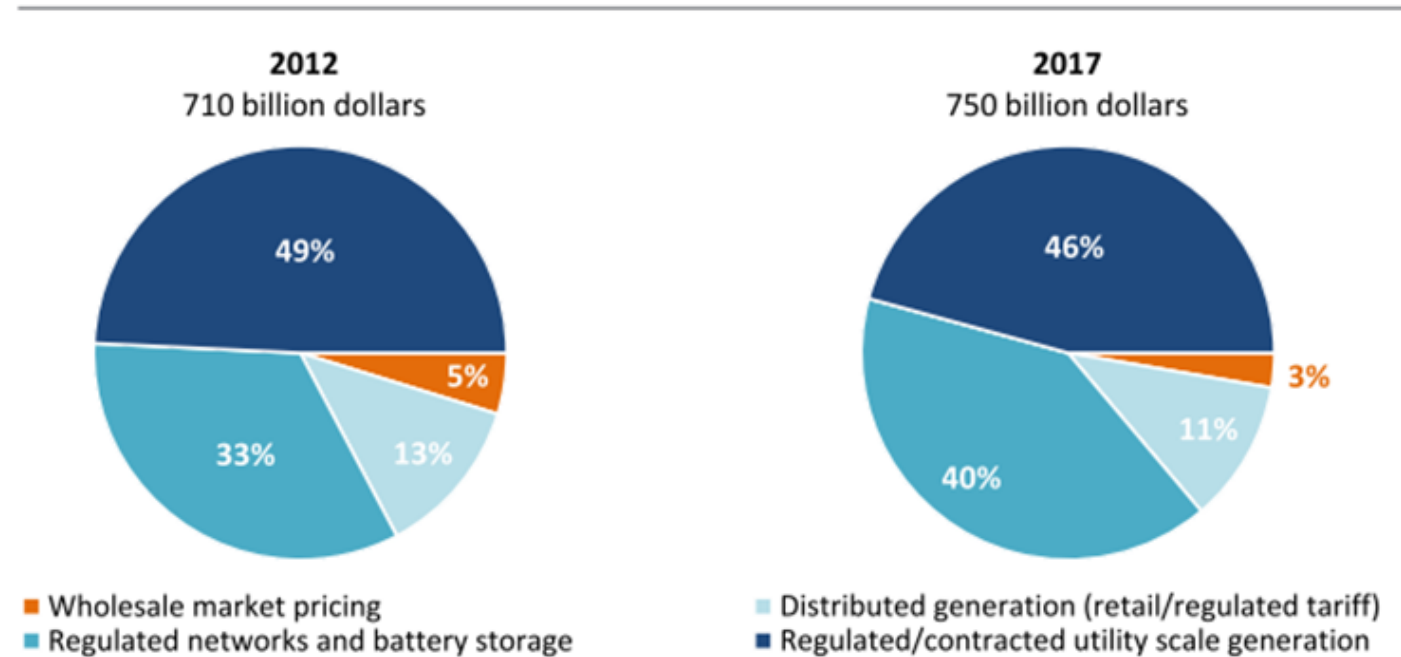


# Globally too, key market role is mainly 'facilitation'

**Seems** the likely future for the NEM given State renewables targets, ongoing consumer DER uptake

**Suggests** that the key AEMC/ESB work should be to facilitate these targets intended to achieve clean energy transition, provide robust 'backup' should those mechanisms fail to deliver required renewables and enabling technologies investment

**Figure 7.28** ▶ Power sector investment by remuneration mechanism (\$2017)



# Does this look like clean energy investment facilitation?

## ESB reboots search for capacity mechanism as renewables transition gains pace

Giles Parkinson 16 December 2021

27

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Victoria Big Battery. Image supplied

The Energy Security Board has re-booted its pursuit of a capacity mechanism in Australia's main electricity market, despite the urgings of many in the industry to move on and consider other options.

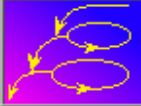
The ESB earlier this year presented a series of new market rules, but was forced to go back to the drawing board after widespread objections – from state ministers and most of the energy industry – to a sort of capacity market that was dubbed “coal-keeper” because it was seen to favour coal fired generators.

Although the idea had strong support from a handful of coal generators, and from federal energy minister Angus Taylor, and despite the ESB's insistence that it was “technology neutral” and was not designed to favour coal – it has been forced to start again.

# The 'externality' problem for market designers

- Electricity sector invariably has a wide range of externalities whose **values likely outweigh direct industry costs**
  - social, environmental are key
  - positive and negative benefits and costs
- Policy and regulatory interventions often explicitly target these 'externalities' + world-wide, electricity industry **investment dominated by policy and regulatory drivers**
- Markets with significant externalities are **inefficient by 'design'** - the AEMC agrees.
- *And hence, efforts to improve efficiency of some parts of an electricity market with unpriced externalities can potentially reduce overall market efficiency*

generating and transporting to consumers. Efficiency is promoted when prices reflect the marginal cost of the provision of a particular product or service, as well as any positive or negative externalities. At times of transmission congestion, the Commission considers that



PRINCIPIA CYBERNETICA WEB - ©

Parent Node(s) :

- [Web Dictionary of Cybernetics and Systems](#)

## PRINCIPLE OF SUBOPTIMIZATION

Optimizing each subsystem independently will not in general lead to a system optimum, or more strongly, improvement of a particular subsystem may actually worsen the overall system. The principle of [suboptimization](#) provides the basis for a link between organizational structure and the policies adopted. (Machol, 1965, pp. 1-8) See also [suboptimization](#).



# Potential implications for some current NEM 'reforms'

## – e.g. Transmission access and pricing from CoGATI to (now) CMM

### Clean energy investors slam AEMC's proposed network access reforms

Michael Mazengarb 26 October 2020

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A group of Australia's leading clean energy investors has slammed the Australian Energy Market Commission's continued efforts to push controversial reforms to transmission network access, saying they will stall new wind and solar investment and ultimately lead to higher electricity prices for consumers.

The Clean Energy Investor Group (CEIG), in a submission to the AEMC's consultation on the proposed reforms, warn the proposed changes – which they see as a revival of the controversial Coordination of Generation and Transmission Investment (COGATI) proposal – could result in the cancellation of up to 3,000MW of wind and solar project, and add billions to the costs of others.

"This is a perverse outcome for investors and consumers, and quite frankly it is difficult to understand why the AEMC is persisting with this proposal. It highlights again why it should not continue with its proposed grid access changes," CEIG chair Simon Corbett, the former ACF

- Does AEMC cost-benefit analysis weigh up possible efficiency improvement against this?

### If valuing 'Time is (climate externality) money'

#### Shadow carbon cost estimation for delaying renewables uptake

Example where 2GW of a mix of wind and PV is delayed by two years

Estimated renewables capacity delayed (MW)	2000
Expected capacity factor (%)	36
Estimated time period of delay (months)	24
Emissions intensity of non-RE replacement generation (tCO <sub>2</sub> /MWh)	0.8
<b>Chosen shadow price on carbon (\$A/tCO<sub>2</sub>)</b>	<b>90</b>
Estimated foregone abatement (mtCO <sub>2</sub> )	10.1
Estimated climate cost of delay cost (A\$m)	908.2

#### Conclusion

Countries may choose different instruments to implement their climate policies, depending on national and local circumstances and on the support they receive. Based on industry and policy experience, and the literature reviewed, duly considering the respective strengths and limitations of these information sources, this Commission concludes that the explicit carbon-price level consistent with achieving the Paris temperature target is at least US\$40–80/tCO<sub>2</sub> by 2020 and US\$50–100/tCO<sub>2</sub> by 2030. A policy environment is in place.



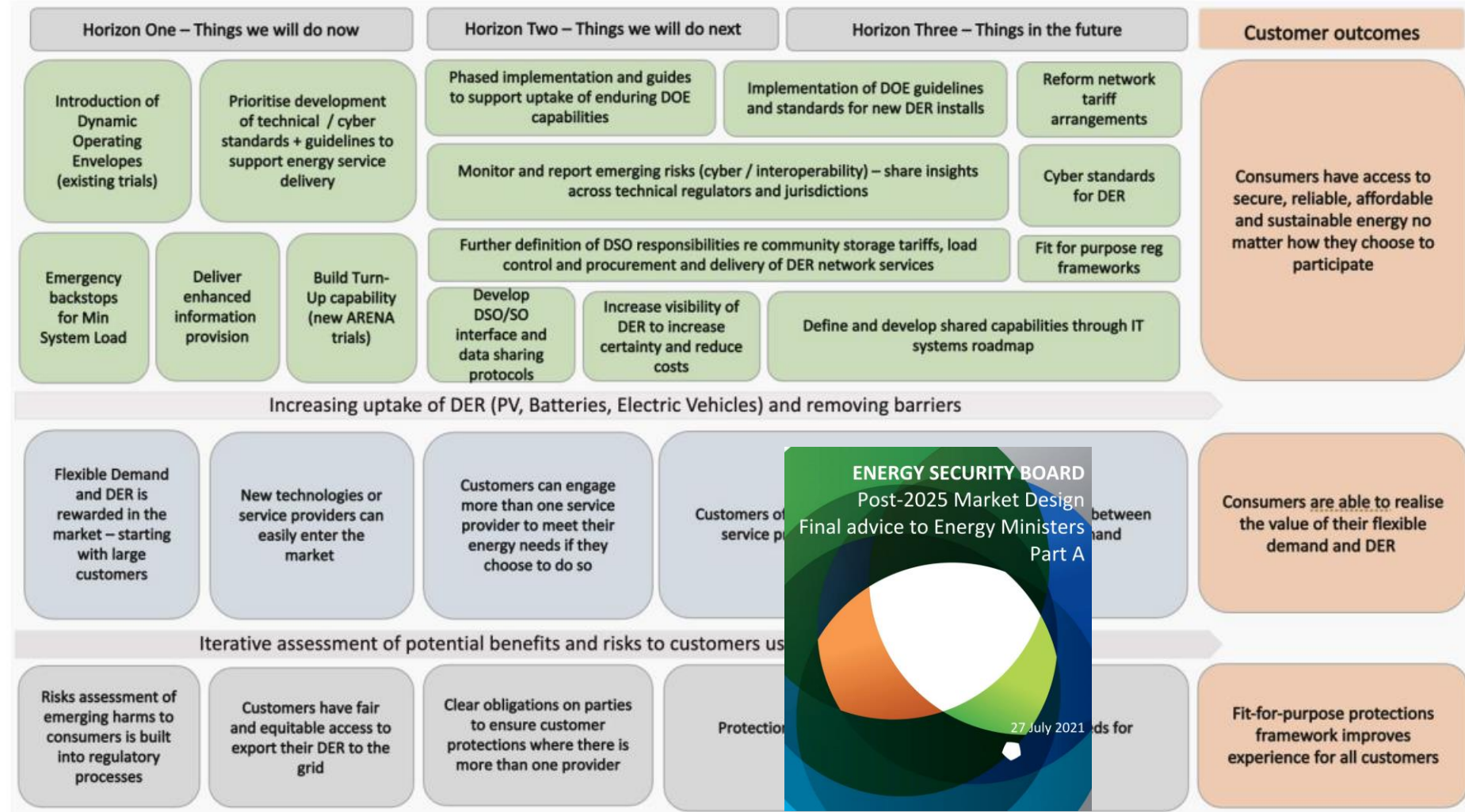


# And what of the investments by energy consumers?

Does the ESB plan suitably recognise the key role of energy consumers in clean energy transition?

... or focus more on reducing PV feed-in tariffs and restrict exports at key times?

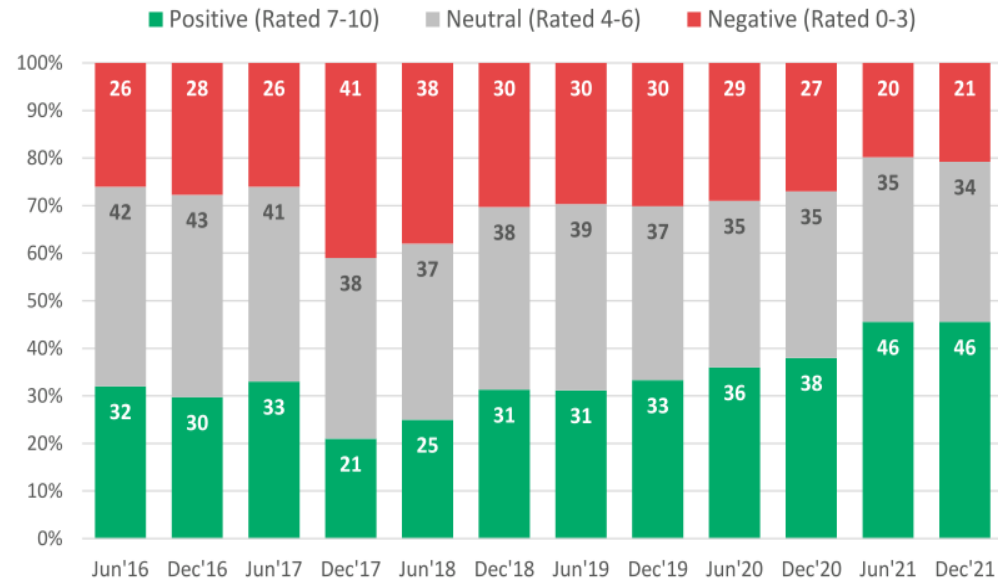
Figure 3 DER Implementation Plan



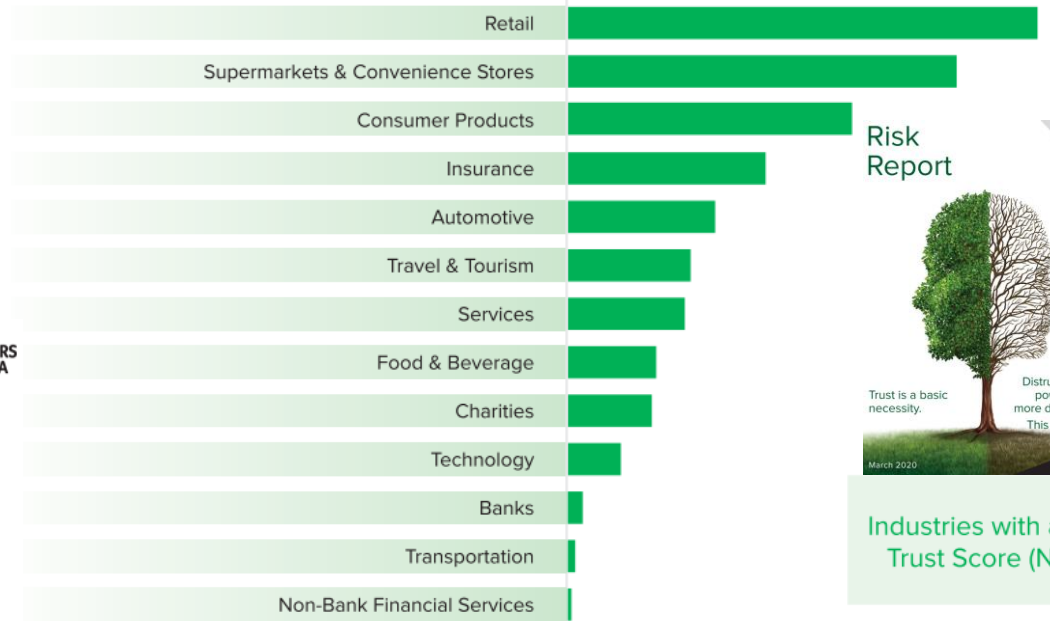
# Is the NEM 'fit for purpose' in building societal consensus?

- The electricity sector suffers significant trust challenges
- ...although appears some progress

## Confidence in the market



**ENERGY CONSUMER SENTIMENT SURVEY**  
Household Topline Results  
December 2021



# Some preliminary conclusions

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- Much to be optimistic about with NEM clean energy transition
  - ... **but** much much more to be done
- Is the NEM 'fit for purpose' in delivering clean energy transition?
  - **Not yet** ... but with work might be made 'fit for purpose' in facilitation role
- Key focus should be on the policies and regulatory mechanisms that will drive assured clean energy transition of the magnitude and speed required
  - Very high risk to assume that an energy market can deliver this transition
  - Likely that the key focus of energy market design should be on efficiently facilitating 'external' drivers
  - while avoiding 'efficiency' improvements that actually impair transition and hence make the market less efficient
- Is current NEM **governance** 'fit for purpose' in delivering clean energy transition?
  - Now, that is a key question....