Centre for Energy and Environmental Markets

UNSW THE UNIVERSITY OF NEW SOUTH WALES SYDNEY • AUSTRALIA



Australian Future Electricity Markets Summit Outcomes

1. End-to-end Mkt Design, 2. Sector coupling; 5. Optimising DER

Iain MacGill

Associate Professor, School of Electrical Engineering and Telecommunications
Joint Director (Engineering), CEEM

Plenary on *Future Electricity Markets – the Australian Experience*

7th IAEE Asia-Oceania Conference

Auckland, February 2020

The NEM just turned 20

- Commencement 13 December 1999
- Seemingly much to ‘celebrate’ on its 15th anniversary

Less so on its 20th

Challenges widely, but not universally, agreed… *less agreement on causes, solutions*

	Current Status	Outlook
Affordability and satisfied consumers	Critical	Moderate
Secure electricity system	Critical	Critical
Reliable and low emissions electricity supply	Moderate	Critical
Effective development of open and competitive markets	Moderate	Good-Moderate
Efficient and timely investment in networks	Moderate-Critical	Moderate-Critical
Strong but agile governance	Critical	Moderate-Critical

POST 2025 MARKET DESIGN FOR THE NATIONAL ELECTRICITY MARKET (NEM)

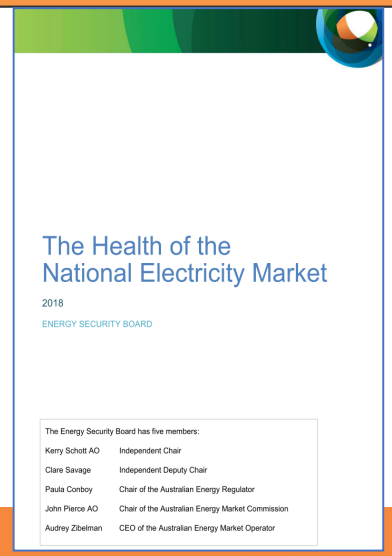
The COAG Energy Council has tasked the Energy Security Board with developing advice on a long-term, fit-for-purpose market framework to support reliability that could apply from the mid-2020s. By the end of 2020, the ESB needs to recommend any changes to the existing market design or recommend an alternative market design to enable the provision of the full range of services to customers necessary to deliver a secure, reliable and lower emissions electricity system at least-cost. Any changes to the existing design or recommendation to adopt a new market design would need to satisfy the National Electricity Objective. A forward work plan for this project is set out at Appendix 1. This forward work plan was approved by the COAG Energy Council at its December 2018 meeting.

Any significant changes to the electricity market design would need to be well considered, including substantial input from stakeholders and detailed consideration of alternative market designs, and telegraphed well in advance of any change to ensure there is minimal disruption to the forward contract markets for electricity.

If changes are required to deliver a long-term, fit-for-purpose market framework by the mid-2020s, then consideration of any required changes should be concluded by the end of 2020 to enable sufficient time for the market to transition to the new market framework.

ESB - Outcomes mostly dire &/or trending worse… *but the key 'market' mechanism is ok & trending better?*

…although ESB does have wider scope of mkt redesign for post 2025



3 Summit Sessions

- Presentations
- Break out discussions with a wide range of stakeholder contributions
- Draft papers under preparation

- *Disclaimer: I have borrowed freely, added my own perspectives, and make no claim to be presenting consensus views on outcomes*

PLENARY 1: END-TO-END MARKET DESIGN

How do we design an end-to-end market that integrates traditional generation and transmission assets, utility scale variable renewable energy generators and a rapidly evolving distribution network connecting loads, generators and DER?

Facilitator:
Audrey Zibelman, CEO Australian Energy Market Operator

Speakers:
- Dr Iain MacGill – University of New South Wales
- Dr Penelope Crossley – University of Sydney
- Dr Brendan Ring – Market Reform
- Assoc. Prof. Amro Farid – Dartmouth College

PLENARY 2: SECTOR COUPLING

The implications of related and emerging industries – such as natural gas, hydrogen markets, and electrified transportation and other sectors – on energy markets and their regulation.

Facilitator:
Prof. Michael Brear, University of Melbourne

Speakers:
- Dr Ross Baldick – University of Texas
- Ian Cronshaw – Australian National University
- Dr Magnus Olofsson – Energy Institute (Sweden)

PLENARY 5: OPTIMISING THE VALUE OF DER

System design to maximise the value of distributed energy resources while respecting customer interests. Optimal regulatory structures for networks capable of handling two-way energy flows, to provide efficient pricing via integrating innovative business models and services that benefit customers.

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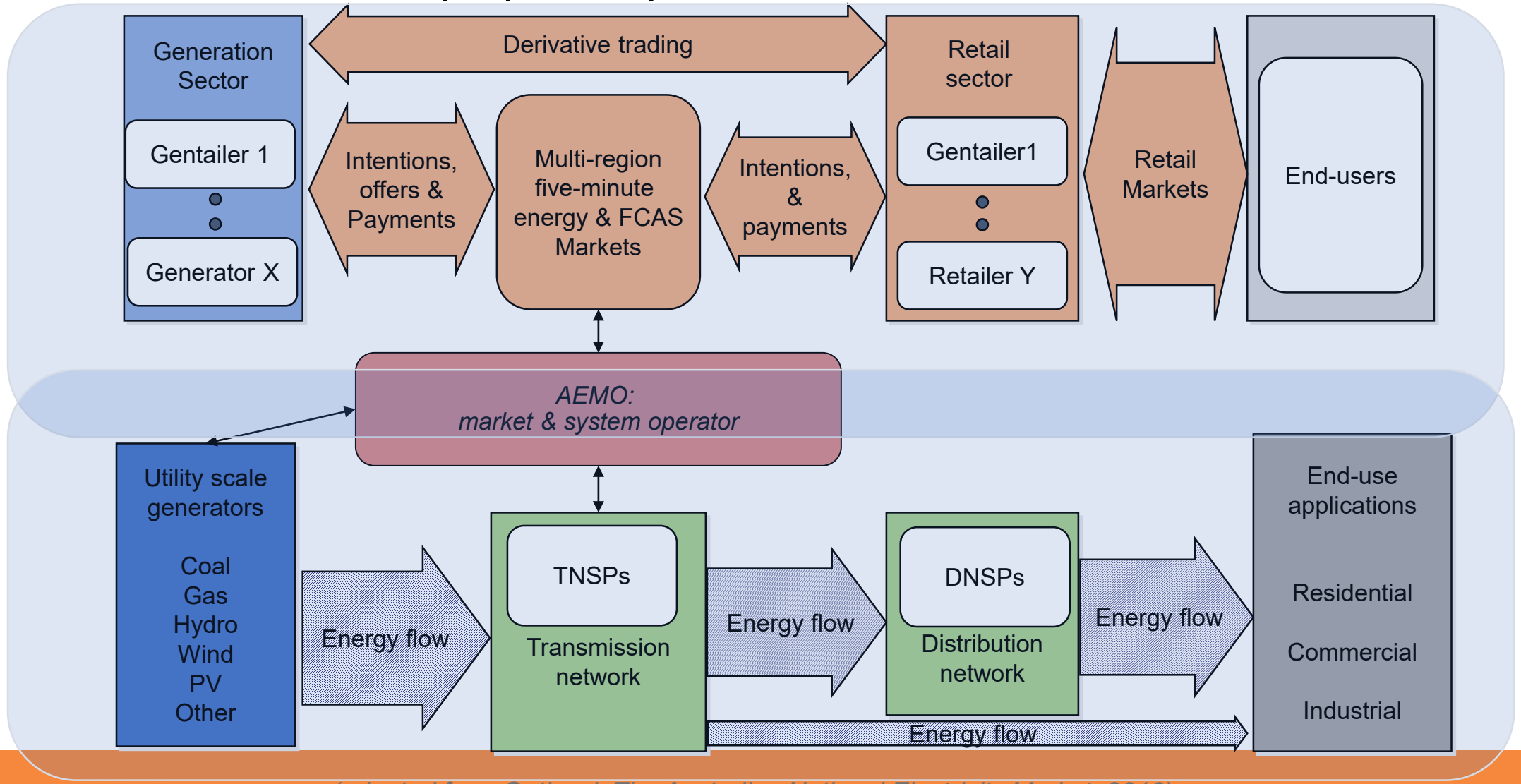
End-to-end market design

The Australian National Electricity Market (NEM)

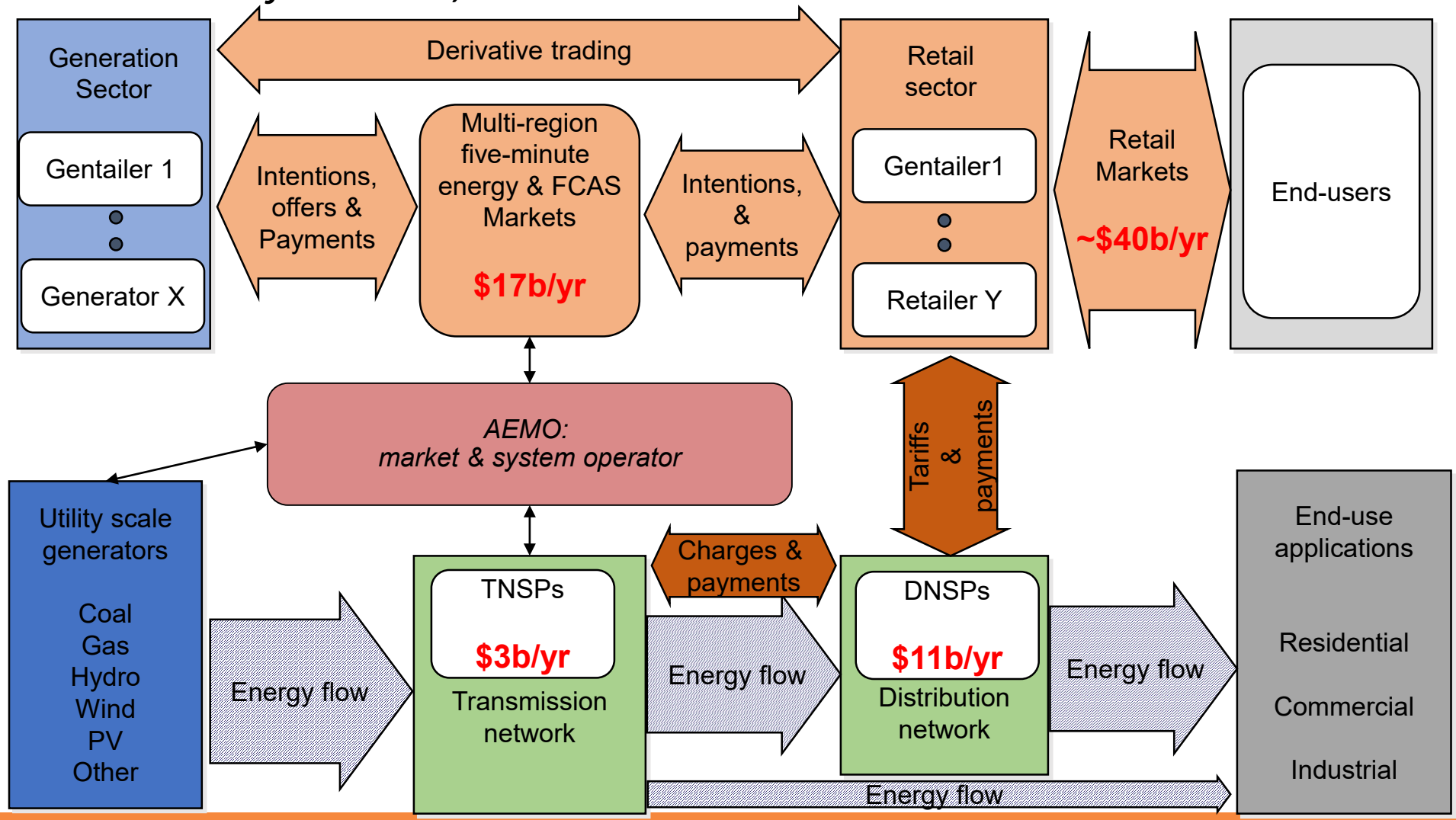
- *Not national, and mostly a power system*



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

$ through NEM – *end-to-end, market and non-market*

- *2017-18 estimates from AER, IbisWorld*



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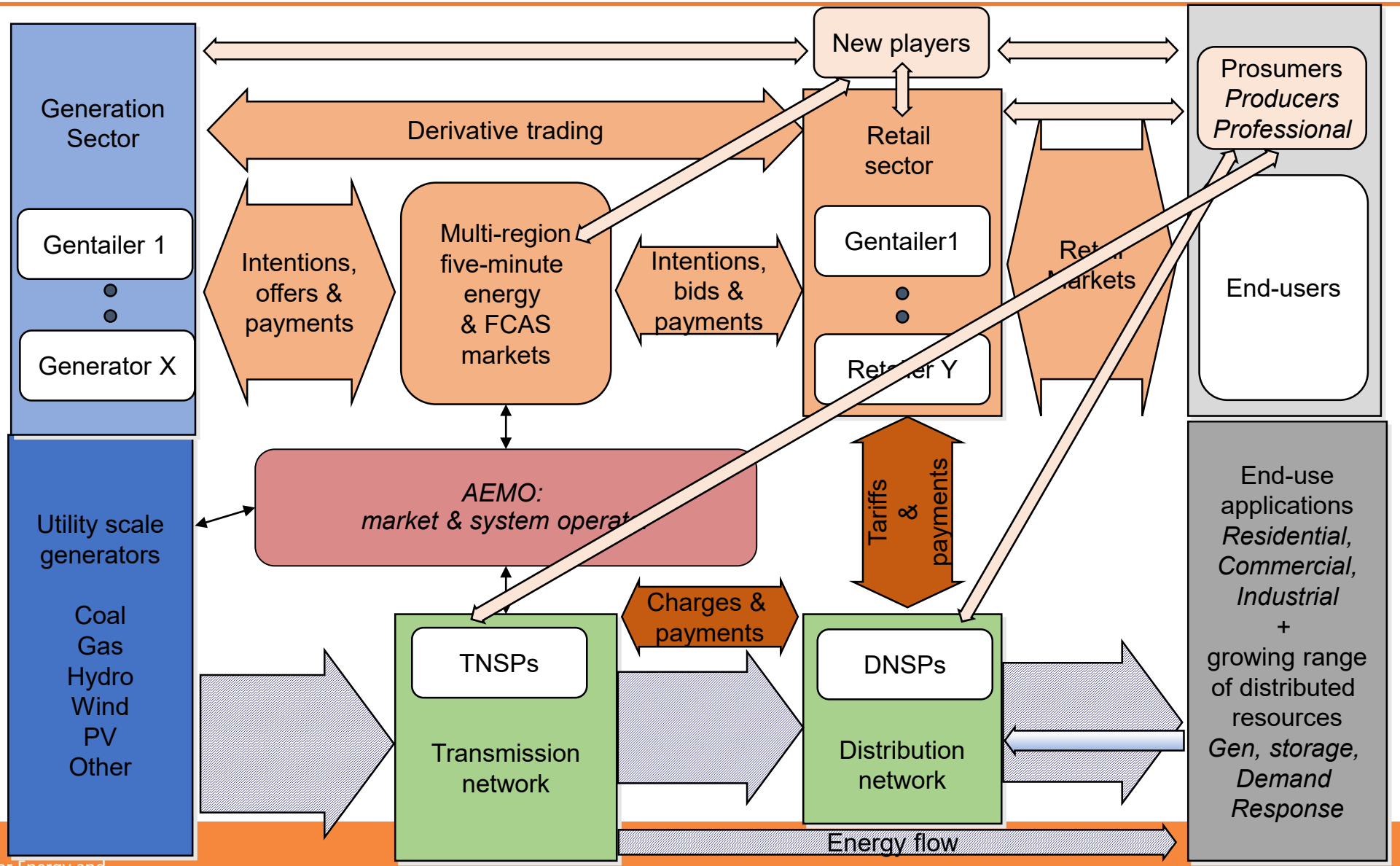
The evolving NEM – not getting simpler, *new markets, players*



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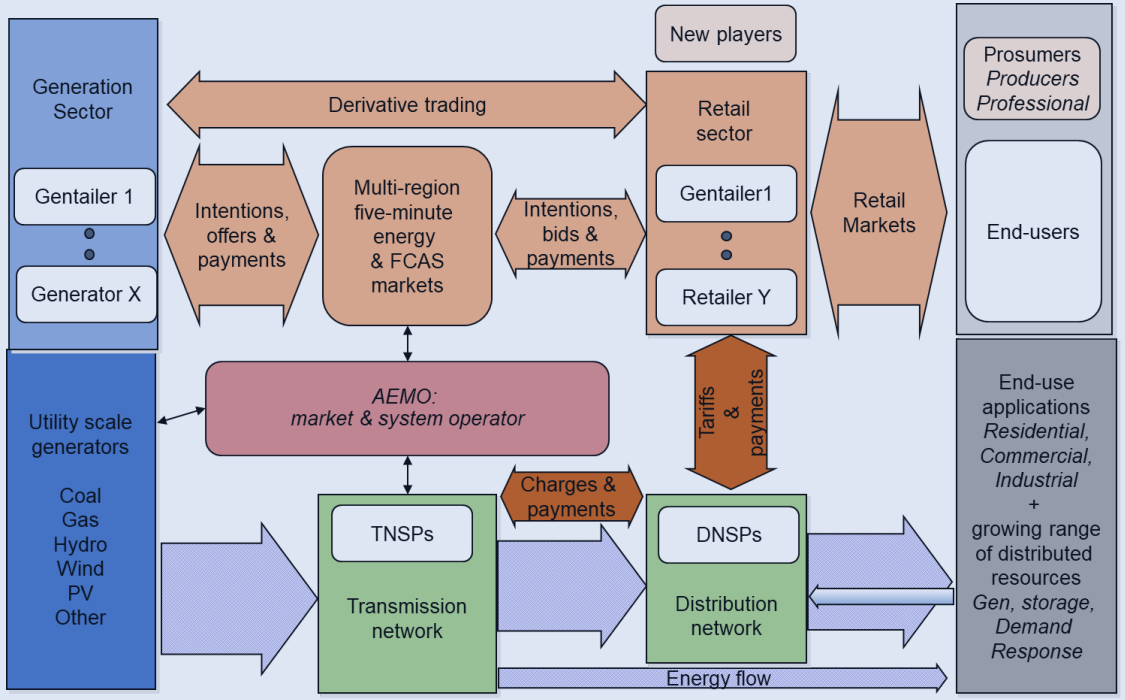
Market design – side to side

- NEM redesign part of a broader design challenge across regulation, markets and external policies
- With a focus on robustness and resilience – ability to perform reasonably well under a wide range of possible futures
- Comprehensive and Coherent development process is key
- … with particular focus on interfaces between these decision making regimes

External Policies – climate, renewable, energy efficiency, fuel, social welfare, economic development….

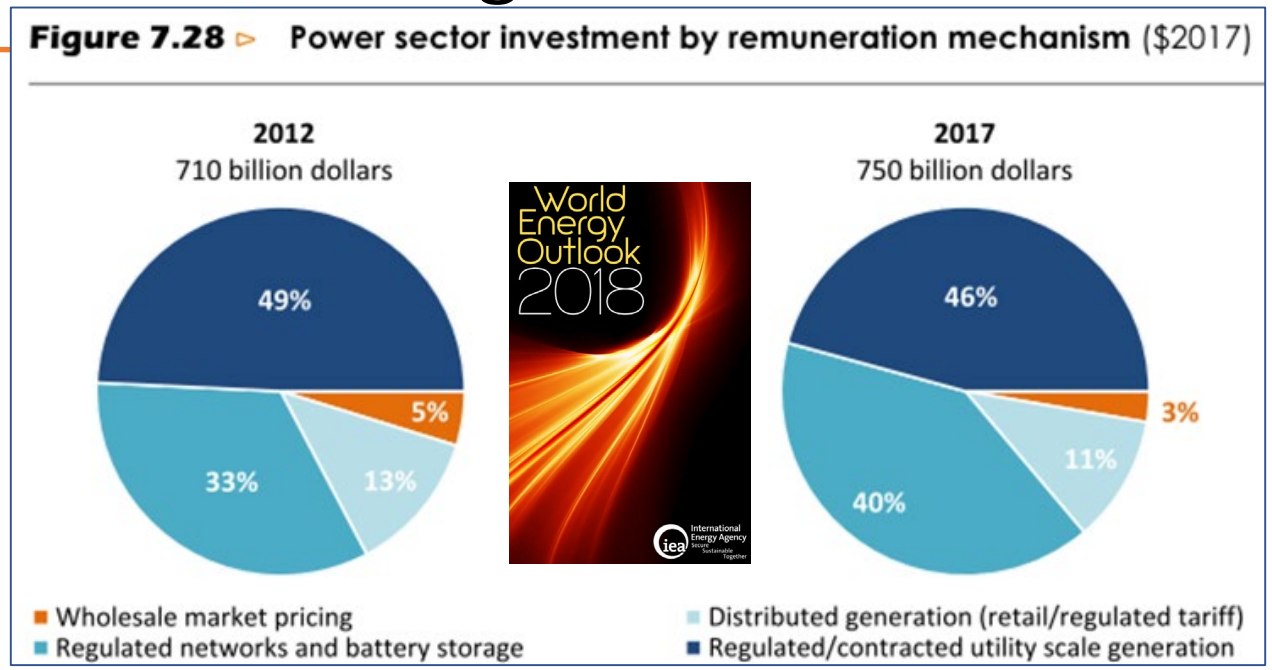


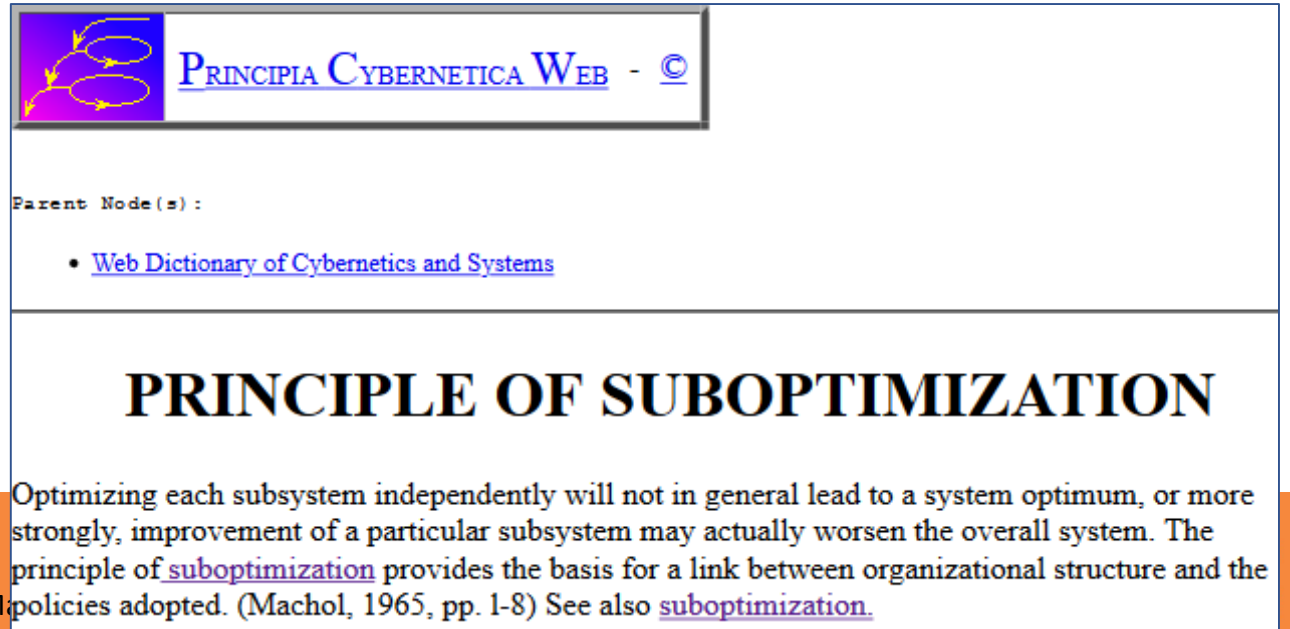
Technical / regulatory – Tx network planning, Dx network planning, grid codes, aspects of security

An ‘externality’ problem for market design

- Electricity sector invariably has 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 target these ‘externalities’
- World-wide, electricity industry investment is dominated by policy and regulatory drivers

- Markets with significant externalities are inefficient by ‘design’***hence***, *efforts to improve efficiency of some parts of an electricity market with un-priced externalities can potentially reduce overall market efficiency*





Key features of end-to-end market design *(draft session paper)*

- The different markets should be consistent, integrated and robust
- We need to seek to internalise key externalities – particularly, but not exclusively the carbon externality
- Effective and efficient market design requires greater consideration of the 'demand' side
- Potentially a wide range of new markets including those with high DER participation
- Security services will need to be incentivised – markets can be a powerful driver of innovation, but limits so mix of technical, regulatory as well as market required
- Social licence a key consideration – markets can damage trust and legitimacy if poorly implemented
- Structure (participants – size, nature) matters too – no market design can withstand poor structures leading to markets breaking, market power …

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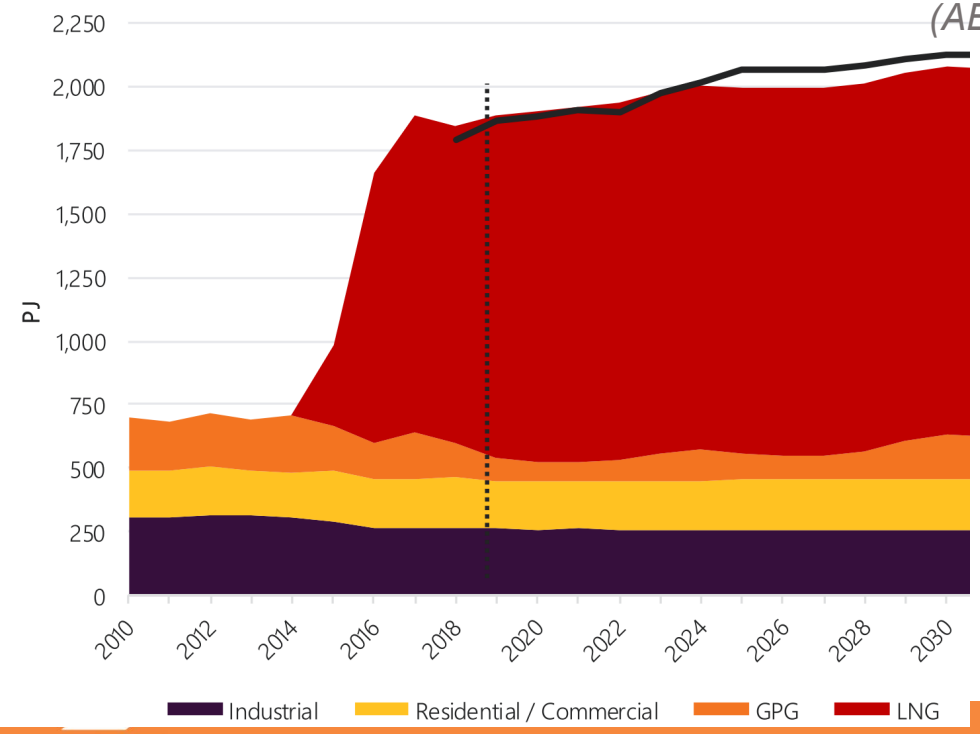
Sector coupling

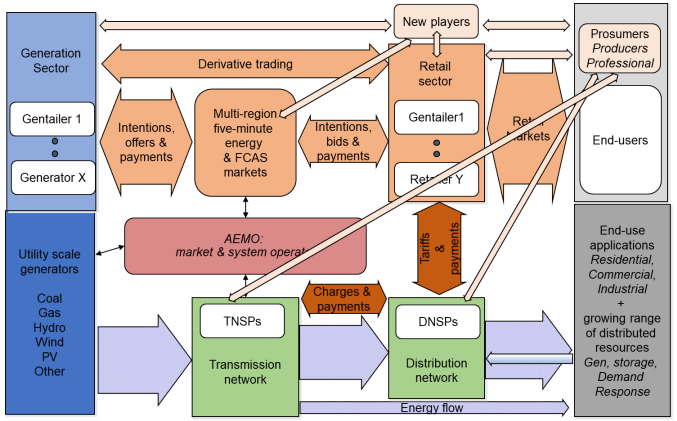
Electricity – Gas coupling

- Coupling both on electricity market ‘supply’ and ‘demand’
- Far less gas generation transition in Australia than seen in some other key markets; including Europe, United States
- Australian coupling is somewhat decoupling, with export LNG now dominating market

Figure 4 **Gas consumption actual and forecast, 2010-38, all sectors, Neutral**



(AEMO, Gas Statement of Opportunities 2019)



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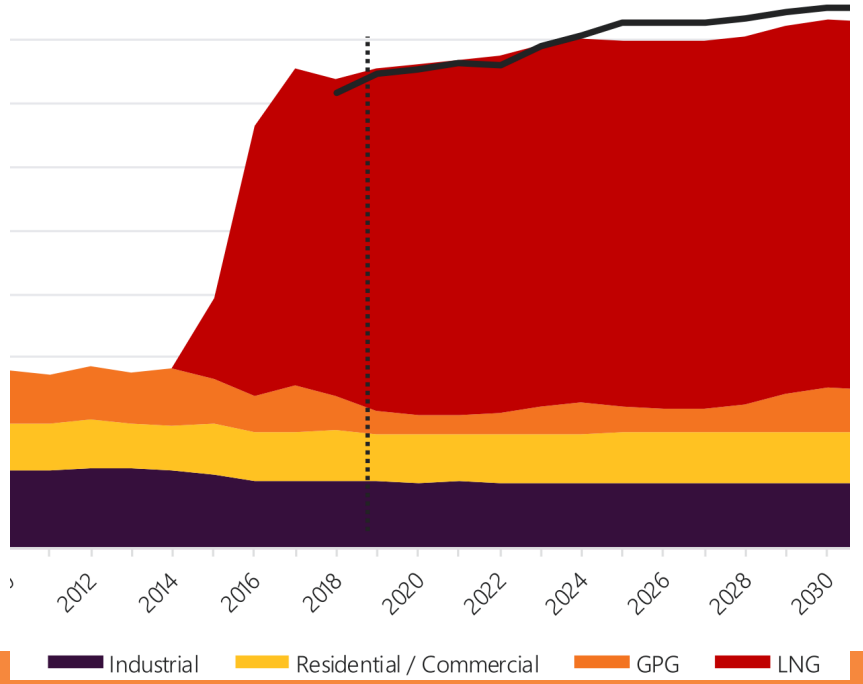
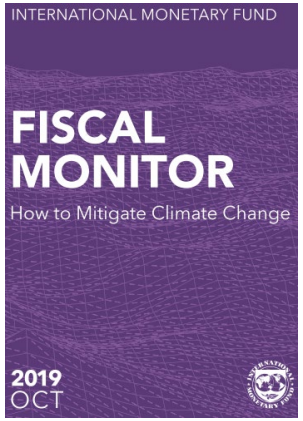
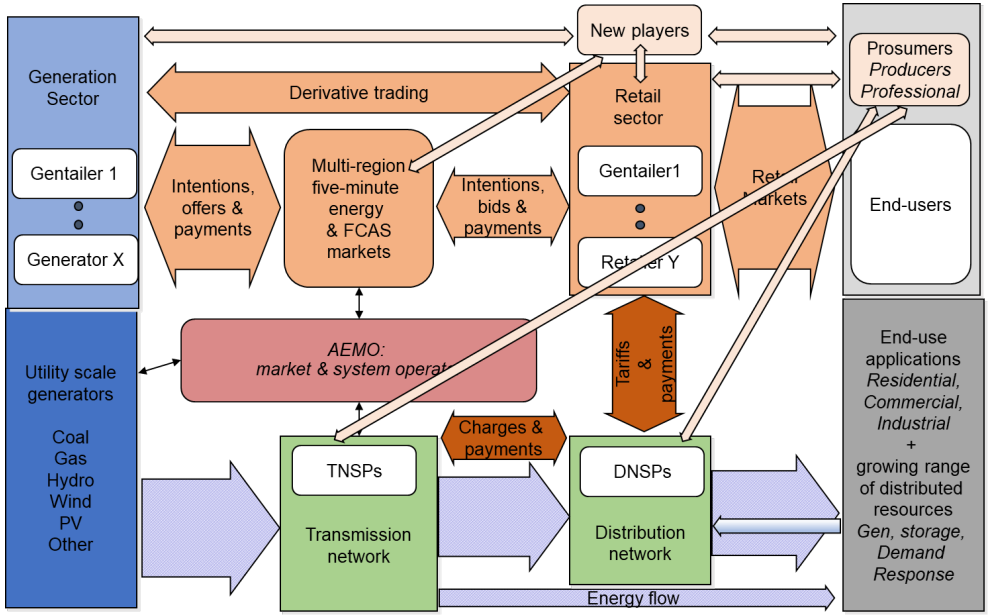


Sector coupling– problems with gas for a major exporter?

- Gas price comparisons challenging but changing Australian ‘gas market’ dynamics and high cost gas have been problematic for NEM transition towards more flexible generation
- Seeing growing demand substitution options between electricity and gas too



	($/GJ)
Argentina	3.0
Australia	9.6
Brazil	3.0
Canada	3.0
China	9.6
France	8.3
Germany	8.4
India	9.6
Indonesia	9.6
Italy	8.3
Japan	9.6
Korea	9.6
Mexico	3.0
Russia	7.0
Saudi Arabia	7.0
South Africa	7.0
Turkey	7.0
United Kingdom	8.3
United States	3.0



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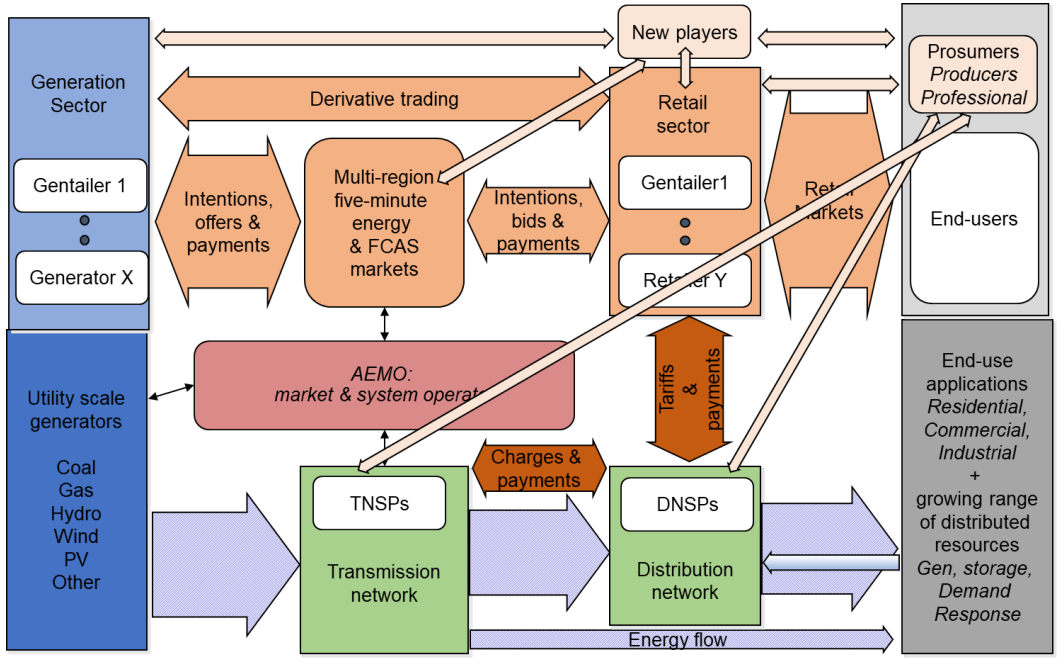
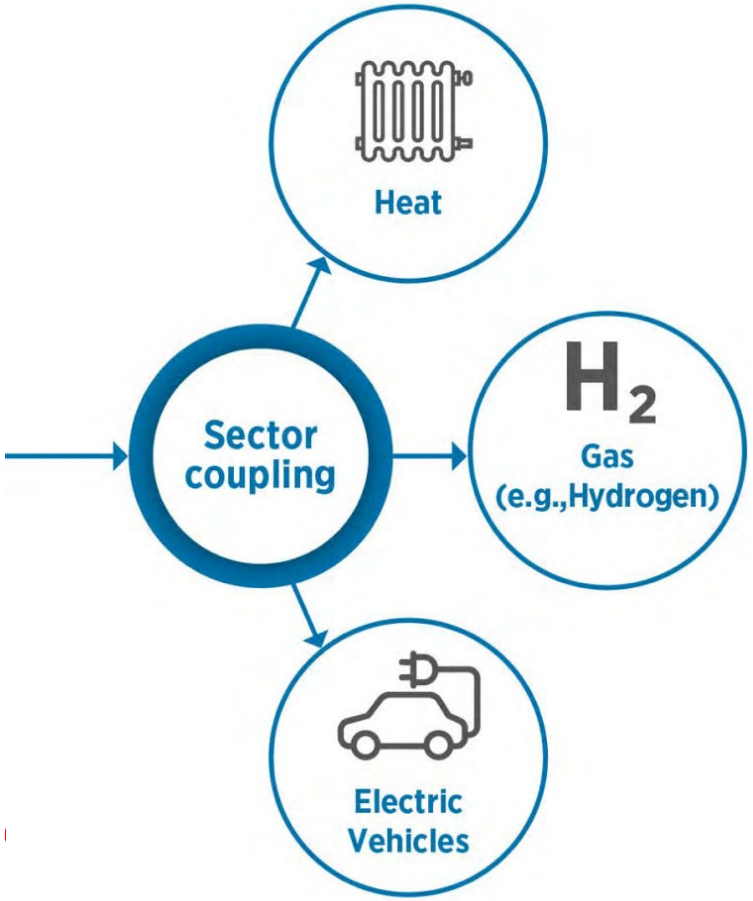
Korea	9.6
Mexico	3.0
Russia	7.0
Saudi Arabia	7.0
South Africa	7.0
Turkey	7.0
United Kingdom	8.3
United States	3.0

(Retail baseline gas price estimates, IMF, 2019)

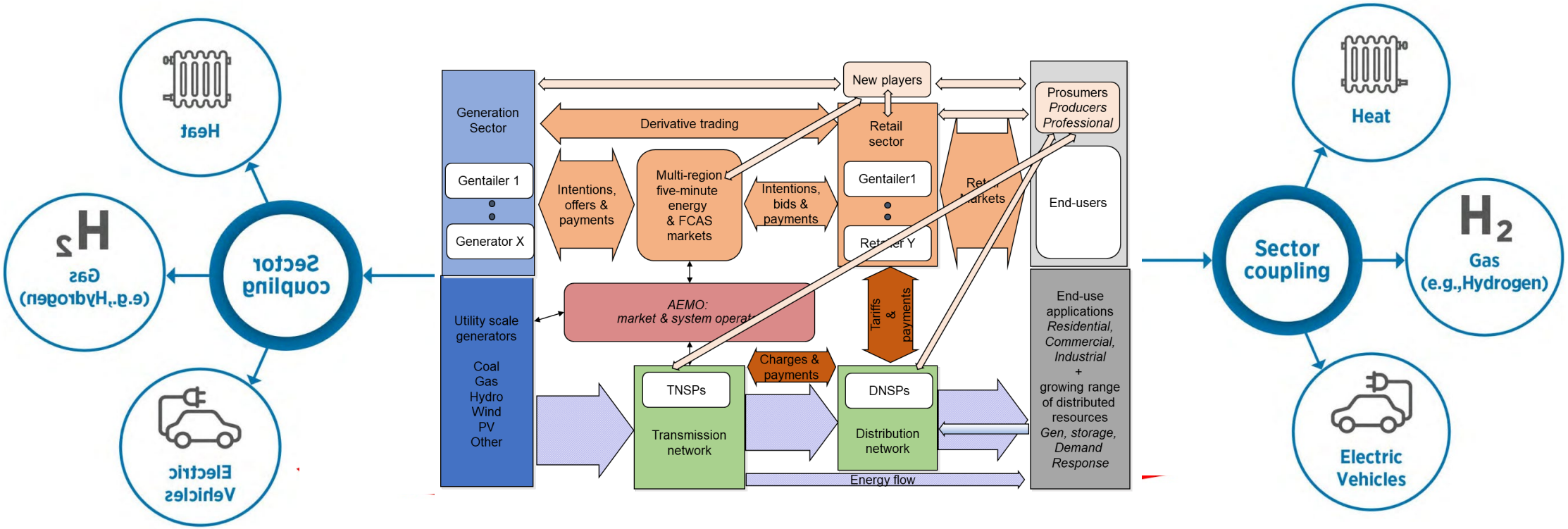
Wider coupling challenges and opportunities



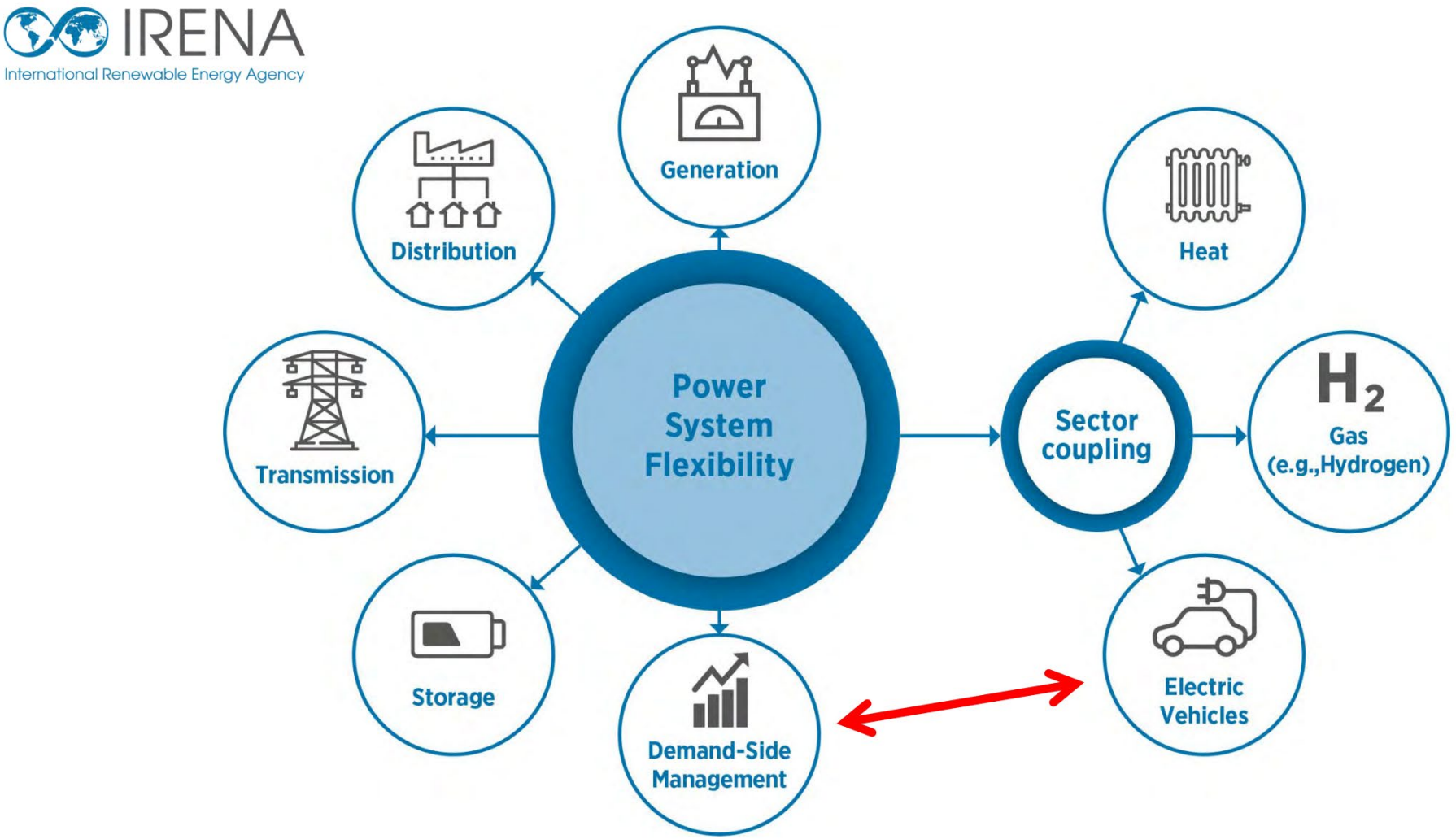


(Retail baseline gas price estimates, IMF, 2019)

More strictly, more coupled

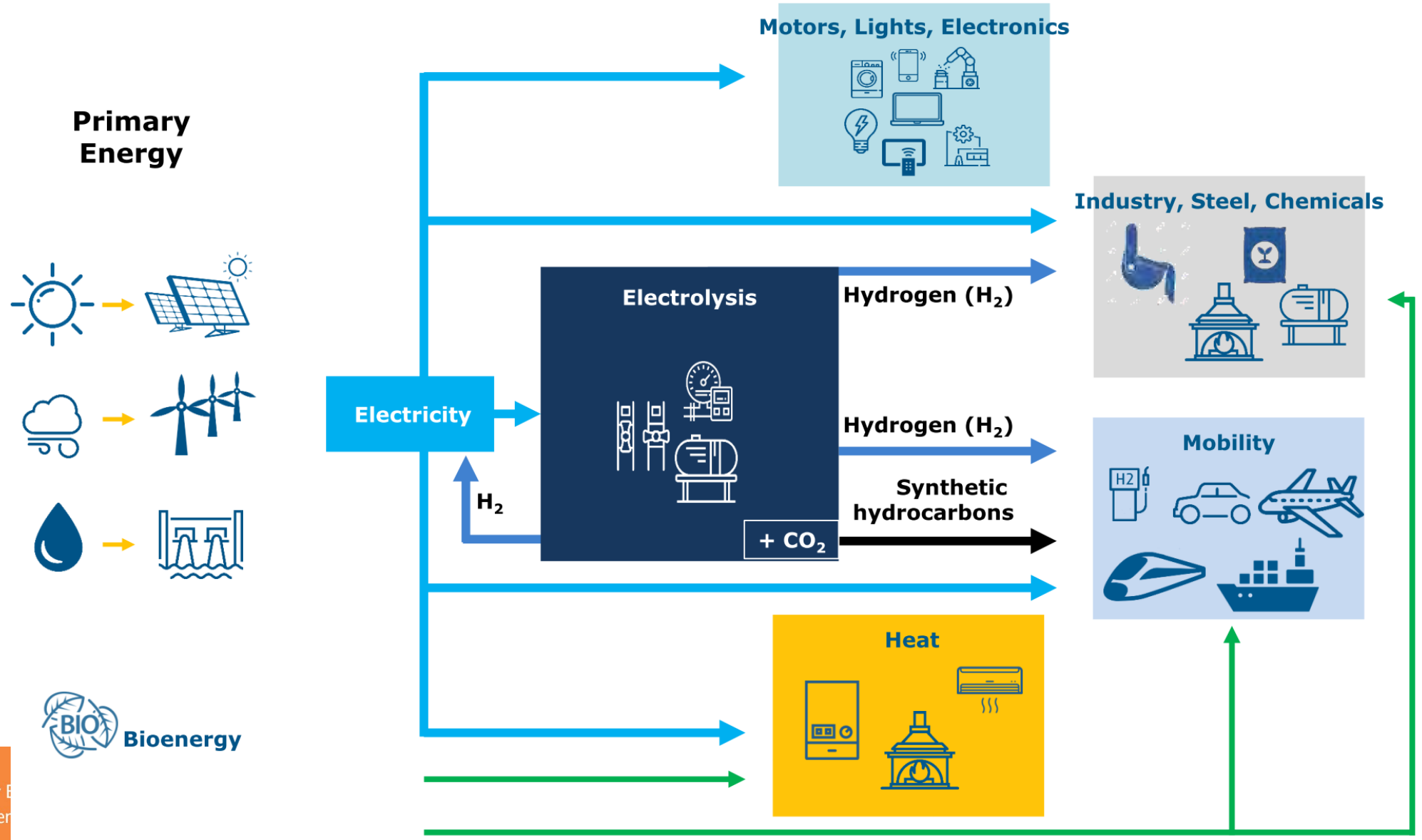


A renewables integration perspective – synergies, challenges



https://www.irena.org/energytransition/Power-Sector-Transformation/Power-System-Flexibility

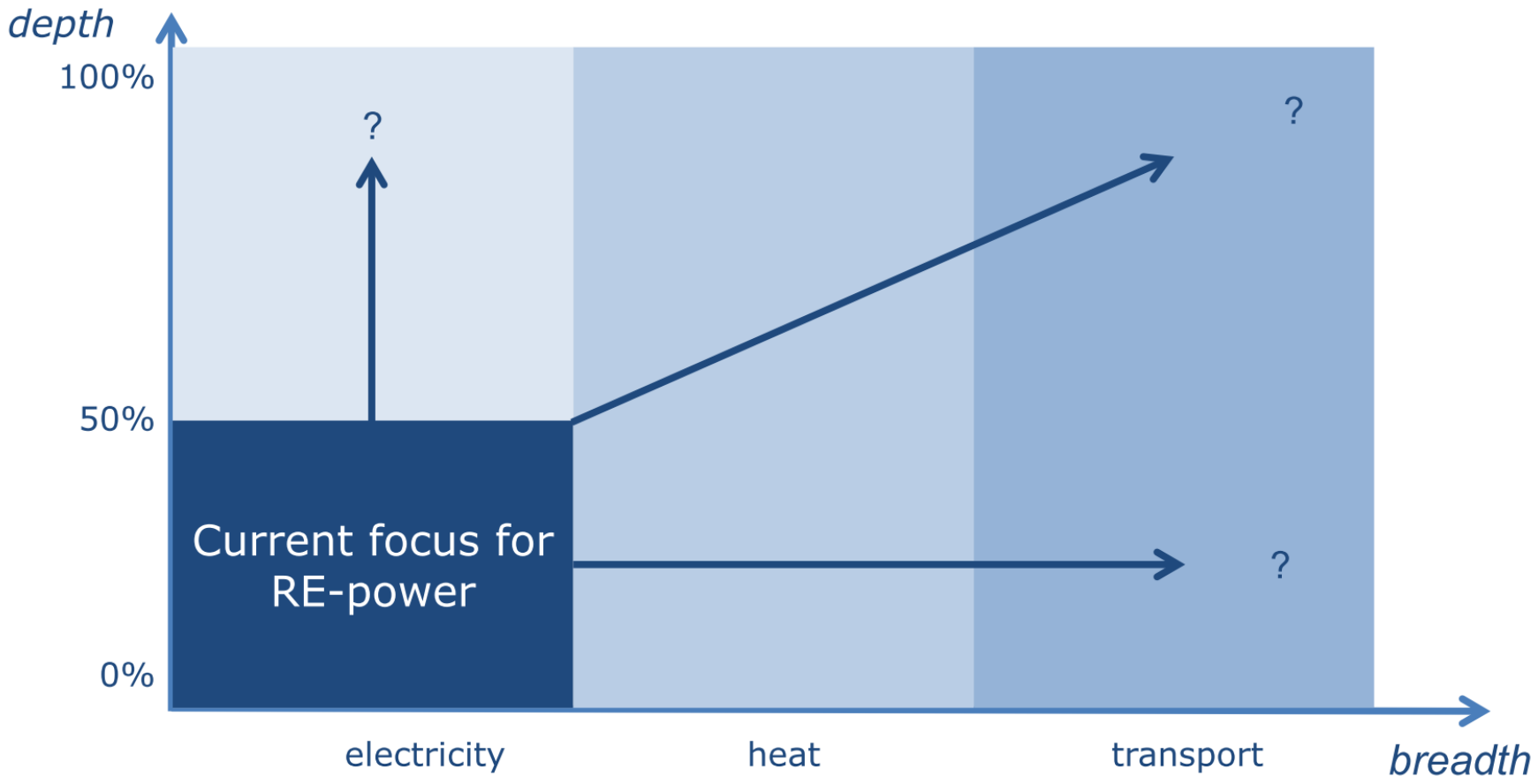
A future electricity – H2 energy sector perspective



Towards a decarbonised gas grid *(draft session paper)*

- If gas to continue to deliver cost-effective flexibility services, using existing or modified natural gas infrastructure, it will need to be produced from renewable sources, or with effective CCS.
- 3 key routes for partial or full replacement of natural gas:
  - Low Carbon hydrogen, produced from low carbon power by electrolysis, gasification of biomass, or from fossil fuels with CCS;
  - Biomethane, by upgrading biogas, removing CO2 and other impurities
  - Synthetic methane, from low carbon hydrogen and atmospheric CO2
- electricity currently provides around 20% of end-use energy services globally, supplying wider energy services by carbon free power (eg electric vehicles, heat pumps for residential and industrial use) even more challenging than decarbonising the existing and expanding power system.
- These technologies, notably H2, have the potential to decarbonize sectors of the economy where may otherwise prove difficult, eg aviation, steelmaking.

Key transition questions for greater electrification *(Simon Mueller)*



To maximize carbon benefits, the power sector needs to be sufficiently decarbonized when covering new demand. Strategies need to consider lead-times for deploying new solutions.

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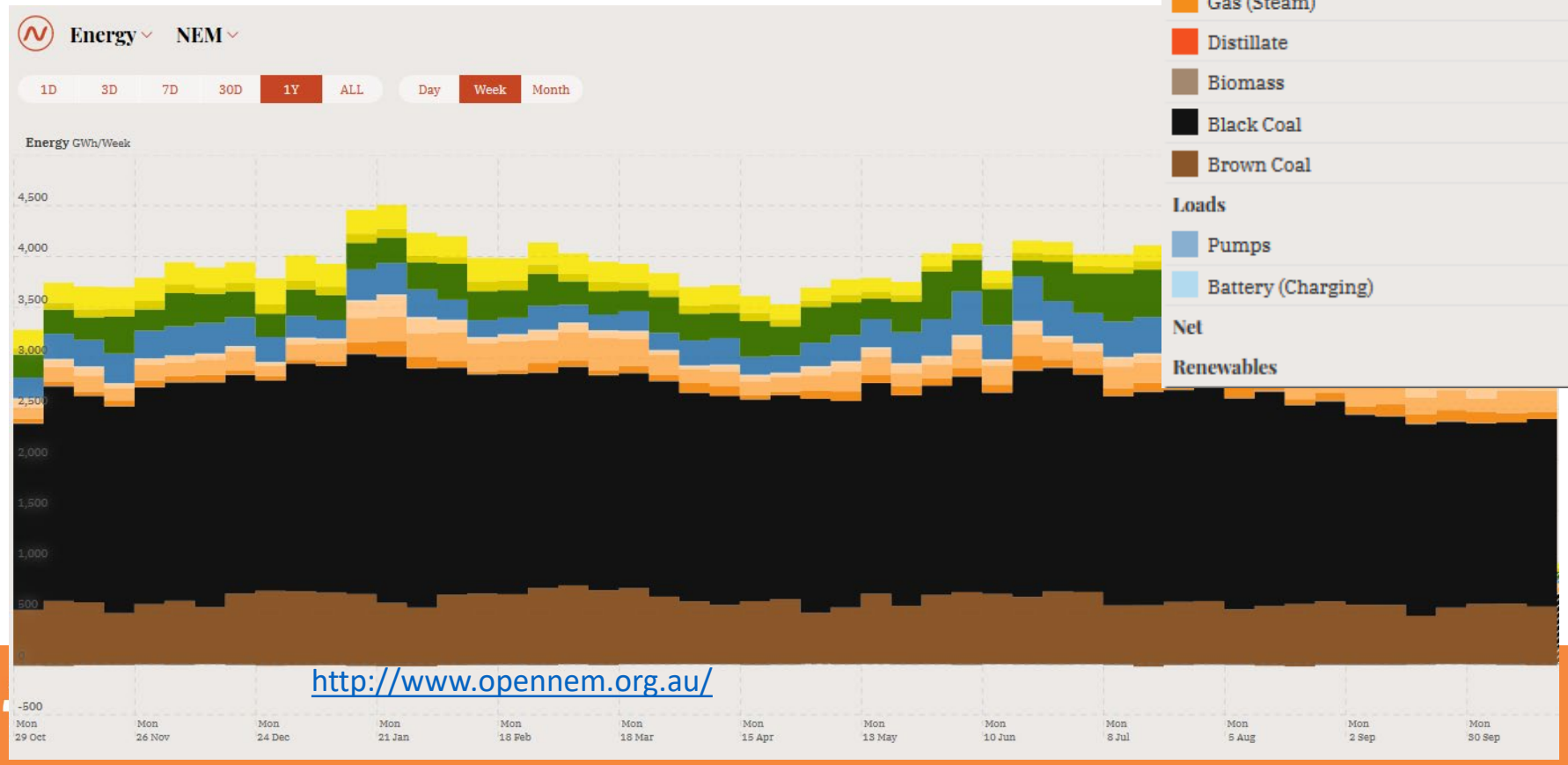
Optimising the value of DER

Distributed PV now contributing over 5% of total NEM generation, 8% in some months

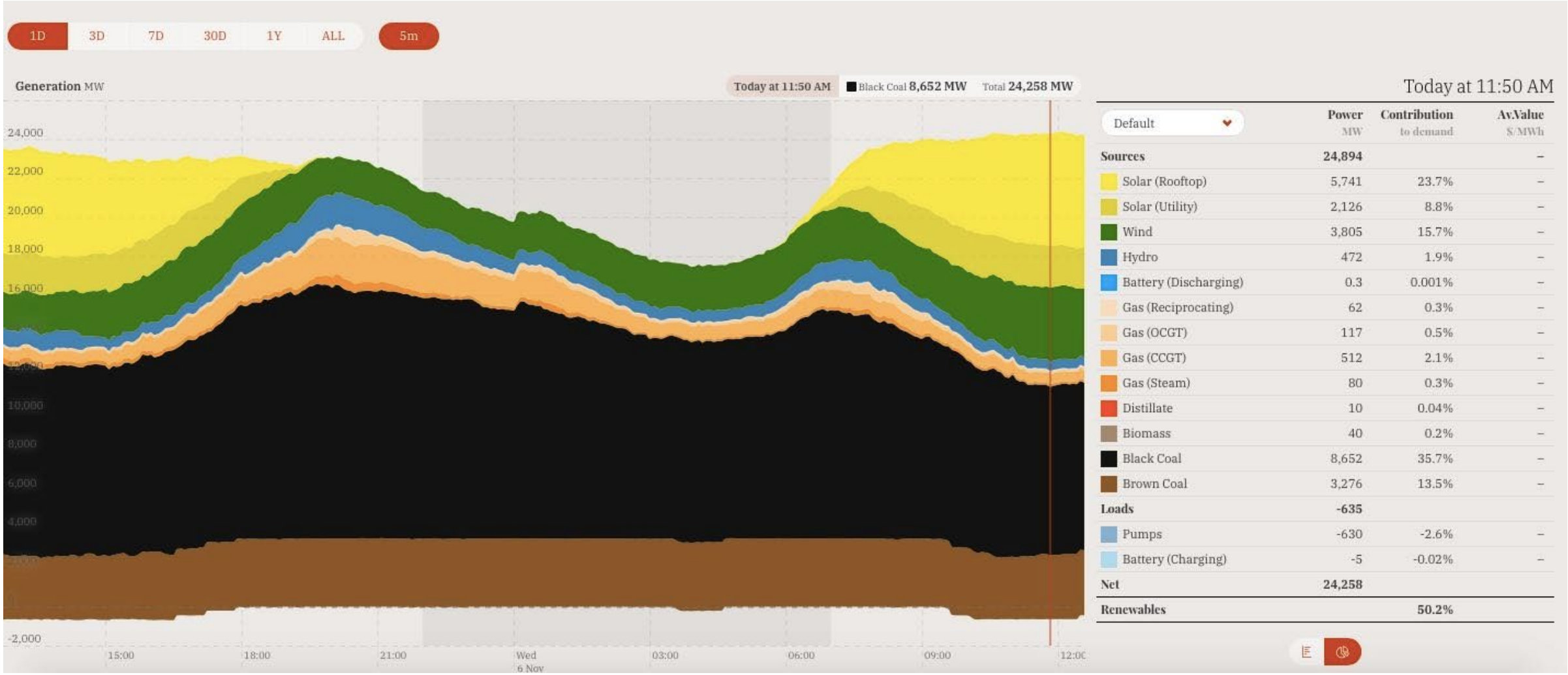


29 Oct 2018 – 27 Oct 2019

Default	Energy GWh	Contribution to demand	Av.Value $/MWh
Sources	**200,702**		**$98.00**
Solar (Rooftop)	9,586	4.8%	$86.81
Solar (Utility)	4,227	2.1%	$82.98
Wind	15,750	7.9%	$86.17
Hydro	13,793	6.9%	$123.04
Battery (Discharging)	61	0.03%	$178.58
Gas (Reciprocating)	711	0.4%	$75.68
Gas (OCGT)	3,912	2.0%	$197.24
Gas (CCGT)	9,709	4.9%	$103.37
Gas (Steam)	3,855	1.9%	$165.77
Distillate	28	0.01%	$1,261.43
Biomass	228	0.1%	$75.83
Black Coal	106,342	53.2%	$84.98
Brown Coal	32,500	16.3%	$114.78
Loads	**-827**		
Pumps	-774	-0.4%	$60.56
Battery (Charging)	-53	-0.03%	$71.09
Net	**199,875**		
Renewables		**21.8%**	

http://www.opennem.org.au/

Up to 25% instantaneously NEM wide



http://www.opennem.org.au/

And approaching 70% instantaneously in South Australia

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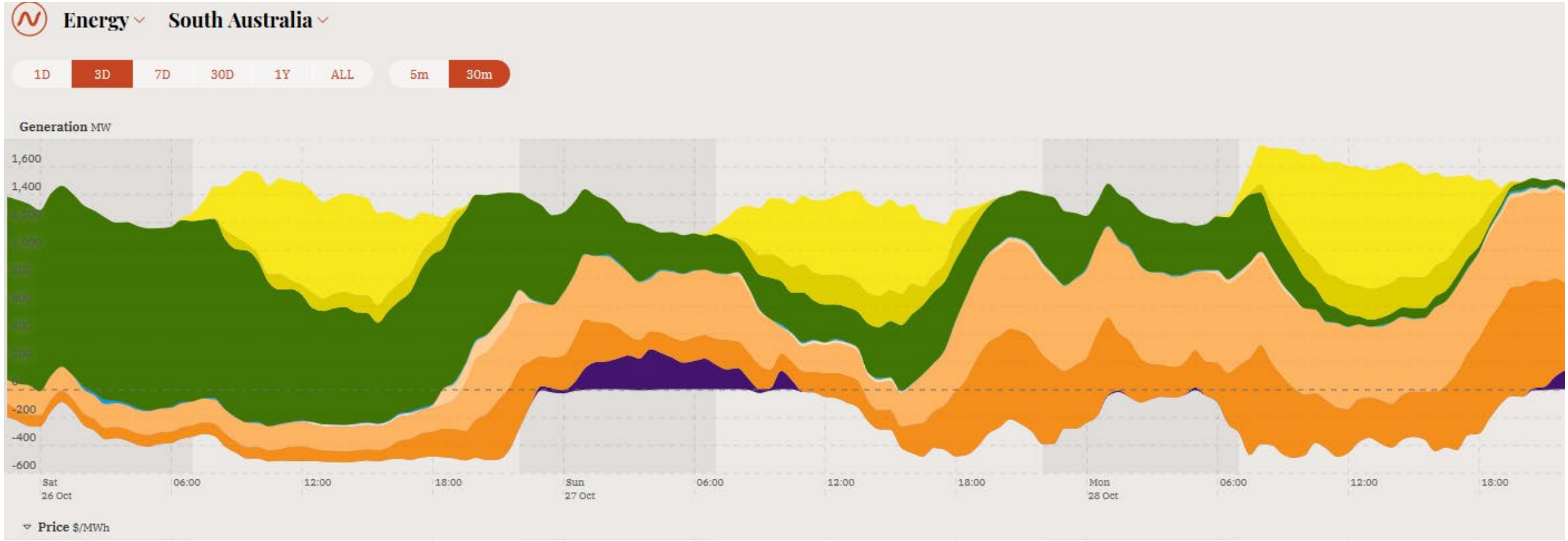
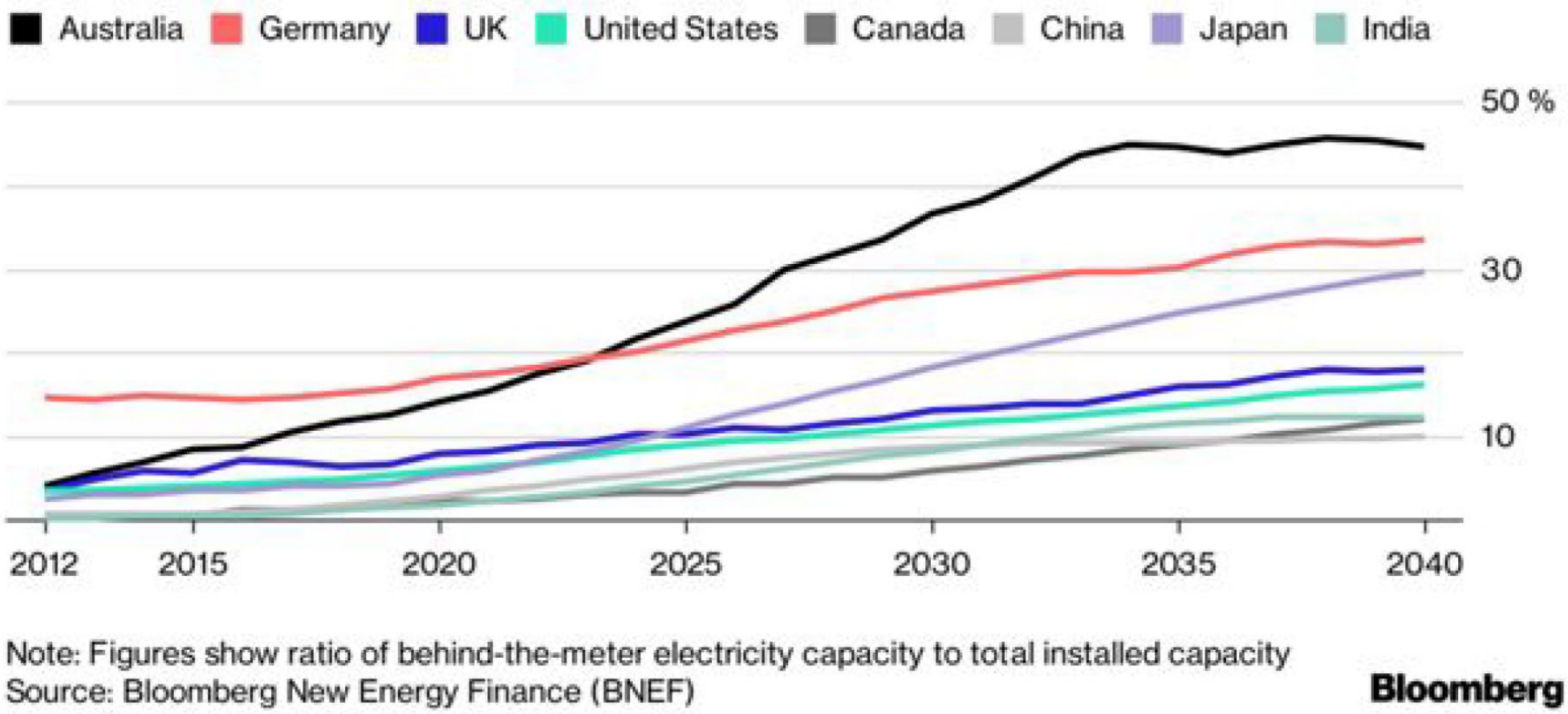


Some projections suggest potentially far greater future role

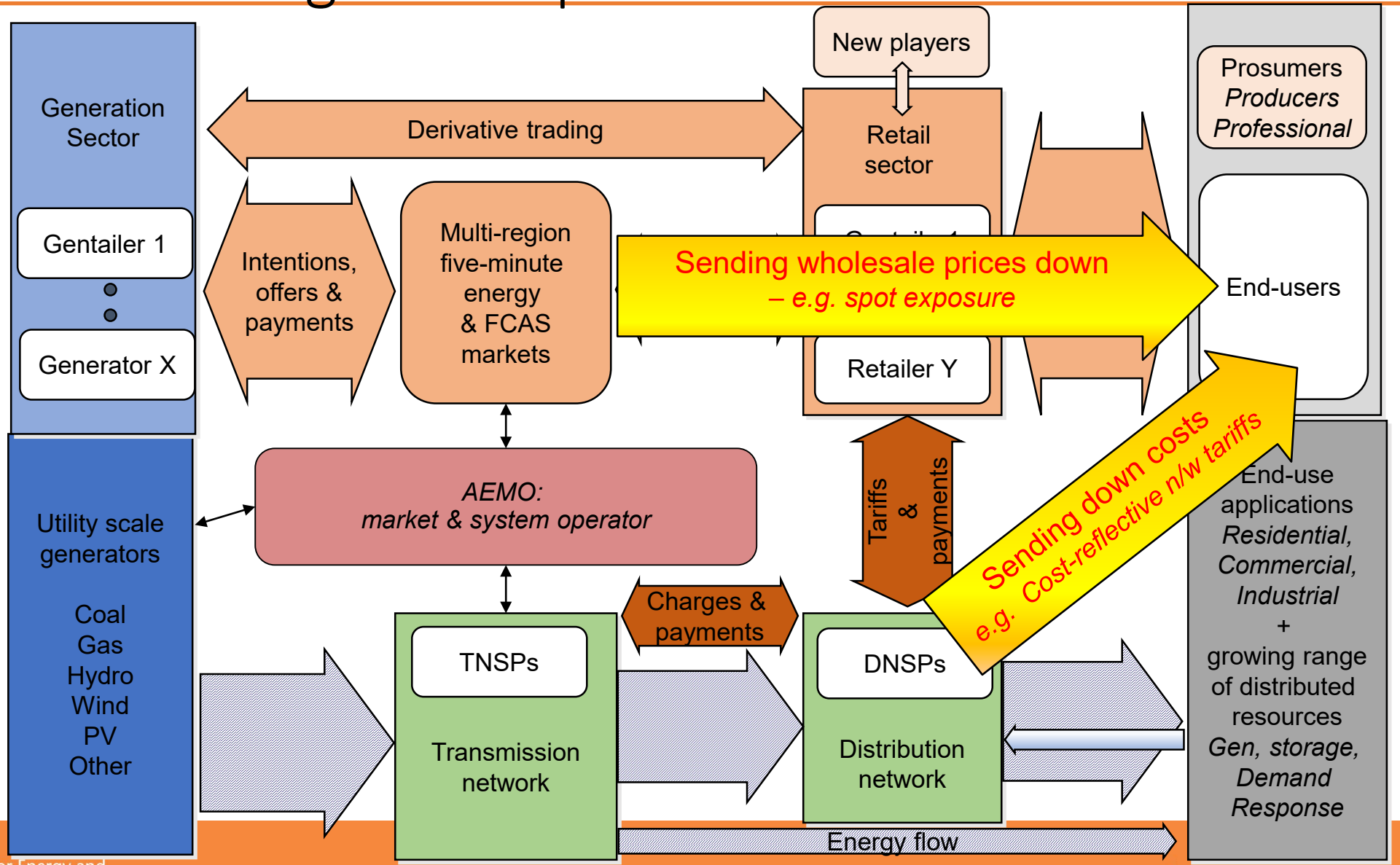


Fundamental challenges *(draft summary paper)*

- Scale:
  - moving from a system that has hundreds of large central generators, to millions of consumer-owned DER that may want market access.
  - Technical operation of the market to keep a high level of reliability and to manage comms, computation and data-access challenges.
  - This shift of services to the edge of the network means dx network will need to change from a largely set-and-forget approach, to being actively managed to cope with multi-way flows.

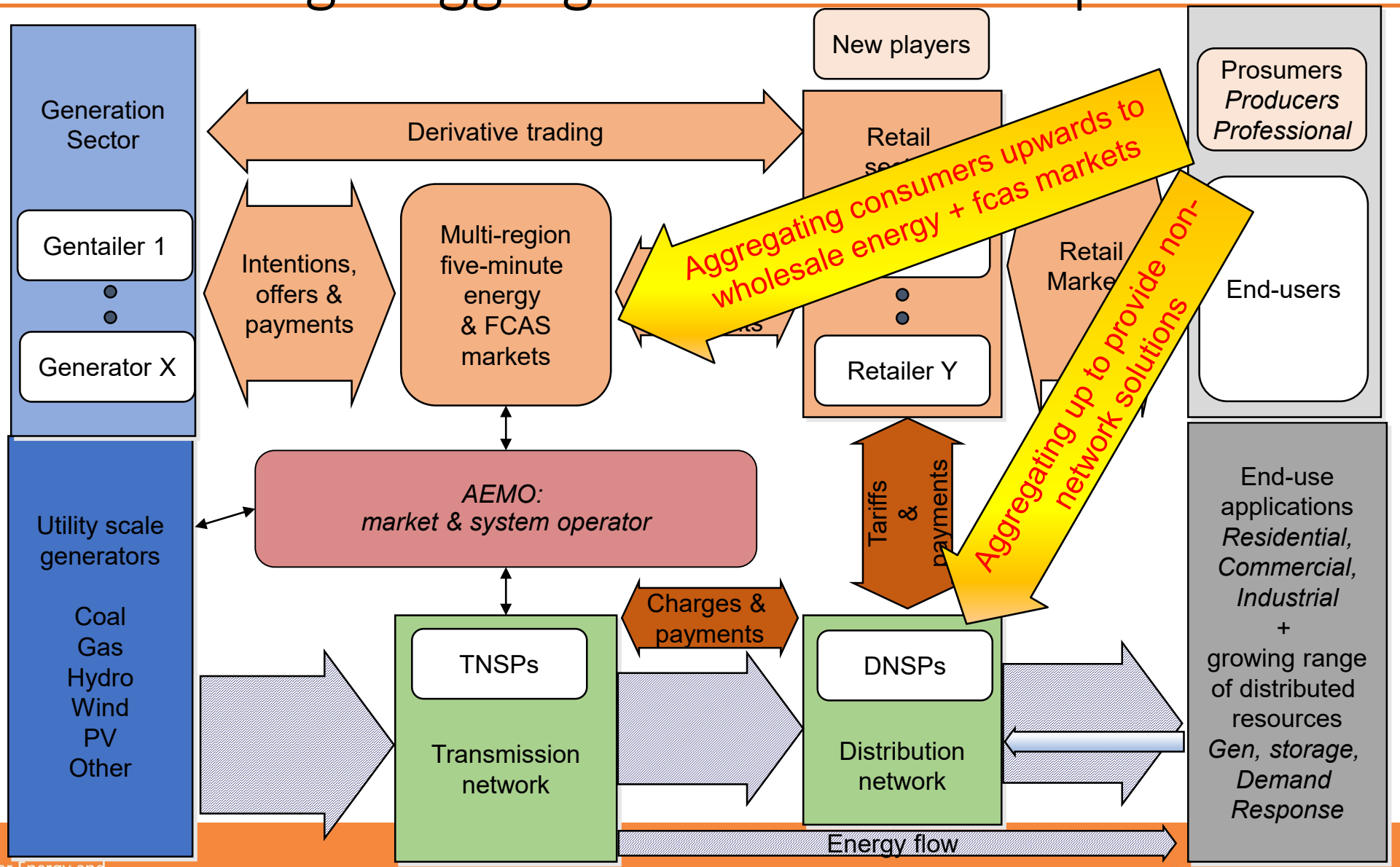
- Engagement:
  - With DER transition comes relying on consumers to provide system-critical services including energy balance, frequency response, and voltage and capacity management.
  - The market has historically not had to deal with or rely on consumers, or their retailer and aggregator intermediaries, in major way to provide these services.
  - Contributing to this challenge is a inherent tension between what some consumers may prioritise and the desirable outcomes for the system as a whole.
  - Aligning the desires and incentives for customers, system and network operators is important, sensible incentives and market design are key ways of achieving this.

Integrating ‘utility’ and ‘consumer’ operational and investment decision making – send prices down



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

Integrating ‘utility’ and ‘consumer’ operational and investment decision making – aggregate consumers ‘upwards’



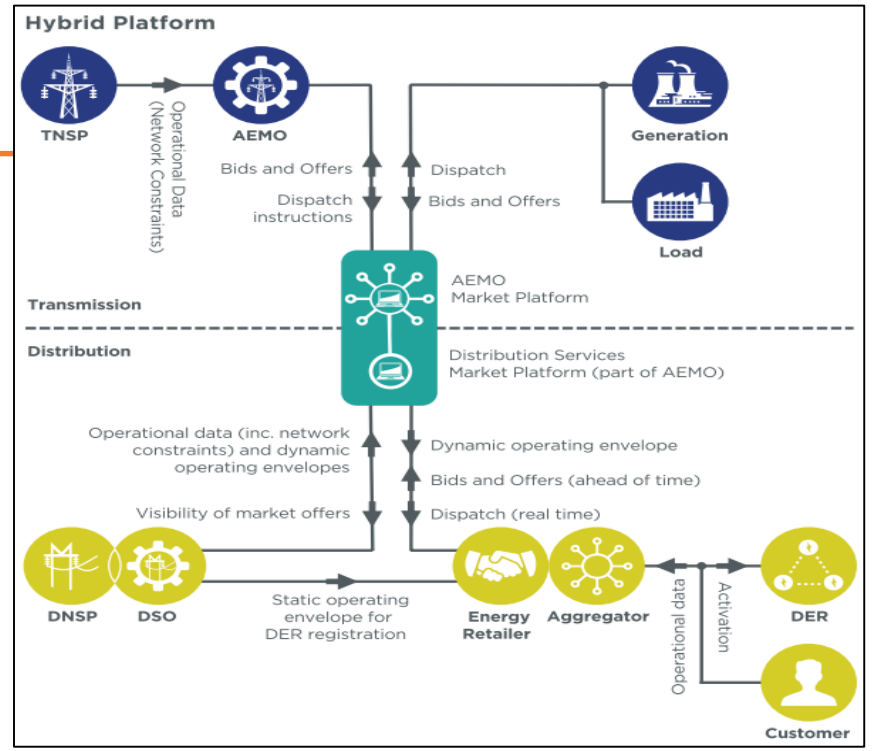
(adapted from Outhred, The Australian National Electricity Market, 2010)

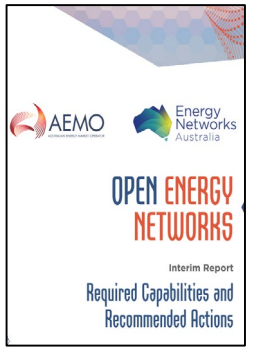
Possible pathways forward

- Sending prices down in key contexts to some consumers
  - For most, current retail ‘tariffs’ more social constructs than ‘market’ outcomes with major transfers, little desire for more complex bills
- Aggregating up a key opportunity, but limited in key regards
  - NEM currently has limited locational pricing, opaque derivatives, excessive market power, conflicted DNSPs and inefficient by design

    … and DER network + local ancillary value likely greater than at tx/wholesale level

    …and challenges for effective competition with scale-economies
- New approaches show promise
  - E.g. AEMO/ENA Hybrid model… *but tradeoffs between complexity and efficiency need care, trust will be key…. + risk missing wider opportunity*
- A broader opportunity
  - Energy users need support to engage effectively
  - Most appropriate interface based around ‘energy services’ rather than commodity energy consumption





Possible conclusions *(draft discussion paper)*

- DER represents a key component of broader electricity and energy system transformation. ‘Courage’ required in making technical, regulatory and market reforms that allow full value of DER to be captured and shared for benefit of all
- This reform broad in scope, will take time to realise. Important to avoid reform that ‘works’ short term but doesn’t fully unlock DER value in med. to long term
- Achieving the ambitious reform agenda required has 3 key steps:
  - A clear vision for a future electricity system that understands and values DER. Requires a strategy for building trust and engagement
  - Agreeing on no-regrets activities and reforms that can be implemented in the short-term to underpin longer-term transition to a high-DER future.
  - Implementing a cross-disciplinary, socio-techno-economic work program to guide necessary medium- to long-term reforms. Also need the systems and technology capabilities that underpin technical integration of DER in networks and markets. Technical program of work must grow beyond present trials and implement solutions at scale.