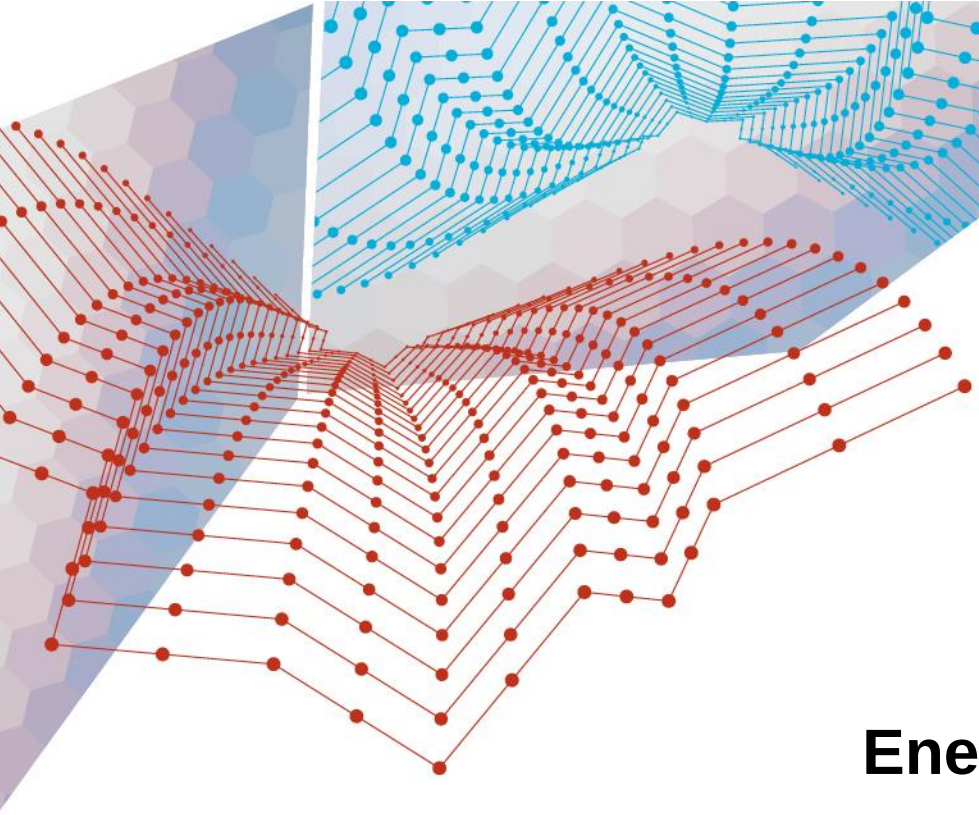


ELECTRICITY NETWORK TRANSFORMATION ROADMAP

2015-25

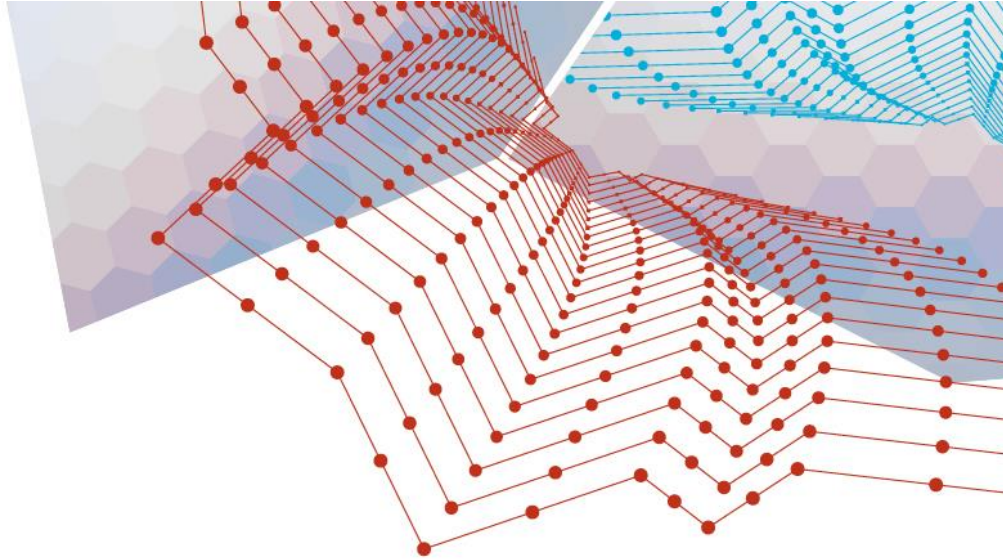
Energy Network Transformation

Dr. Stuart Johnston
Executive Director, Assets and Network Transformation

ena energy networks association

CSIRO

Overview



- ENA – scope and current focus
- Disruptive change driven by customers and technology
- Network businesses are responding
- Network Transformation Roadmap project

ENA Members

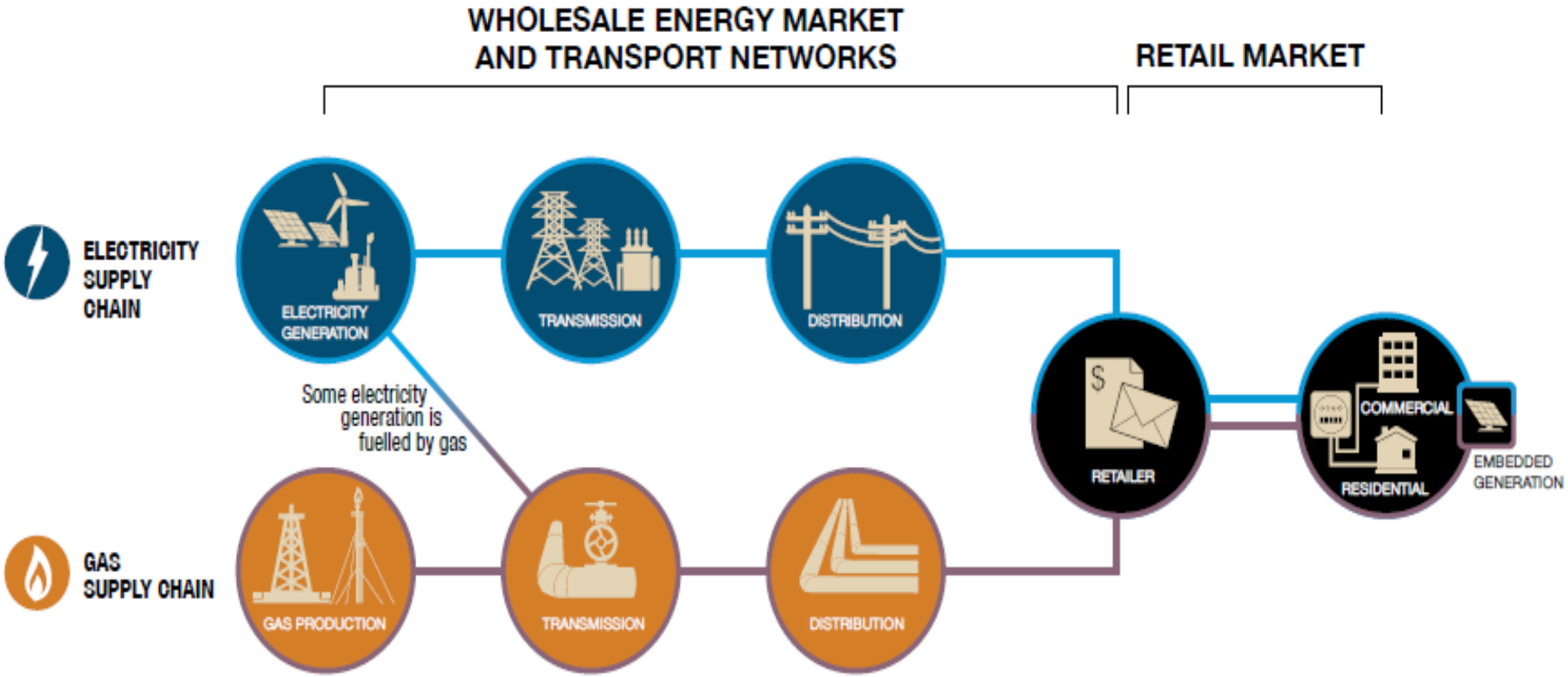
The peak national body representing gas distribution and electricity transmission and distribution businesses throughout Australia.

Twenty-six electricity distribution and transmission and gas distribution network companies are members of ENA.

Energy Networks Association

- Energy networks are the lower pressure **gas pipes** and low, medium and high voltage **electricity lines** that transmit and distribute gas and electricity from energy transmission systems directly **to the doorsteps of energy customers.**
- More than **$100 billion in assets and almost 15 million customer connections nationally**
- Total line length of distribution infrastructure is more than 900 000 km
- Key focus areas include:
  - the national and state government **policy and regulatory** environments
  - key technical issues such as network **safety and security of supply, skills and training, reliability and power quality and energy efficiency**.

The traditional energy supply chain…

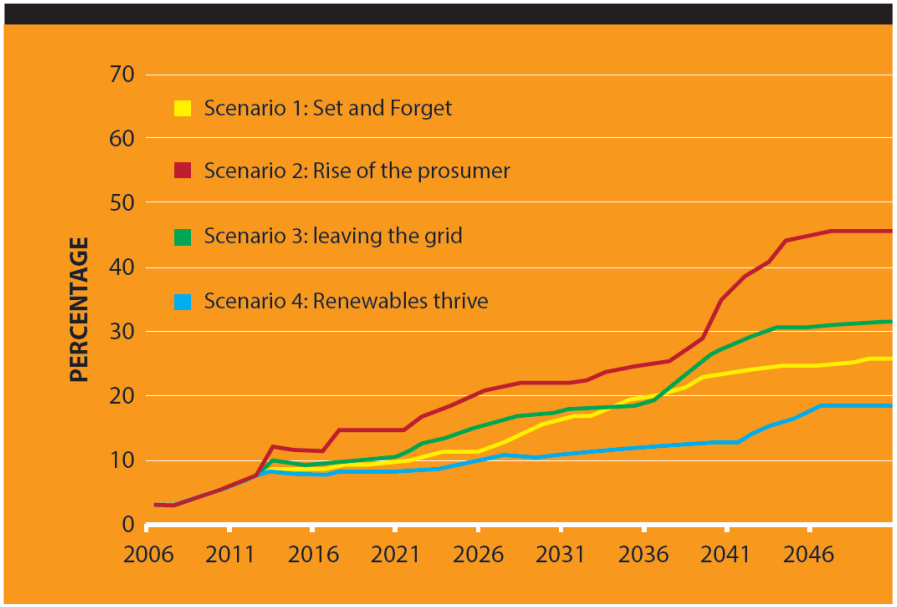


Source: AEMC

Generation Transport Consumption

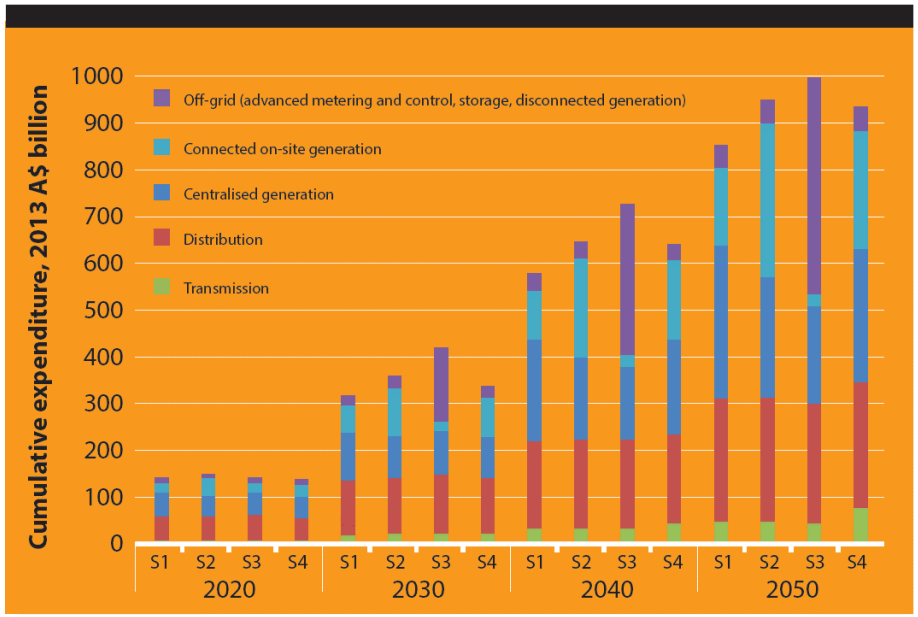
Australia's Great Energy Disruption

FIGURE 1: PROJECTED SHARE OF ELECTRICITY DELIVERED FROM ONSITE GENERATION



Data sourced from 'Change and Choice' Figure 16, p. 34

FIGURE 2: PROJECTED CUMULATIVE SYSTEM COST BY 2050



Data sourced from 'Change and Choice' Figure 23, p. 44

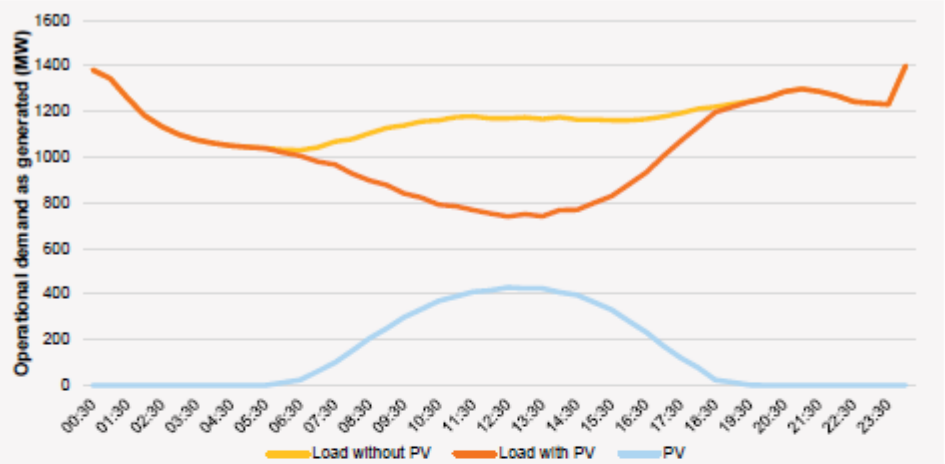
While future scenarios are diverse, all scenarios will include increased PV, EV, batteries and customers exercising choice.

https://publications.csiro.au/rpr/download?pid=csiro:EP1312486&dsid=DS13

Upending our Energy System

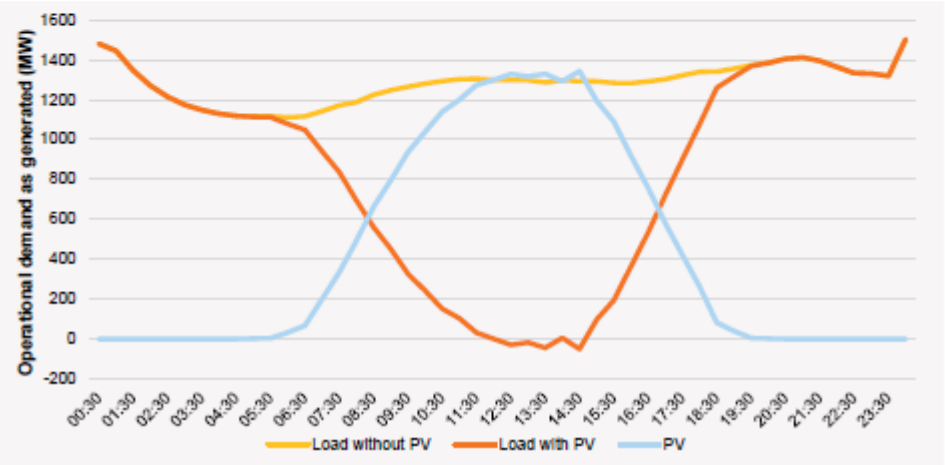
- AEMO: Solar PV capacity to increase 500% to 2035
  - Output ranging from 9.3% (NSW) to 28% (SA) of Energy
  - Shifting peak to 7.30pm in SA and Qld

Figure 38 2014-15 summer 90% POE minimum demand load profile for South Australia



- Within 10 years, Solar PV output could exceed minimum demand in South Australia

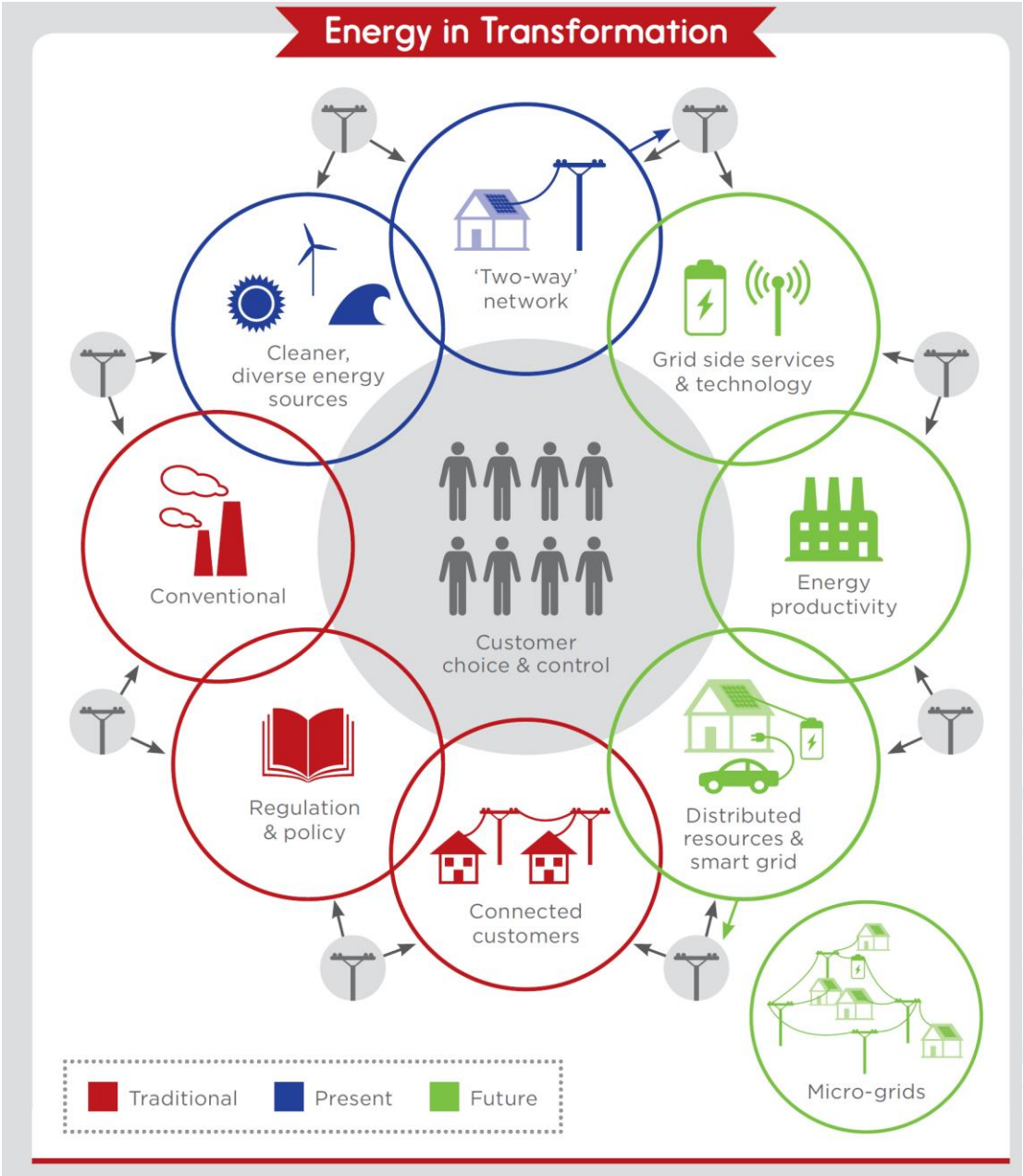
Figure 39 2024-25 summer 90% POE minimum demand load profile for South Australia



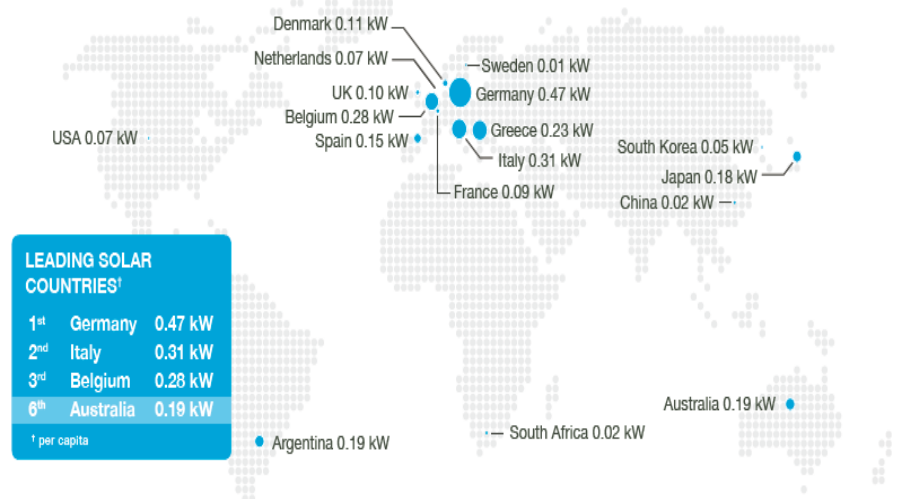
Technology is disrupting the traditional Energy business model

In many aspects the pace of change in Australia is ahead of other countries

Australian Energy businesses must act now



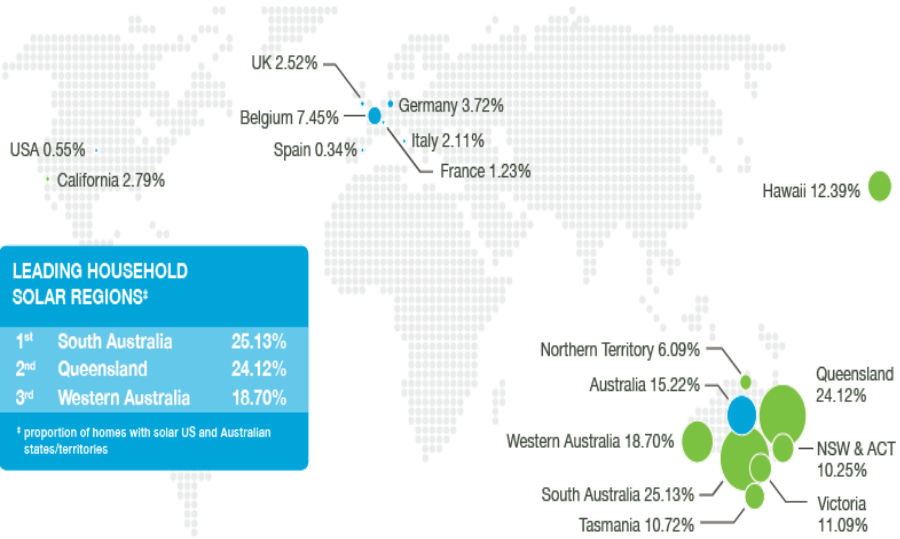
Australia leads the world in the penetration of household solar PV



LEADING SOLAR COUNTRIES†

1st	Germany	0.47 kW
2nd	Italy	0.31 kW
3rd	Belgium	0.28 kW
6th	Australia	0.19 kW

† per capita



LEADING HOUSEHOLD SOLAR REGIONS‡

1st	South Australia	25.13%
2nd	Queensland	24.12%
3rd	Western Australia	18.70%

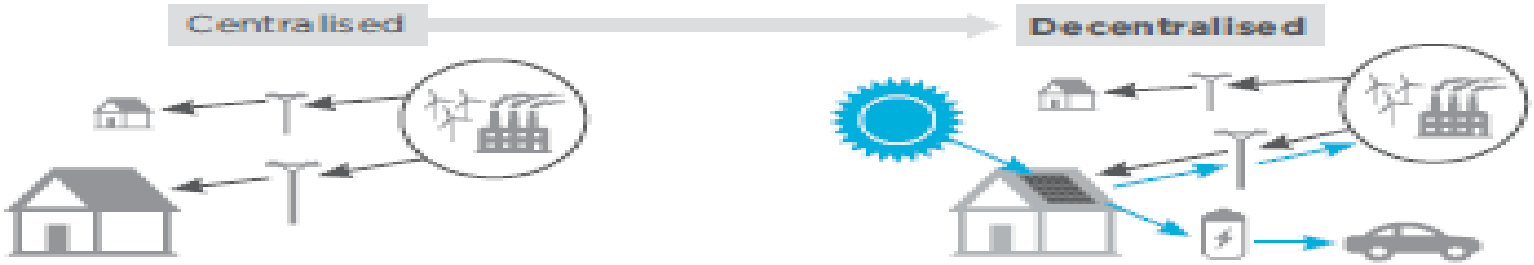
‡ proportion of homes with solar US and Australian states/territories

Germany has the highest solar generation per capita (0.47kW). Only 3.72% of dwellings have rooftop solar.

By contrast, Australia places 6th on the solar generation per capita league table (0.19kW); and has the highest penetration of household PV.

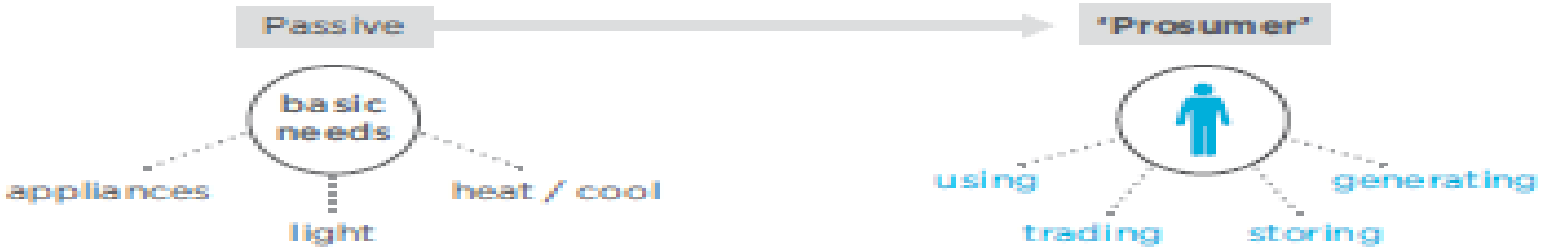
Australia has significant untapped potential for grid scale PV.

Decentralisation



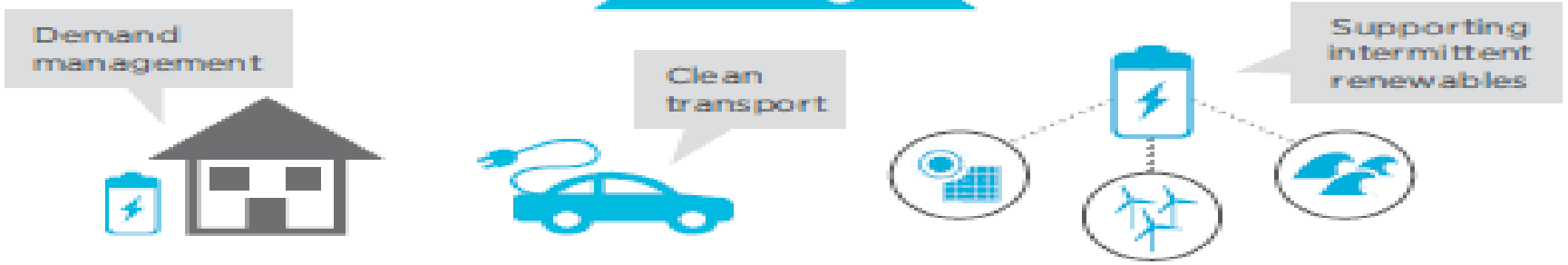
Transition from a one way, centralised system, to a two way, more decentralised system

Customer Expectations



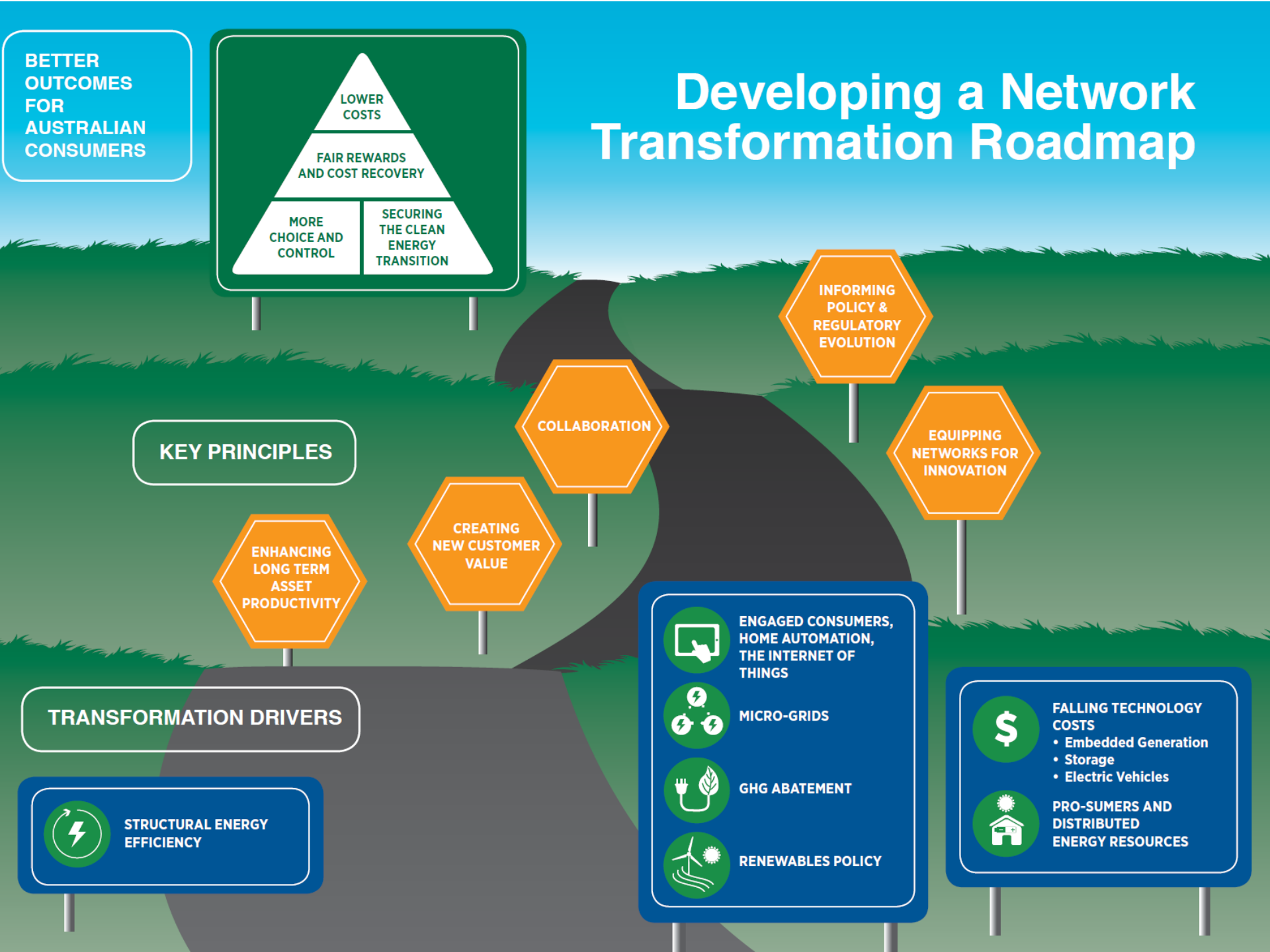
Expectations are changing for many customers

Storage



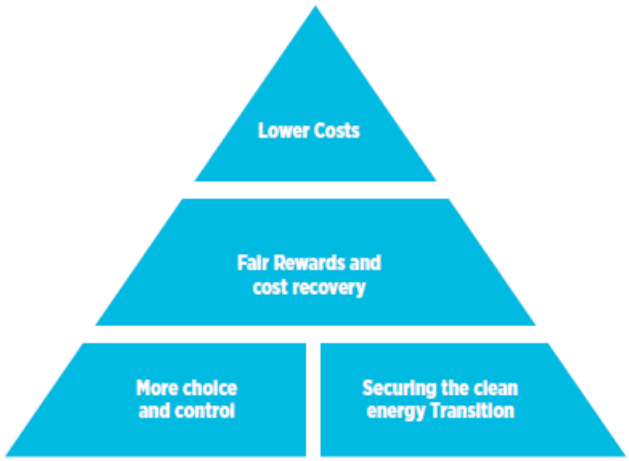
Storage is becoming more affordable and has many possible applications

Developing a Network Transformation Roadmap



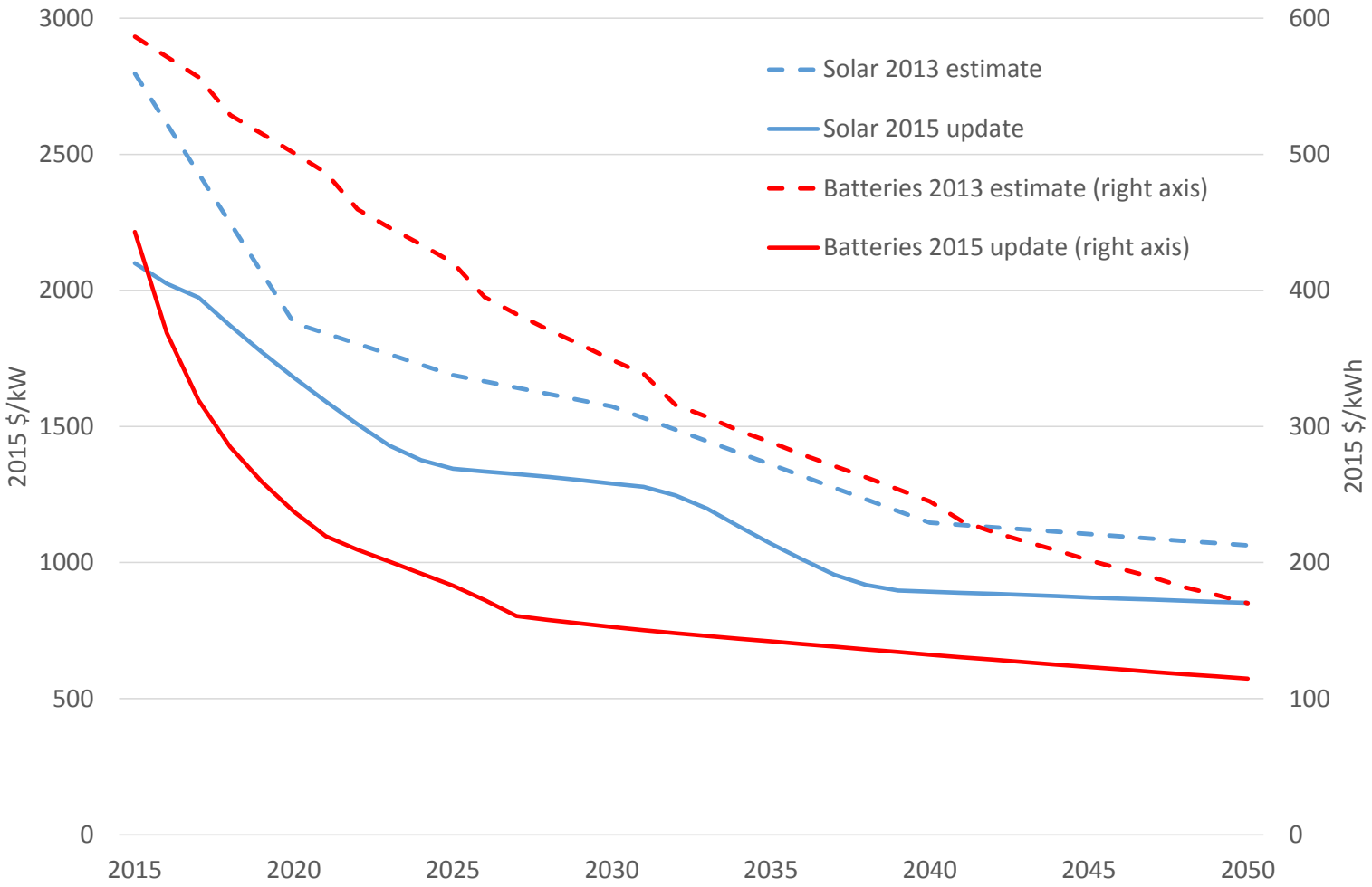
Balanced Scorecard for Consumer Outcomes

- There are many ways that Australia's energy future may unfold. The Roadmap Program has been initiated because **some potential futures will produce demonstrably better customer and societal outcomes compared to others**.
- Many aspects of long-term transition cannot be planned and will depend on the varied forces of innovation, disruption and vibrant competition. The Roadmap seeks to foster an operating environment where Australia's energy system gives greatest priority to serving diverse and evolving customer needs.
- Whether some customers become highly engaged in their electricity solutions and others retain a low level of engagement, it is likely that Australians will continue to place a high priority on electricity solutions which are safe, reliable, affordable and sustainable.
- In the future, network customers are also increasingly likely to have a voice in a 'negotiated service' outcome including consideration of some service features that have traditionally been standardised, like reliability of supply for example.



Updated Future Grid Forum scenario analysis

The key transformation drivers – competitive on-site generation and storage – have each strengthened their competitive position since 2013 by about 20%

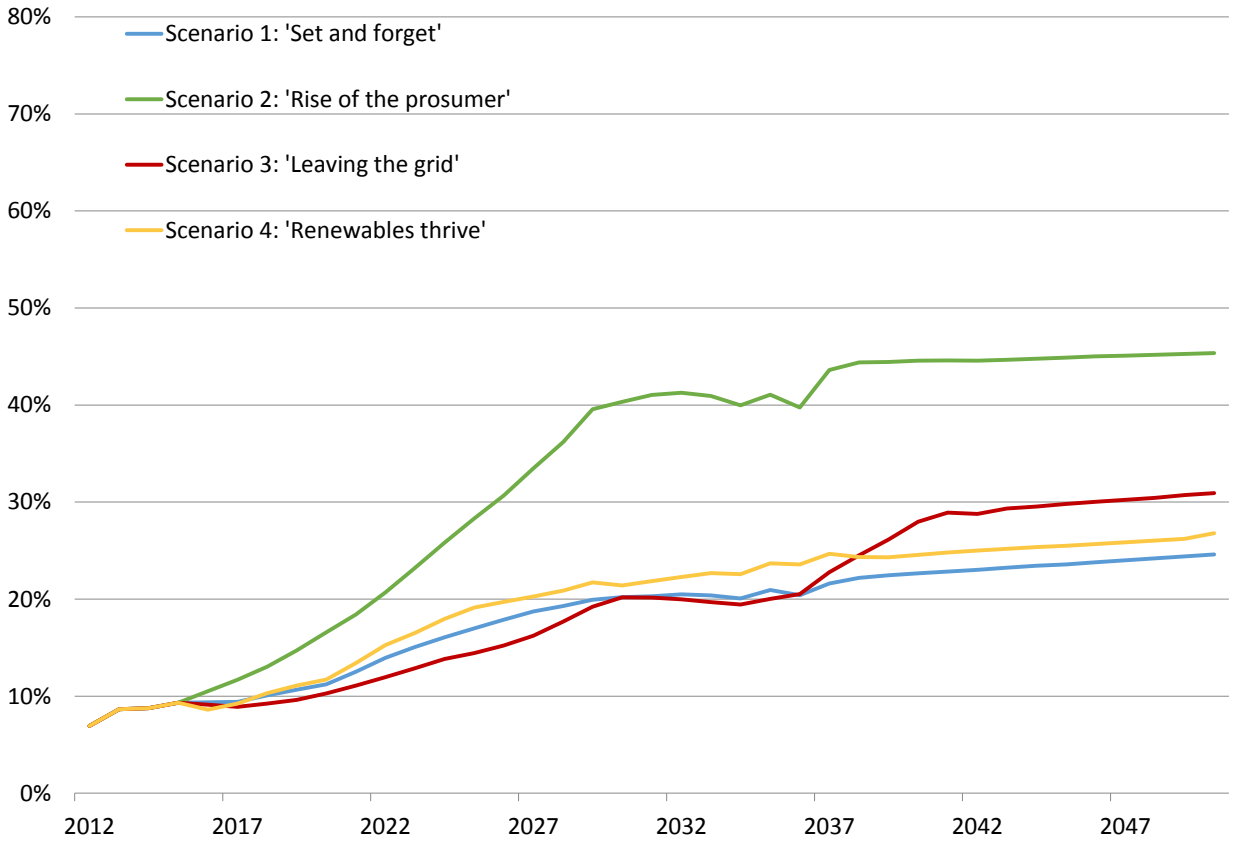


Updated Future Grid Forum scenario analysis

Two (of four) key Findings:

- Australia faces a broad spectrum of potential energy futures which vary greatly in the take-up of new technology, levels of centralisation and mode of customer engagement.
- Solar PV take-up is dominating embedded generation and tracking to the high end of the 2013 projected share.

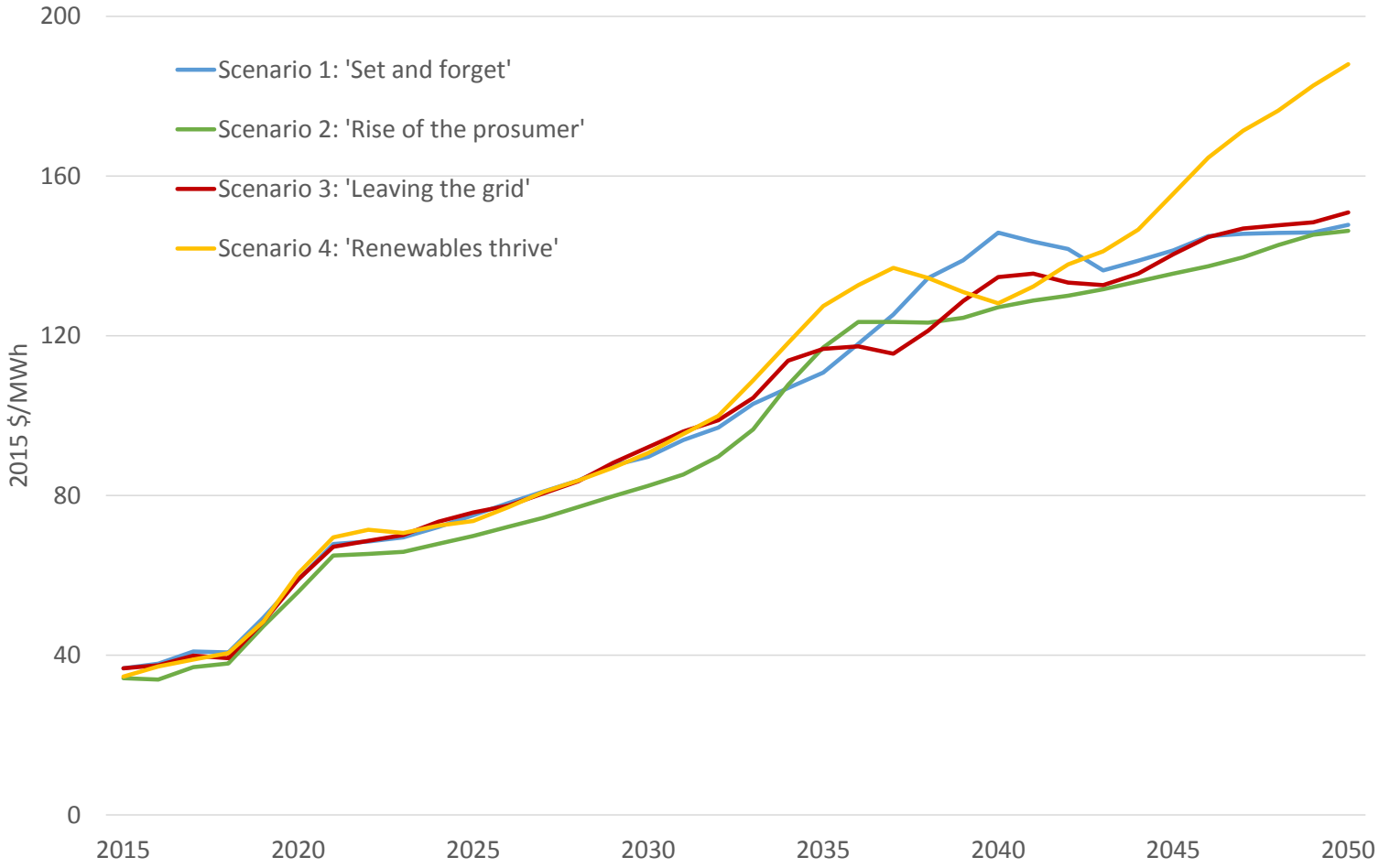
Projected share of distributed generation (mostly rooftop solar PV systems) by scenario



Updated Future Grid Forum scenario analysis

Generation sector prices:

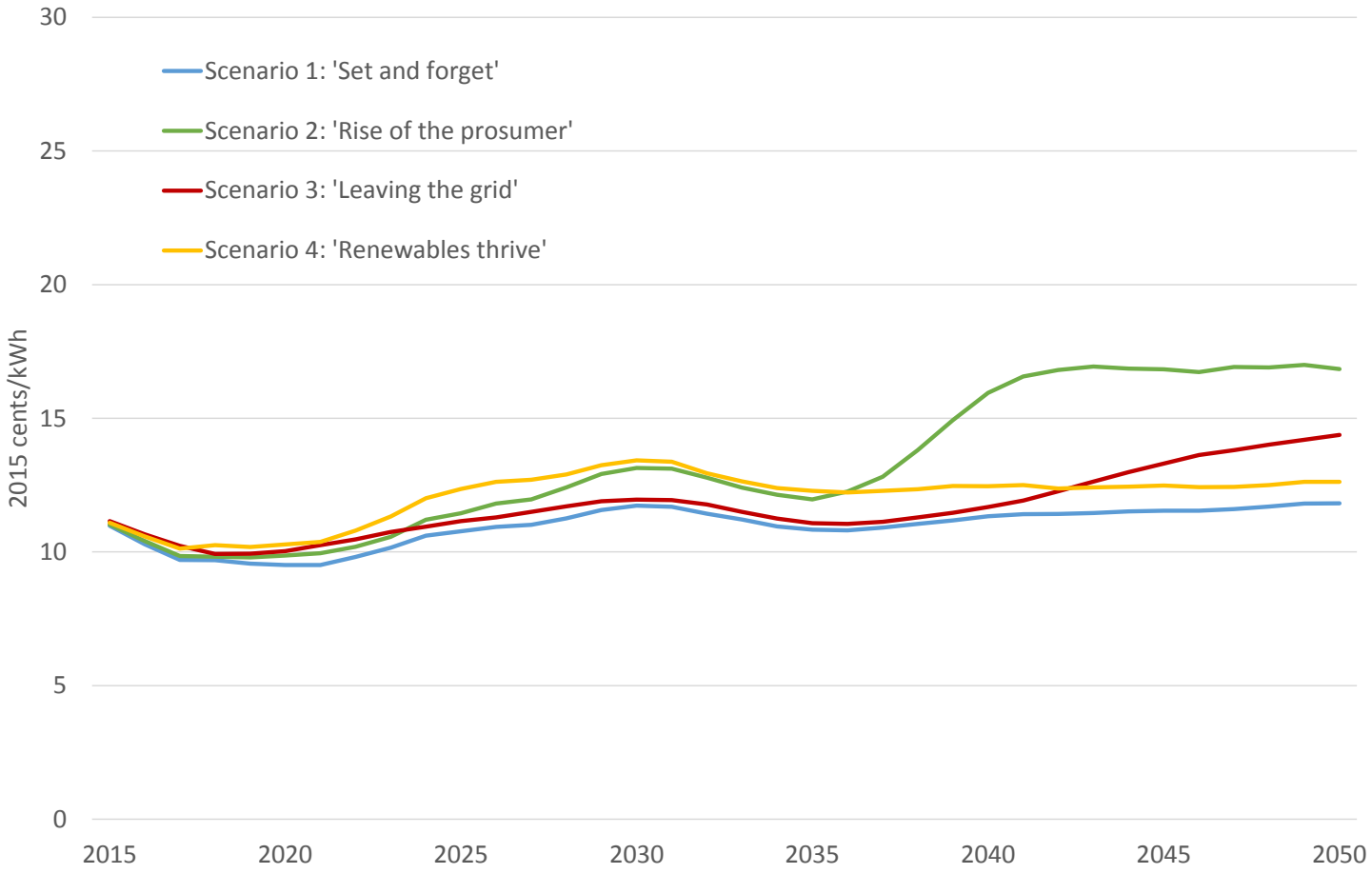
- We assume GHG abatement policy mechanisms settle and strengthen from 2020
- Costs are based on similar carbon price level to 2013 modelling, but updated generation costs from APGT2015



Updated Future Grid Forum scenario analysis

Distribution sector prices:

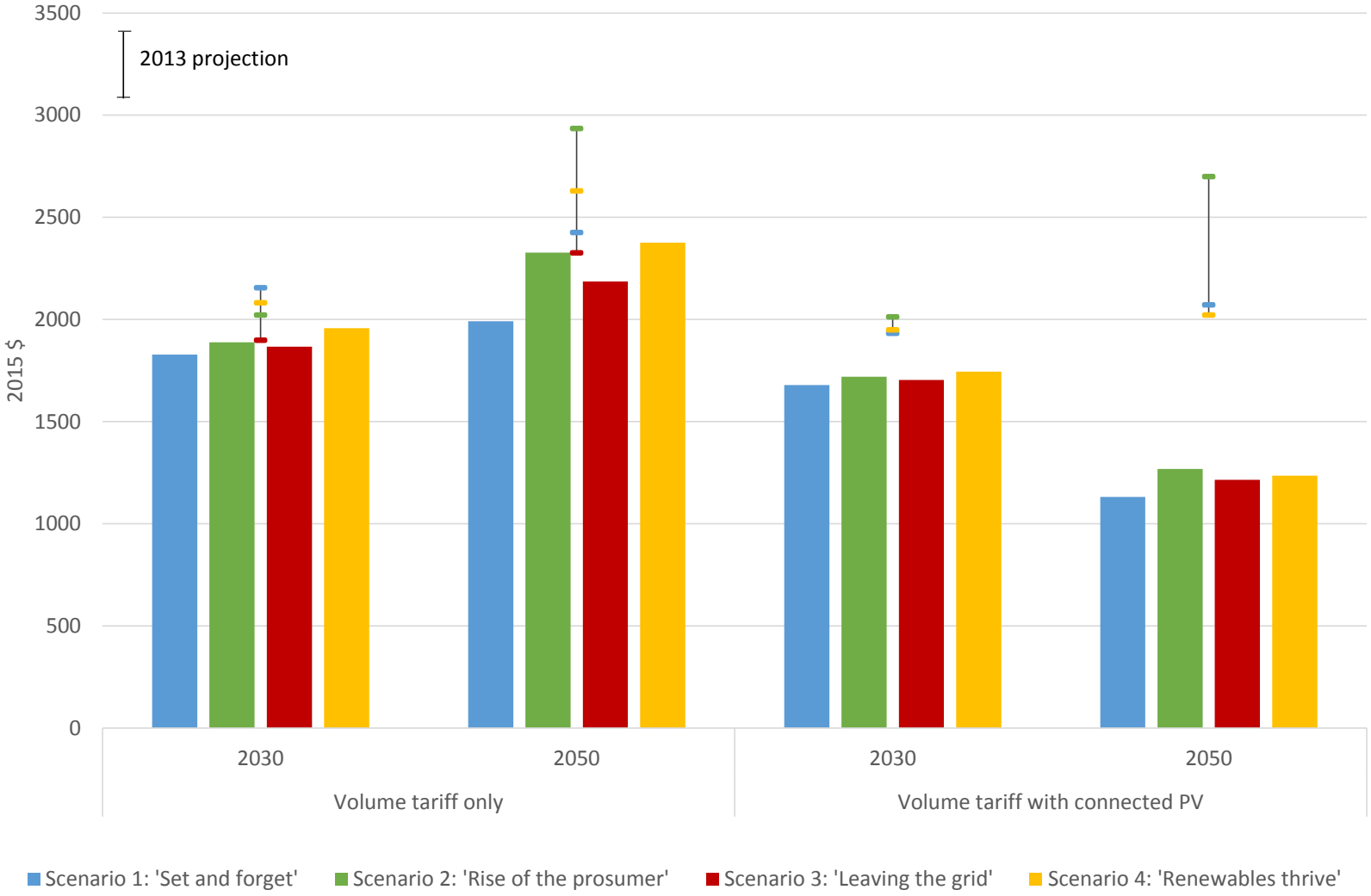
- We have a similar level of on-site generation to 2013 but demand management is stronger, mainly due to greater confidence in what battery storage might be achieve (together with incentive environment)
- Overall a much flatter profile



Updated Future Grid Forum scenario analysis

Third key finding

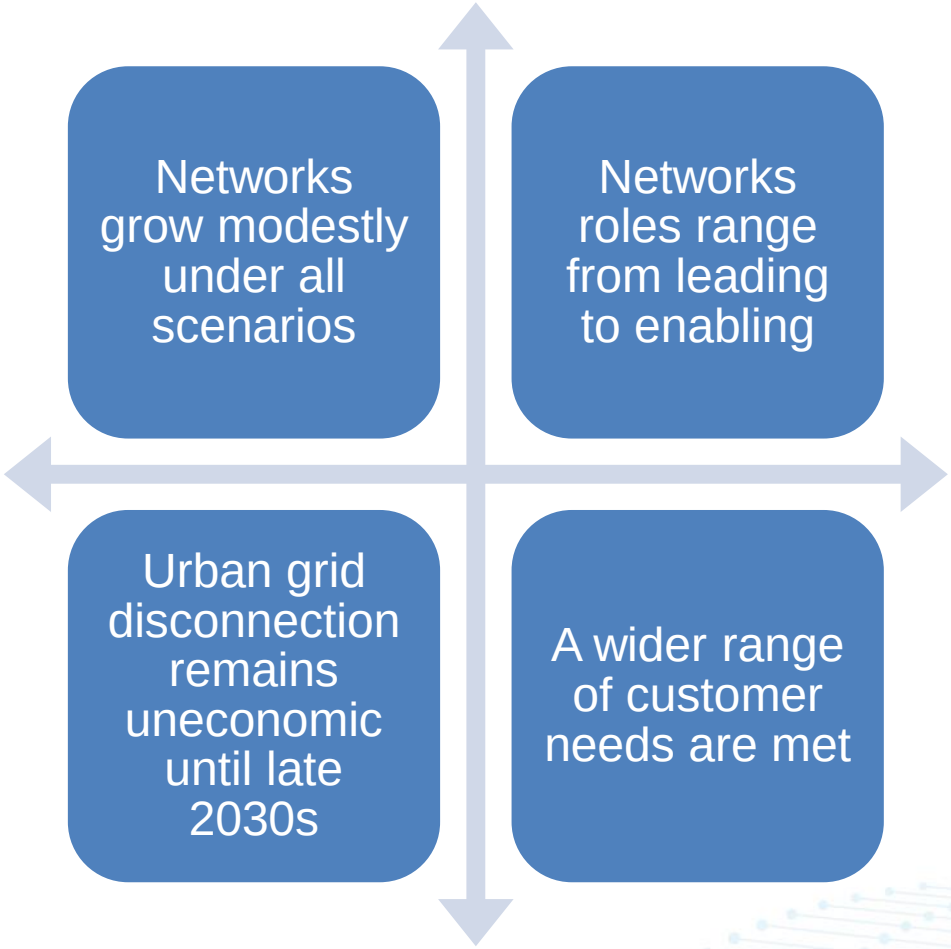
- Residential customer bills outcomes are slightly lower than forecast in 2013.



Updated Future Grid Forum scenario analysis

Fourth key finding

- The updated scenarios continue to reflect electricity networks performing an evolving range of critical roles by 2050 supporting diverse energy use and services for customers



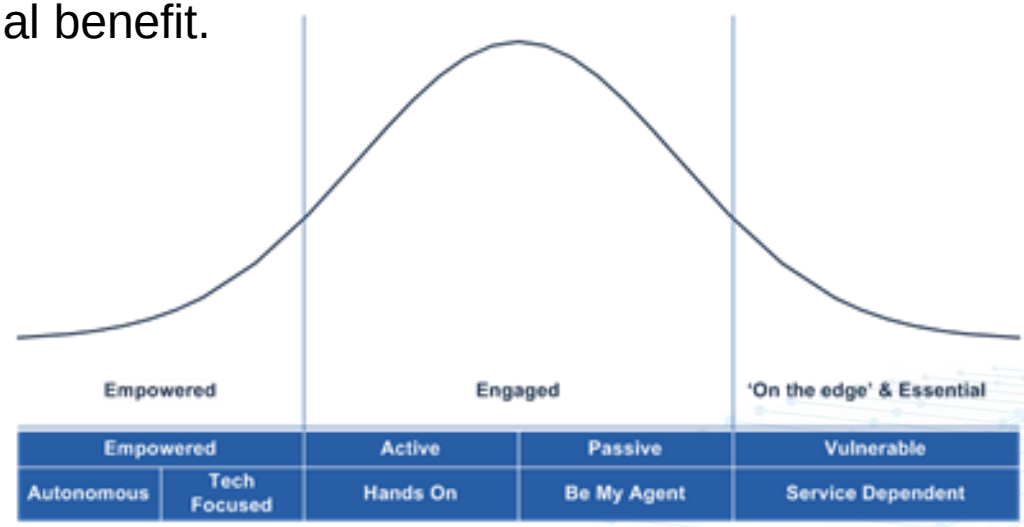
Customer-orientation of Networks

- Future electricity customers are expected to be increasingly heterogeneous in their expectations across a broad ***vulnerable—engaged—empowered* spectrum** of market segments.

- Diverse future customers are likely to:

  – Continue to value solutions that provide **secure and reliable** electricity for an increasingly digitized and automated lifestyle and the expanding role of electric vehicles; and,

  – Some customers will be **willing to trade-off** aspects of service features that have traditionally been standardised in return for a financial benefit.



Prospective 2025 Market Segments - Residential

Segment	Empowered		Engaged		Vulnerable
	Autonomous	Tech focused	Hands on (Active)	Be my agent (Passive)	Service dependent
Descriptor desires and needs	Independent: Desires complete control and highly granular cost management Can sometimes be motivated by cost or reliability reasons In many cases may leave the grid	Empowered: Affinity with technology and high desire to be in control – cost is important and customer needs to see return on investment Able to interact with market and buy/sell energy	Active: Pushes for more information and options to reduce cost and enhance levels of control – control leads to cost savings	Passive: Desires ease and convenience from energy services, reduced cost and some access to data/information Will invest in cost saving measures if easy A portion value time and convenience over cost	Dependent: Needs affordable network services May also include customers who are unable to choose to adopt new services or products because of agency/split incentive barriers – for example renters, or those with a lack of access to capital

Prospective 2025 Market Segments – Comm & Ind

	Autonomous	Active	Passive	Vulnerable
Focus on energy	High	Medium/High	Low	High/Medium
Ability to act	High	Medium	Medium	Low
Descriptor	I want to act and I can		I don't need to act	I need to act but can't
	Highly empowered set of business customers who will be very interested in how technology can reduce their costs, improve their green image or improve operational efficiency Heavily focused on innovation and environment. They will seek highly configured and customised solutions and will spend more effort in research/engaging with complicated price structures or solutions	In Control: Highly engaged and motivated to maximise savings and efficiency by engaging more with the energy system. This group is likely to be large Willing to invest in technologies and accept a higher level of complexity, so long as they can offset the additional time and (potentially) investment with a positive return on their investment, reflected either in ongoing cost savings and/or a positive environmental impact	Extremely busy customers and have little time to understand their energy costs or needs Any extra complexity is a challenge for these end-users, who are busy maintaining or growing their business Require a simple set of solutions that take the worry and effort (time to manage, risk of interruption, potential cost savings or loss) out of energy – will remain largely passive to the energy system	Service dependent customers who are highly dependent on grid supply to keep their business running Need help because they are unable to engage with new technologies or offers and will have a high level of cost sensitivity Want to concentrate on running their business and keeping solvent, and increased energy costs or complexity are a barrier Like residential

Customer-orientation of Networks

- Future market segments are not perfect ‘predictions’ of customers in 2025 but do enable **future strategic options** to be explored in detail

- An increasingly competitive operating environment means that a strong customer orientation will be vital for network businesses and their ‘value-network’ partners to:

  – **Comprehend and anticipate** changing customer expectations;

  – Optimise existing services to foster **social license**, **trust** and **loyalty**; and,

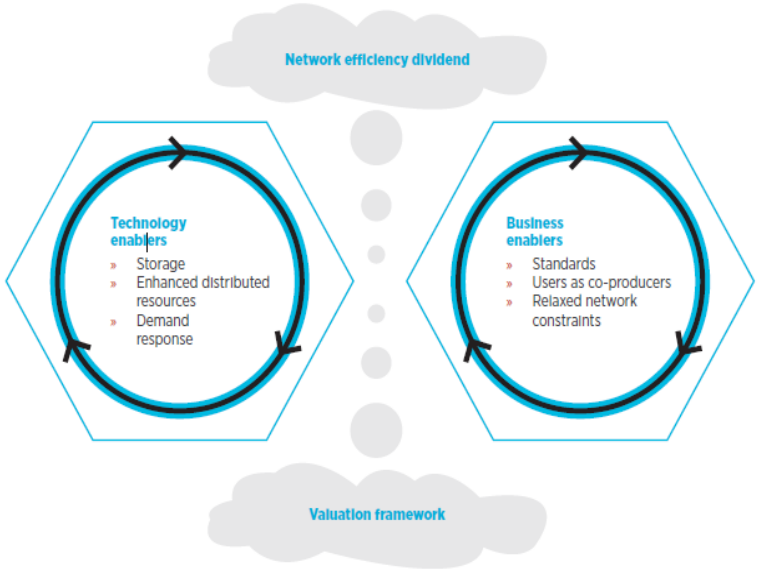
  – **Innovate new electricity solutions** and **business models**, often in concert with value network partners.

Challenges and Opportunities of Distributed Energy Resources

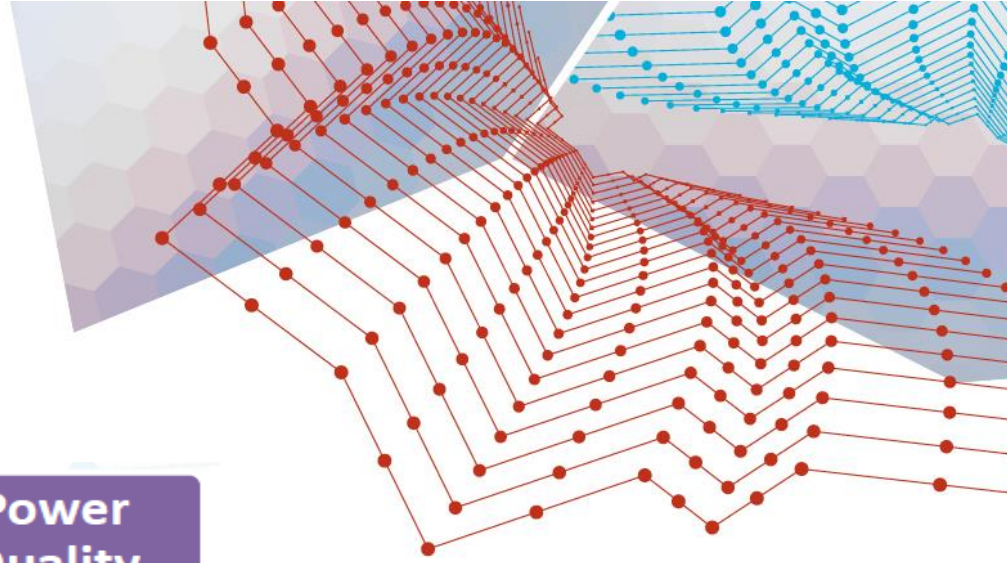
Integration of Distributed Energy Resources requires a careful operational response to challenges such as voltage management, frequency regulation and network stability.

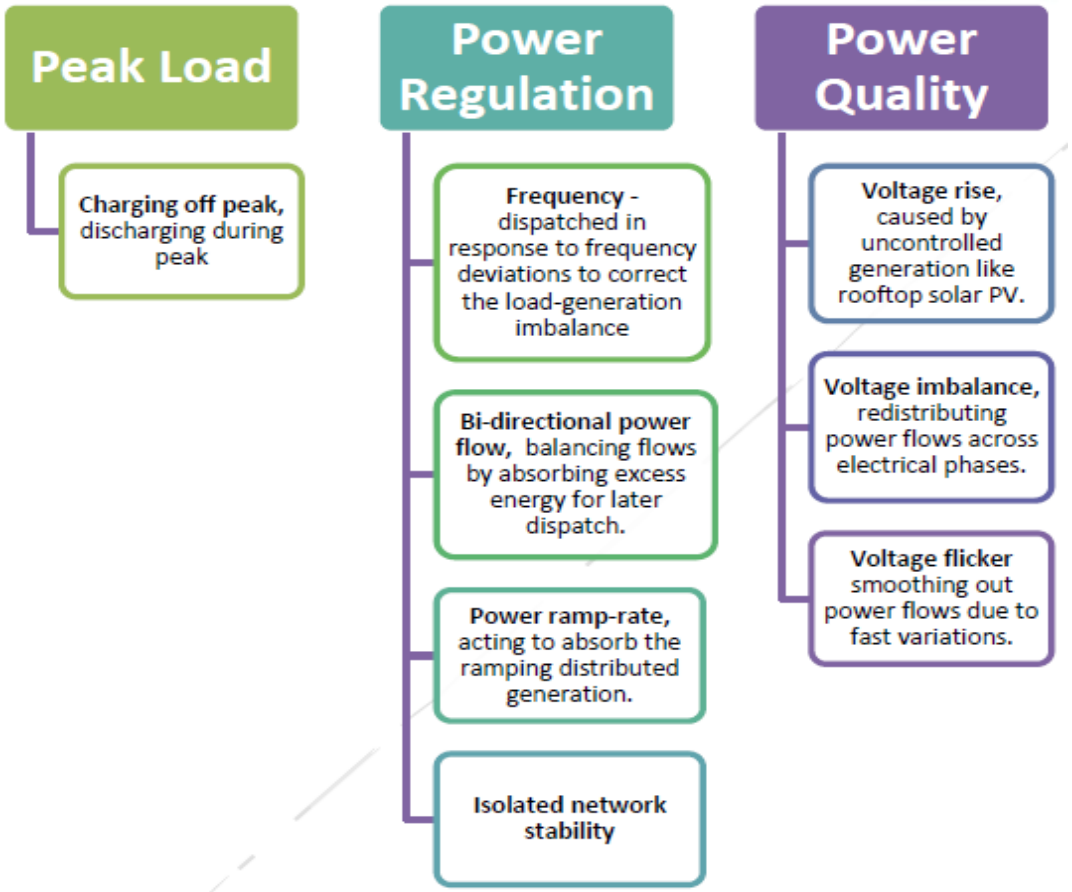
However, well-integrated DERs can also provide solutions for addressing these network challenges and improving network efficiency. This is likely to require:

- New regulatory frameworks;
- Enhanced standards; and
- Commercial responses which unlock the potential of energy storage, demand response services and power electronics solutions.



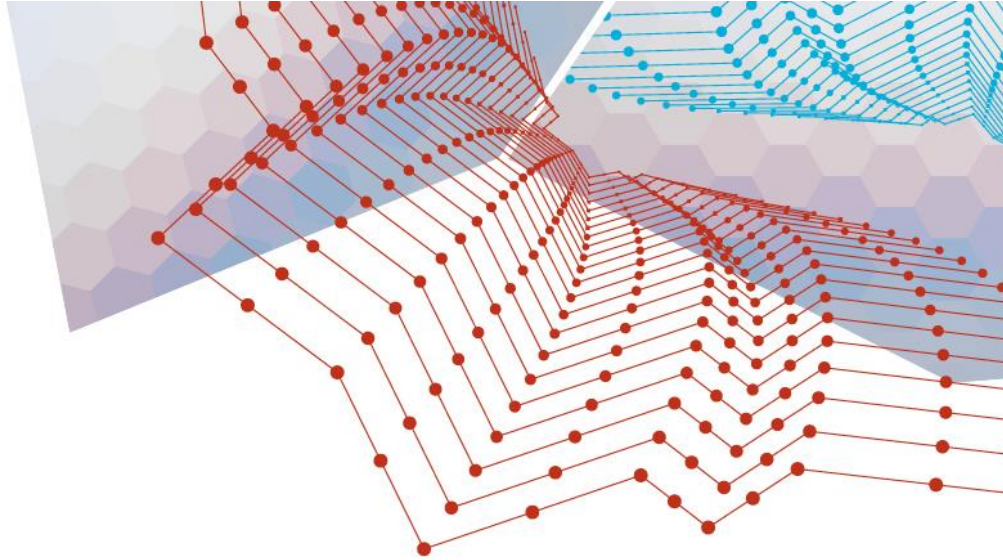
Key Findings - The key role of Energy Storage in integrating Distributed Energy Resources





Energy storage, in its many forms, is an incredibly versatile distributed energy resource. Storage can help to manage a large variety of challenges relating to the existing grid, and mitigate many of the additional challenges from the increasing penetration of distributed energy resources.

Key Findings - Other Integration Tools



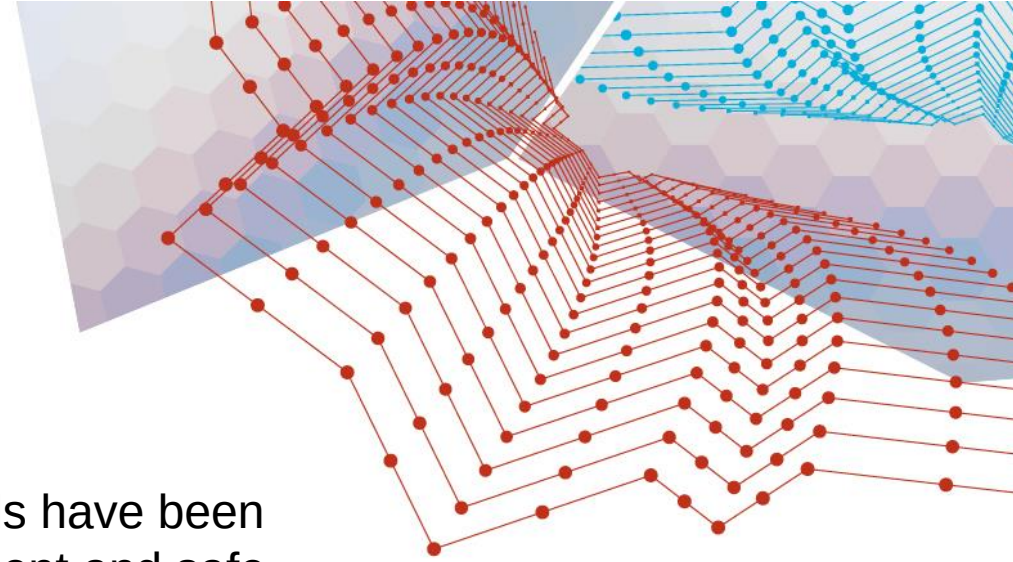
Intelligent Distributed Resources:

Distributed energy resources, such as rooftop solar PV systems and embedded/distributed wind turbines, are already reducing customers' electricity bills and providing significant benefits and cost savings to energy networks. The addition of smarter control, better storage, or both, enhances these benefits to improve power quality and increase reliability. Some key opportunities include:

- Smart Energy Resources such as power electronics
- Voltage Control

Adaptive Systems – Demand Response and Prediction: are critical to predicting and controlling network loads in the integrated grid. If enabled appropriately, they can bring multiple benefits to both networks and customers.

Key Findings - Standards

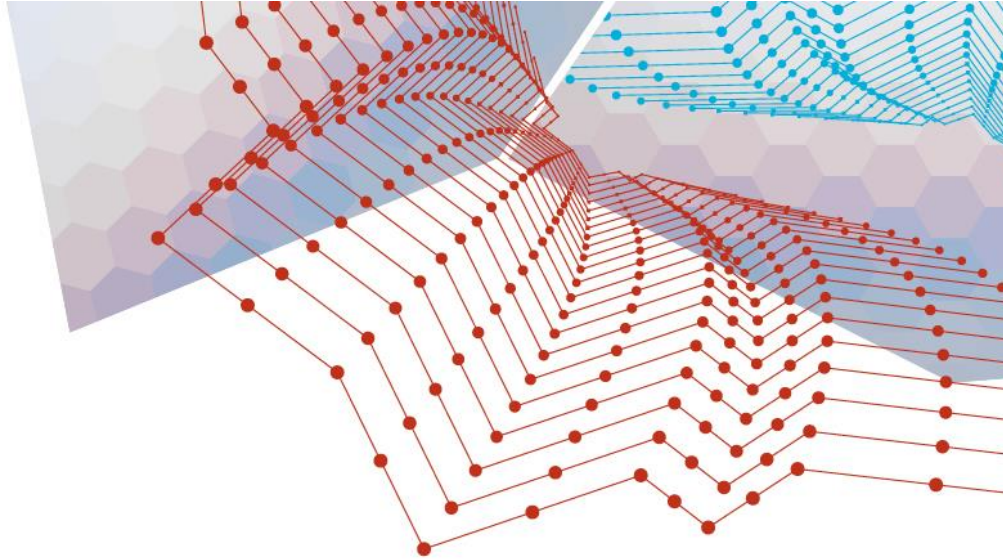


Advances in Standards:

A number of new technical standards have been identified that are critical to the efficient and safe deployment of technology enablers of the integrated grid. These include:

- Storage Safety Standards
- Electric Vehicle Standards
- Inverter Standards
- Protection Relay standards
- Smart Meter Standards

Key Findings – EG Report



Customers can become active participants in a cooperative structure under which their distributed energy resources (typically solar PV and storage) are integrated to maximise the value of electricity services for all participants.

Network service providers are well placed for coordinating the integration of distributed energy resources into the electricity grid in a way that maximises performance and shared benefits for all customers.

New Operating Principles for Progressive Business Models

Future Business Model Progressive principles:

- Being able to integrate all types of generation.
- Enabling consumers to provide services back to the grid.
- Offering enhanced or optional services, such as microgrid services and other DER support services.
- Being agnostic about supply.
- Facilitating a retail market for consumers and third-party providers to buy and sell services.

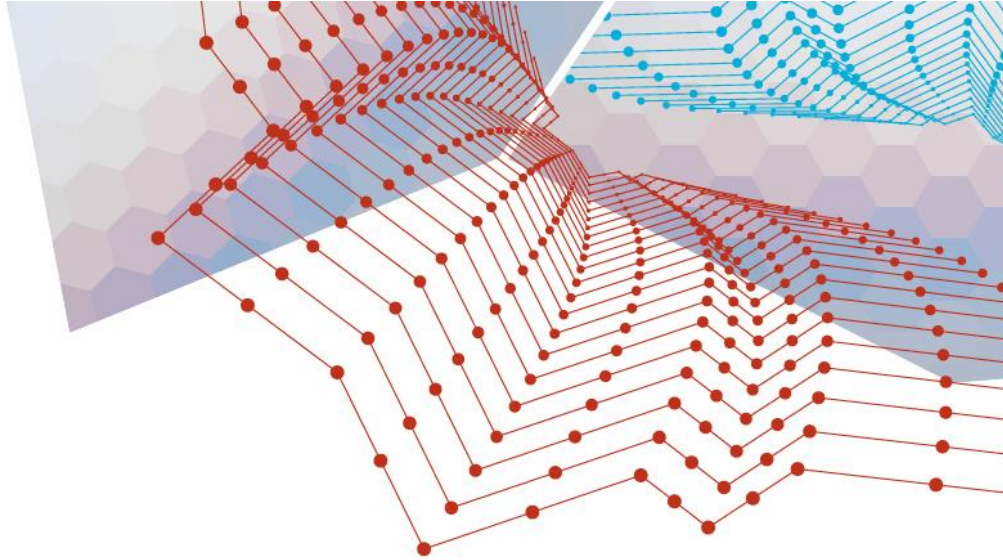
Foundational operating principles for the traditional grid model

Maintaining a safe and reliable grid	**Increasing grid efficiency**	**Optimizing asset utilisation**	**Support / implement public policies**	**Highly reliable & resilient energy services**	**Identify most cost-effective ways of achieving outcomes**

Effective Tariffs and Incentives

'First Wave' reform from 2017 – NSPs meet their universal responsibility to all customer segments improve fairness and efficiency.

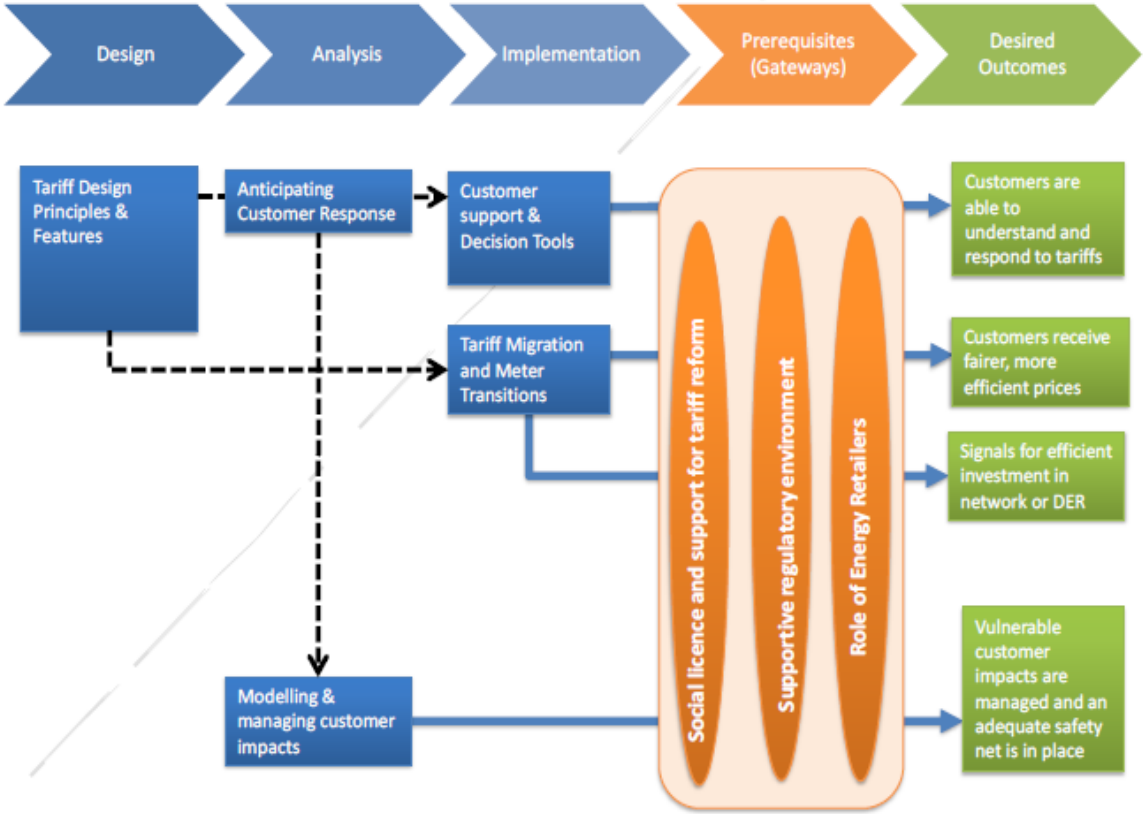
'Second Wave' may see customers participate in new pricing options or markets, which are likely to be location-specific and dynamic in real time.



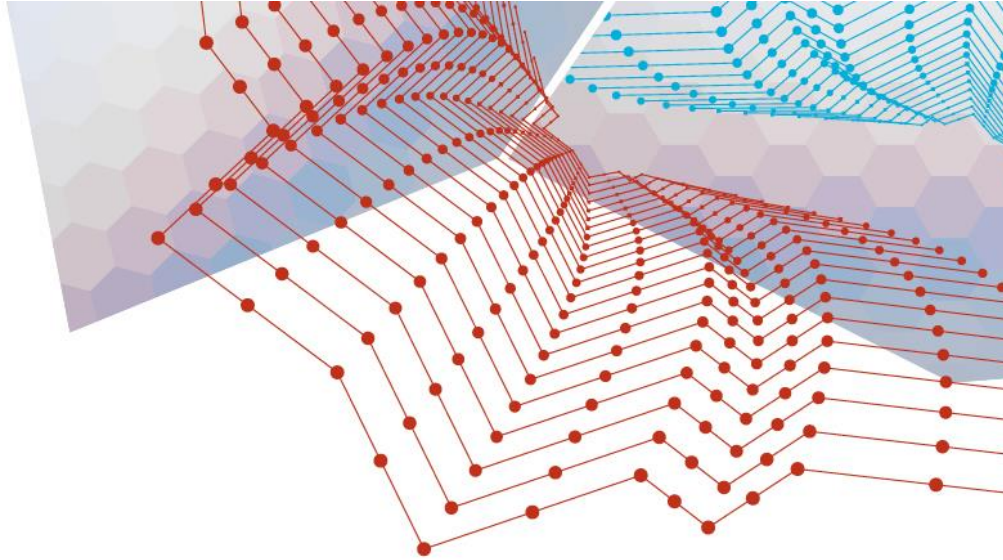
First wave			Second wave
Highly volumetric tariffs Fixed | Usage (c/kWh)	**Improved fixed cost recovery** Fixed | Usage (c/kWh)	**Demand based tariffs** Fixed | Usage | Demand (c/kW)	**First Wave Reform PLUS** **Voluntary, localised Pricing options** + Demand management storage tariff + Back up supply charges + Critical Peak Pricing + Peak Time Rebates **Voluntary incentive (payment) options** + embedded generation incentives, credits or feed in tariffs + ancillary services payments
✗ Significant cross-subsidies between consumers ✗ Technology takeup (air-conditioning, solar, storage) driven partly by cost-shifting ✗ No reward to shift consumption off-peak ✗ No 'locational' reward to customers to reduce network costs (through demand management or embedded generation) ✗ No incentive for new energy markets and services	✓ Reduced cross-subsidies between consumers ✓ Reduced incentive for technology takeup (air-conditioning, solar, storage) to be driven by cost-shifting ✗ No reward to shift consumption off-peak ✗ No 'locational' reward to customers to reduce network costs (through demand management or embedded generation) ✗ No incentive for new energy markets and services	✓ Minimises cross-subsidies based on customer use of the network ✓ Economic incentives for technology take-up based on contribution to avoided network costs ✓ Reward to shift consumption off-peak ✗ No 'locational' reward to customers to reduce network costs (through demand management or embedded generation) o Some incentive for new energy markets and services	✓ Minimises cross-subsidies based on customer use of the network ✓ Economic incentives for technology takeup based on contribution to avoided network costs ✓ Reward to shift consumption off-peak ✓ 'Locational' reward to customers to reduce network costs (through demand management or embedded generation) ✓ Incentives for new energy markets and services

Effective Tariffs and Incentives

ENA's forthcoming network tariff reform guideline supports a national, collaborative and integrated approach to reform, with a range of stakeholder engagement.



Australia's energy regulatory framework



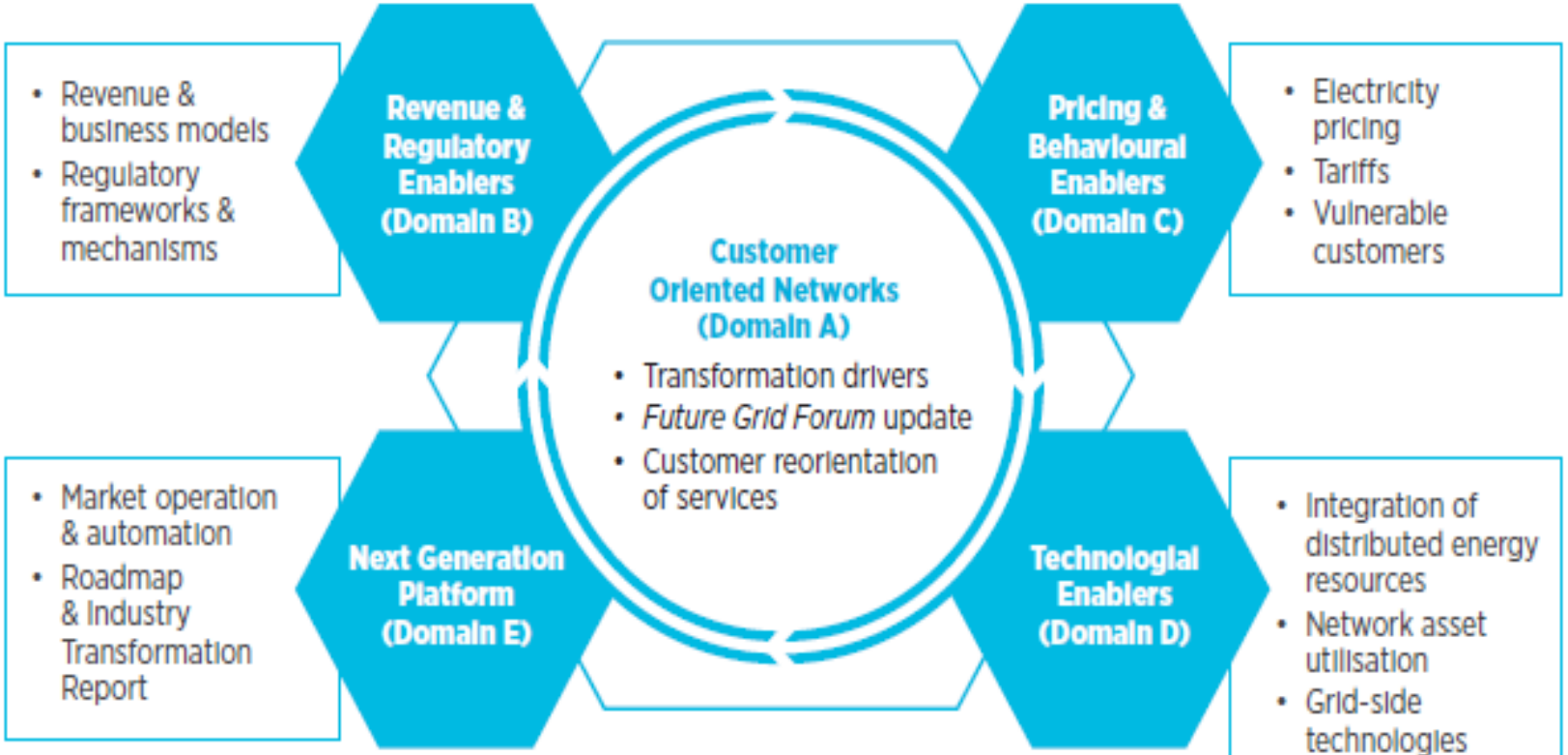
Key elements of Australia's energy regulatory framework are robust, however a managed – rather than ad hoc - approach to regulatory reform is required to support:

- flexibility and innovation;
- the introduction of contestability;
- new approaches to risk allocation; and
- the transition to more fit-for-purpose regulation.

Stage 2 of the Network Transformation Roadmap is expected to include:

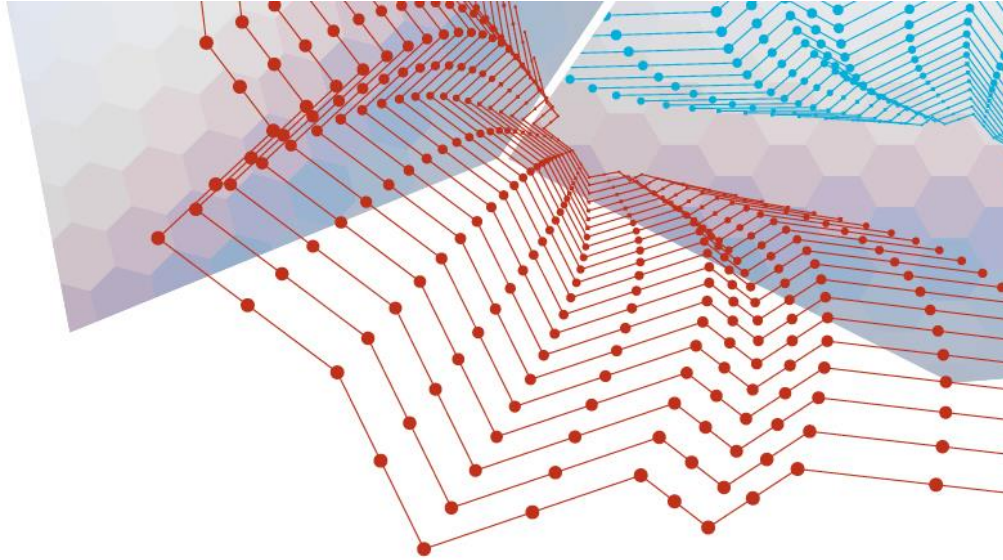
- Consideration of options exploring how best to structure and deliver universal service obligations in a disrupted or transformed energy market
- Detailing ways to transition to new forms of regulation, and moving to reliance on greater competition for network and energy services
- An evaluation of regulatory approaches to drive innovation and new technologies through the grid

Stage 2 Overview



Major Additions to Domain D for Stage 2:

- **Microgrids:** emulation, delivery models, operations and regulatory frameworks.
- **Power Systems Stability and Reliability:** high penetration of renewables scenarios, transmission level system reliability, ancillary services and potential commercial, technical and regulatory requirements



Thank You !!!