Modernising Australia's Electricity Grid

Submission to House of Representatives Standing Committee on the Environment and Energy – April 2017

Energy Networks Australia

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Overview

Energy Networks Australia welcomes this opportunity to make a submission in response to the House of Representatives Standing Committee on the Environment and Energy's new inquiry into 'Modernising Australia's Electricity Grid'.

Energy Networks Australia is the national industry body representing businesses operating Australia's electricity transmission and distribution and gas distribution networks. Member businesses of Energy Networks Australia provide energy to virtually every household and business in Australia.

Australia's transmission and distribution network infrastructure represents the most significant element of the electricity supply chain by value and extent, with over 900,000 kilometres of "wires" and billions of dollars of supporting infrastructure across the National Electricity Market (NEM) ensuring safe, reliable supply of energy to support the Australian economy and the everyday lifestyle of individuals.

Our submission has addressed the specific questions in the consultation paper. The key themes of our submission include:

1. **Improved governance and coordinated policy and regulatory frameworks are the most significant opportunities -** the current governance framework is not delivering on timely implementation of agreed reform. The policy and regulatory frameworks have significant strengths, but contradictory national/state policies or reform programs are straining the capacity of participants to deliver better outcomes in an agile manner.

2. **Technology neutrality and flexibility, rather than prescription and 'picking winners', will deliver better outcomes –** while pilots, trials and demonstration projects have a role to play, the goal should be a stable policy and regulatory framework that delivers the right solutions, in the right places, at the right times. Due to the diversity of Australian grid infrastructure, this will be different in different places.

3. **Getting incentives right and implementing network pricing reform can lower costs of current and future customers** - implemented well, incentives and pricing reforms can deliver a sustainable grid in which networks efficiently orchestrate and purchase grid services from customers. Pricing reform is also important fairer customer outcomes.

4. **Network regulatory frameworks will need evolution to meet customer needs -** The current network regulatory framework has significant strengths, such as providing access to low cost capital to meet future investment needs. There are aspects of the framework, however, that need to evolve to meet the needs of future customers, including putting the customer at the centre of the

regulatory process, new approaches to incentives, output-based regulation and ‘Totex’ expenditure decisions.

5. **Australia is at the leading edge of the transforming grid and the CSIRO and Energy Networks Australia have collaborated with key stakeholders to identify pathways for cost-efficient grid modernisation that will benefit customers.** The Network Transformation Roadmap has identified a range of sequenced activities in policy, regulation, intelligent grid systems, standards, markets and pricing reform, to help meet the grid modernisation challenge.

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1. *"The means by which a modern electricity transmission and distribution network can be expected to ensure a secure and sustainable supply of electricity at the lowest possible cost."*

General Comments

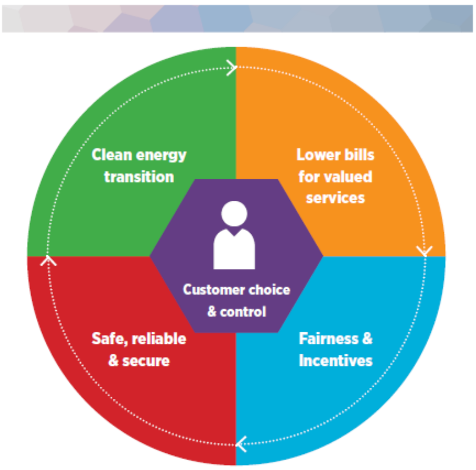
Australia's electricity system is changing at an unprecedented scale. The transformation is driven by customers, as they embrace new technologies, take control of their energy use and support action on climate change.

Australians are installing rooftop solar at world leading rates. Energy Networks Australia and CSIRO analysis estimates that customers - not utilities - will determine over $200 billion in system expenditure by 2050. The full value of these customer installed energy resources can only be realised through a connected future enabling multilateral exchanges of energy, information and value. This co-optimisation allows future network investments in 'poles and wires', to be lower than otherwise anticipated, while also supporting the creation of more value for customers through the platform of smarter electricity networks.

Q. 1 - How are the objectives of security, reliability, sustainability, and affordability interrelated?

The objectives listed (**Security and Reliability, Sustainability, and Affordability)** are often referred to as the 'Energy Trilemma' in recognition that that the preferred customer outcomes will rely on balance between the objectives, with no single objective dominating the others.

Figure i: Balanced Scorecard of Customer Outcomes



In the recently released *Electricity Network Transformation Roadmap* (the Roadmap), the Australia's national science agency CSIRO and Energy Networks Australia identified two additional objectives for customer outcomes in a transforming electricity system. The extent to which the system enables *'Customer choice and control'* should also be a key performance indicator, but the new flexibility provided by technology and empowered customers, also highlights the need to assess '*Fairness and Incentives*'.

A customer oriented energy transition must focus on carefully balancing key customer outcomes. The electricity system must achieve decarbonisation at least cost for customers without jeopardising power system security. Equally, it must also incentivise and enable new customer choice and control, while appropriately protecting consumers and avoiding unfair impacts on

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vulnerable customers.

There is strong consensus among stakeholders that political dispute in the sector has undermined the necessary stable and enduring policy settings required to enable better outcomes for customers. This has been evidenced by poor coordination in carbon and energy policy; inconsistent State and Federal Government frameworks; and inaction on agreed COAG Energy Council reforms.

In our view, the greatest single risk to an efficient and secure transition is conflicting government policy frameworks in a national market and a lack of regulatory cohesion. Energy Networks Australia therefore regards this inquiry as a further opportunity to reset consensus-based policy and regulation and strengthen our institutional capacity to respond to unprecedented opportunities and threats to customer outcomes.

Q. 2 - What should be the highest priority objectives of a modern grid in Australia?

We encourage the Committee to consider the analysis and conclusions of the Roadmap cited above. It sets out the prioritised Milestones and Actions to transform the Grid, identifying the timeframes for implementation by both industry and government.

The key insight is that the transformation is customer driven and neither governments and industry cannot 'command and control' outcomes during the transition and certainly not in disparate State by State approaches. The next decade will see a step change in the adoption of new technologies, including Distributed Energy Resources (DER) such as rooftop solar, energy storage and electric vehicles. With falling technology costs and significant carbon abatement objectives, there is a limited window of opportunity to reposition the electricity system to achieve balanced long-term customer outcomes.

- The agility with which ***networks can connect, integrate and incentivise*** new, lower carbon energy choices will directly influence the cost, fairness, security and reliability of customer outcomes.
- Urgent ***regulatory and policy changes*** will be required to retain power system security, while providing new benefits and savings for customers through efficient use of distributed energy resources, standalone systems and micro-grids.
- The ***timely development of technical standards, operational practices and new information platforms*** will be required to animate new distributed energy resources markets and support enhanced customer services.
- Significant efficiency gains can be made by ***optimising operations and auxiliary systems*** using more sophisticated control systems and energy-efficient equipment. This utilisation of connected devices will enable higher levels of distributed energy resources connection without compromising technical operation.

A poorly planned transition will create significant challenges to power system security affordability and achievement of carbon abatement outcomes. By contrast, there is the opportunity for the Roadmap to achieve a transformation which results in the improved operation of an integrated grid. In this future, millions of distributed energy resources interoperate effectively in the system - providing credible non-network alternatives, and can deliver equivalent firmness as would otherwise be provided by network replacement and augmentation, but at a lower cost.

The summary of the Network Transformation Roadmap is provided at Figure ii below.

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Overview of the Electricity Network Transformation Roadmap

	FOUNDATION (2017, 2018, 2019, 2020, 2021, 2022)	IMPLEMENTATION (2023, 2024, 2025, 2026, 2027, 2027+)	Overall Customer outcomes by 2027	Overall Customer outcomes by 2050
CUSTOMER ORIENTED ELECTRICITY	**Improve trust with Customers** » Enhanced customer engagement and collaboration » Customised choices, better information on services and new connection and advisory services » Demonstrate investment reflects customer value while improving service performance and response times » Review of customer protections and concessions	**Networks provide a service platform** » Open network platforms embrace diverse customer needs and aspirations » Collaborate with customers and market actors to create new value with streamlined connections » Leverage network information and digital services for personalised innovation in a dynamic market	**CUSTOMER CHOICE AND CONTROL** » Over 40% customers use onsite resources: 29 GW solar and 34 GWh of batteries. » Concessions to support those who need it most.	**CUSTOMER CHOICE AND CONTROL** » Almost 2/3 customers use onsite resources, including 1/3 customers on a new stand alone system tariff.
POWER SYSTEM SECURITY	**New systems to support diverse generation** » Update Transmission Interconnection test » Review frameworks for protection systems, efficient capacity and balancing services » New market frameworks for ancillary services » Develop new power system forecasting and planning approaches to anticipate system constraints » Enhanced intelligence and decision making tools » Close focus on physical & cyber security	**Harmonised system operations at all levels** » Transmission networks support system stability with new services. » Distribution networks provide visibility of DER and potentially Frequency Control Ancillary Services (FCAS) and delegated balancing services. » Real-time communication and controls	**LOWER BILLS FOR VALUED SERVICES** » Avoid over $1.4 BN in network investment. » Average network bills 10% lower than 2016.	**LOWER BILLS FOR VALUED SERVICES** » Total system spend is $101BN lower to 2050. » Save households $414 pa by 2050. » Network charges 30% lower than 2016.
CARBON ABATEMENT	**A stable carbon policy for higher targets** » Develop nationally integrated carbon policy framework » Implement emissions Baseline & Credit Scheme » Set light vehicle emissions standard policy to provide incentives for electric vehicle uptake, supporting climate goals » Review Australia's emissions reduction target » Agile network connections and integration of large and small scale renewable technologies	**Reviewing scope for greater efficiency** » Review technology specific incentive schemes to focus on least cost abatement » Review scope for more efficient economy wide carbon pricing where consensus » Review Australia's emissions reduction target (2027)	**FAIRNESS & INCENTIVES** » Networks pay over $1.1 BN pa for DER services. » Over $1.4 BN in cross subsidies avoided, saving $350 pa for med size family without DER.	**FAIRNESS & INCENTIVES** » Networks pay over $2.5 BN pa for DER services. » Over $18 BN in cross subsidies avoided, saving $600 pa for med size family without DER.
INCENTIVES & NETWORK REGULATION	**Incentivising efficiency and innovation** » Ensure extensive smart meter penetration » Assign customers to new range of fairer cost reflective network tariffs, with a choice to opt out » Enable standalone systems and micro-grids as a substitute for traditional delivery models » New innovation incentives in regulation and competition frameworks	**Unlocking value of distributed energy resource orchestration** » Networks pay for distributed energy resource orchestration to provide system support in the 'right place at right time' » New network tariffs that provide beneficial incentives for standalone systems and micro-grids to stay connected to the grid » New and more adaptive regulatory approaches that are customer focused	**SAFETY, SECURITY, RELIABILITY** » Planned and efficient market response avoids security & stability risks. » Robust physical & cyber security management.	**SAFETY, SECURITY, RELIABILITY** » Real time balancing, reliability and quality of supply at small and large scale, with millions of market participants.
INTELLIGENT NETWORKS & MARKETS	**Essential information for an integrated grid** » Establish open standards and protocols to enable secure system operation, management and exchange of information and interoperability with distributed energy resources » Networks enhance current system monitoring and models to inform advanced system planning » Build distributed energy resource maps and feeder hosting analysis to support locational valuation of distributed energy based services	**Networks optimised with distributed energy resources** » Active network management for technical stability, enabling distributed energy resource markets and efficient optimisation » Networks provide a suite of grid intelligence and control architectures to animate distributed energy resource markets, as well as providing system security » Establish a new network optimisation market to procure DER services for network support » A flexible and agile workforce to support the new optimised energy system	**CLEAN ENERGY TRANSITION** » Electricity sector carbon abatement to reach 40% by 2030 – greater than current national target of 26-28%.	**CLEAN ENERGY TRANSITION** » Electricity sector achieves zero net emissions by 2050.

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Q. 3 - What are appropriate standards for the security and reliability of the electricity system

As discussed further below, there are a number of key standards that underpin the National Electricity Market (NEM) including:

i. The Reliability Standard
ii. The Frequency Operating Standard;
iii. The Generator Performance Standards and Connection Access Standards; and
iv. The System Restart Standard.

Recent review processes have identified the need for substantial revision of the frameworks by which to define, and achieve, electricity system security objectives. The review processes include:

- The AEMC's System Security Market Frameworks Review;
- The AEMO Future Power System Security Program; and
- The Review of NEM Security chaired by Professor Alan Finkel AO.

Subject to the specific feedback provided in its submission, Energy Networks Australia supports the general direction of the AEMC's proposed reforms to allow the procurement of inertia and fast frequency response services.

i. The Reliability Standard

The reliability of the power system relates to having sufficient capacity to generate and transport electricity to meet consumer demand. The Australian Energy Market Commission's (AEMC) Reliability Panel is responsible for the review of the reliability standard and its settings – i.e. a set of parameters that affect wholesale price, investment and ultimately reliability in the National Electricity Market (NEM).

The reliability standard currently requires that there is sufficient generation and transmission interconnection such that 99.998% of annual demand for electricity is expected to be supplied. It is not an 'enforced' regulatory or performance standard, but rather is a planning standard used to indicate to the market the required level of supply and demand on a regional basis.

ii. Frequency Operating Standard

As the Committee may be aware, the AEMC's Final Determination on the Emergency Frequency Control Schemes rule change proposal published on the 30th of March 2017 discusses this issue in detail.

The frequency requirements that the Australian Energy Market Operator (AEMO) must meet are defined in the National Electricity Rules (NER) and the power system security standard (known as the Frequency Operating Standard (FOS)) which is determined by the AEMC's Reliability Panel.

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Energy Networks Australia considers it would be appropriate to review these standards, as the FOS for Tasmania was last reviewed and determined by the Reliability Panel on the 18th December 2008. The mainland NEM's FOS was last reviewed and determined on the 16th April 2009. The latter review relaxed the operational frequency tolerance band when load is being restored during a time of supply scarcity. The remainder of the Mainland FOS remains unchanged since September 2001 when it was determined by the then National Electricity Code Administrator's Reliability Panel.

iii. Generator performance and connection access standards

Generator performance and connection access standards are specific performance standards established for each registered generator in accordance with the NER or included in an AEMO register of performance standards. The Rules establish up to around 15 separate technical requirements (set out in Schedule 5.2 of the Rules) and vary for each generator depending on when the performance standard was registered with AEMO.

It is also noted that the AEMC will consider further the appropriateness of current generator performance standards relating to RoCoF withstand capability and whether it is necessary for work to be undertaken to better understand the withstand capability of generating units connected prior to the introduction of these standards in 2007.[1]

A generator and the relevant Network Service Provider need to agree upon relevant technical matters in respect of each new or altered connection of a generating system to a network including:

- Design at, and physical layout adjacent to, the connection point;
- Protection; communications facilities;
- Fault levels and fault clearance times;
- Switching and isolation facilities; and
- Metering installations.

iv. System Restart standard

The System Restart Standard sets out several key parameters for system restoration following a major supply disruption, including the speed of restoration, how much supply is to be restored and the aggregate level of reliability of System Restart Ancillary Services (SRAS). The Standard provides a target for the procurement of SRAS by AEMO.

However, the System Restart Standard is not an operational standard, nor does it fully address testing of SRAS, nor the full restoration of customer load. The most recent Standard was finalised in late 2016. The AEMC's Reliability Panel has made a series of

1 See AEMC, *Directions Paper: System Security Market Frameworks Review*, 23 March 2017

recommendations including greater involvement of Network Service Providers with AEMO and increased testing of SRAS facilities contracted by AEMO to provide such services in the different NEM regions.

It should also be noted that transmission businesses are required to plan to meet jurisdictional reliability standards in conjunction with Part B of Chapter 5 of the NER.

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Energy Network Australia considers that there is a need for strengthened generator obligations in licence conditions, including the need to meet connection and performance standards. This is exemplified in South Australia where AEMO's interim advice (March 2017) on the Essential Services Commission of South Australia inquiry into inverter connected generators provided support for a tightening of licence conditions for this type of generation source.

Additionally, based on locational conditions, efficient system security outcomes require that the relevant Network Service Provider should be in a position to holistically consider requirements for generator performance. For instance, Tasnetworks has developed region-specific requirements for the connection of asynchronous generation. The requirements sit within the current NER framework and describe the minimum technical performance that must be satisfied to achieve connection in Tasmania. The objective of this approach is to increase the ability of the Tasmanian power system to host future renewable energy projects while managing power system security and reliability.

2. *"The current technological, economic, community, and regulatory impediments and opportunities to achieving a modern electricity transmission and distribution network across all of Australia, and how these might be addressed and explored"*

Q. 4 - What are the costs associated with an 'outdated' grid?

The modernisation of Australia's electricity system should occur in a timely way and be economically efficient, based on its capacity to deliver additional value to electricity customers. There is significant evidence that a failure to modernise the electricity system will impact both qualitative and quantitative outcomes for the Australian community.

Analysis undertaken by CSIRO, Energy Networks Australia and expert consultants identified significant benefits in achieving an efficient transformation (the Roadmap Scenario), and significant costs under an extension of the status quo (the

Counterfactual Scenario). Some of the key costs of retaining an 'outdated grid' identified in the Roadmap analysis include:

- Total electricity system expenditure (across all parts of the supply chain including consumer owned resources) would be $101 billion higher than necessary by 2050;
- Electricity system security and reliability essential to our community lifestyle and employment is in jeopardy;
- Carbon abatement for the electricity sector is achieved at higher cost and the sector fails to achieve the COP 21 aspiration of zero net emissions;
- Electricity network infrastructure expenditure would be $16 billion higher than necessary due to a failure to employ 'orchestration' of distributed energy resources;
- An outdated grid denies the opportunity to achieve network charges which are 30% lower in 2050 than in 2016;
- Average household electricity bills would be $414 higher than necessary by 2050;
- The electricity bill of a medium sized family who cannot take up distributed energy resources would be over $600 per annum worse off in 2050 due to increasing cross subsidies, compared to the Roadmap scenario.

The drivers of these higher costs of an outdated grid include the increasing diversity of customer energy use, rapid uptake of distributed energy resources and significant carbon abatement objectives. Customers are becoming more engaged in how their energy needs are met, resulting in increasing amounts of distributed energy resources, such as rooftop PV, leading to significant levels of volatility at the point of connection between the distribution networks and transmission connection points.

As a result of these changes and increased complexity of the electrical characteristics of the power system, some traditional operating and control approaches are likely to become inadequate or obsolete. Therefore, timely action is required to ensure the system can provide the agility required to connect, integrate and incentivise new, alternate energy choices that will directly influence the cost, fairness, security and reliability of customer outcomes.

Without action to modernise the grid, Australian customers may be exposed to:

» Compromises to the security, integrity and reliability of the power system at physical, operational and data levels.

» Excessive operational costs or avoidable constraints, such as costs of balancing or achieving frequency control, or the emergence of avoidable localised network constraints.

» Inefficient investment, low utilisation of assets or over-engineering.

» Impediments to innovative new markets offerings and business models leveraging modern grid, with lost benefits to consumers and the economy.

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Q. 5 - What might be the role of new technologies in improving system security, reliability, sustainability, and affordability? What is the potential for new technologies to alter the inter-relationships between these objectives?

The joint Electricity Network Transformation Roadmap (ENTR) provides an extensive evidence base in sections 10 and 11 of the report. The following examples illustrate the potential benefits of new technologies.

i. System Security and Reliability

Key contributions of new technology to system security and reliability include:

- **System Security:** With the loss of synchronous generation, advanced energy system analysis is required to anticipate system security risks at a granular level specific to individual NEM regions.
- Such 'stress testing' analysis of system strength and credible contingency events would inform a range of technical solutions to achieve inertia and frequency management outcomes, including the use of synchronous condensers, rotational stabilisers, large scale batteries, flywheel technology and emulated inertial responses from, for instance, super-capacitor technologies or wind turbines by using the kinetic energy to support the frequency by interchanging this energy with the grid.
- **System Reliability:** New technologies and systems can support energy balancing solutions in a low or zero net emissions system through optimising renewables diversity (technological and geographical), 'pumped hydro' storage, 'Power to Gas' hydrogen storage, concentrated solar thermal generation or gas-fired generation supported by carbon capture and storage (CCS) technology, firm or dispatchable renewable capacity and demand management.
- **Distribution System Interface:** Additionally, the distribution system is also a potential source of new ancillary services to support transmission-level system stability. New sophisticated control systems will allow inverter connected devices to set and maintain frequency, enabling genuine replacement of synchronous generation in large network systems.

ii. Contributions to sustainability

New technologies will have an important role in enabling a more sustainable electricity system, by:

- facilitating greater deployment of variable renewable energy (such as large scale wind and solar PV farms) by maintaining system security as discussed above.
- increasing the 'hosting capacity' of distribution networks that allows more efficient connection of small scale generation and distributed energy resources, enabling abatement; and

- increasing the economic potential of distributed energy resources delivering carbon abatement through enabling networks to provide financial incentives for the 'orchestration' of distributed energy resources.
- enabling the significant decarbonisation of transport, through integration of electric vehicles.

iii. Contributions to affordability

As noted earlier, customers, rather than traditional utilities are likely to determine a significant portion of electricity system expenditure between now and 2050. Effectively employing and incentivising customer resources has the potential to achieve total system expenditure savings of $101 billion by 2050; network charges which are 30% lower in 2050 than in 2016 and avoid significant inequity occurring through unintended cross subsidies between customers.

However these outcomes require the implementation of key measures in the Roadmap which leverage new technologies such as:

- Substantial deployment of smart meters to enable a transition to fair and efficient electricity pricing by 2021;
- Significantly greater distribution network monitoring, forecasting and active system management relying on communications at distribution substation and on the low voltage (LV) network, 'big data' analytics and decentralised control systems.
- Locational valuation and incentives for distributed energy resources; and
- Cyber security of systems to mitigate risks of damage and unauthorised use, or, exploitation of information and data, to ensure confidentiality, integrity, and availability.

Q. 6 - How can the grid better accommodate the rapid pace of technological change, including an increasing level of variable electricity generation?

Energy Networks Australia provided an extensive submission in response to the Independent Review into the Future Security of the National Electricity Market's December 2016 Preliminary Report. In that response, Energy Networks Australia highlighted some key themes:

i. Technology neutrality and flexibility, rather than prescription will deliver better customer outcomes

While new technology identification and testing will be important, a principle of technological neutrality should be adopted, in combination with a mix of market and regulatory frameworks which encourage innovation and competition. Measures supporting research and development, pilots and trials can play an important role in niche areas of technology development. Market-based approaches and open platforms for the release of information will assist the 'animation' of new markets and maximise value for these sectors while also creating value for a broad range of customers.

Network Service Providers (NSPs) should have the flexibility to innovate in this transformation through new technologies (e.g. early application of system stability enhancements) and non-network solutions.

ii. Incentives play an important part in the energy market transformation

The two-year joint CSIRO/Energy Networks Australia Electricity Network Transformation Roadmap (ENTR) project suggests a 'co-optimised' energy system could reduce average network costs by 30% below 2016 levels by 2050. However, this is reliant on:

- frameworks where customers or aggregators are given efficient incentives to provide flexible capacity services through Distributed Energy Resources (DER) 'in the right place, at the right time', and
- networks effectively providing cost-reflective network tariffs which are important for efficiency and fairness.

iii. Multiple pathways to deep decarbonisation

CSIRO analysis undertaken as part of the ENTR concluded a plausible projection for meeting wholesale energy requirements and achieving zero net emissions by 2050 envisages a primary role for storage in balancing the output of intermittent variable renewable energy (VRE). While battery storage is forecast to be the dominant new source of energy balancing, a diversity of potential solutions exist which could be employed as alternative options while still achieving zero net emissions, depending on their changing economic potential. For example: renewables diversity (technological and geographical); pumped hydro storage; power to gas hydrogen storage; concentrated solar thermal generation or gas-fired generation supported by carbon capture and storage (CCS) technology; firm (dispatchable) renewable capacity; and demand management.

iv. New rules for generator connection and disconnections

New generator connections could include an obligation on new generators to provide inertia and system strength to the NEM, or enter into an agreement with another provider of the services through market arrangements. Retirement or disconnection of existing generator assets should be subject to some form of regulation to ensure that adequate notice is provided to ensure that the NEM is able to appropriately respond. It is not only essential that alternative sources of generation are available to replace the retiring generators, but alternative system security services can be made available if a synchronous generator is disconnecting from the NEM.

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Q. 7 - What possibilities are there for alternative pricing models (for example, cost-reflective pricing) to better reflect the true cost of services provided by a modern grid?

Analysis by Energy Networks Australia and CSIRO suggests a 'co-optimised' energy system could reduce average network costs by 30% below 2016 levels by 2050 and contribute to avoided network expenditure of $16 billion by 2050.

However, this is reliant on:

» ***First wave tariff reform:*** networks effectively providing cost-reflective network tariffs which are important for efficiency and fairness; and

» ***Second wave incentives:*** networks providing incentives for grid support services 'in the right place, at the right time'. Customers would be paid to avoid the need for network investment in return for orchestrating distributed energy resources (whether distributed generation, storage, demand response, etc).

Analysis by CSIRO suggests that without more urgent attention to current pricing incentives in network tariff arrangements, Australia will not achieve the benefits from integration of network and behind the meter infrastructure. This will increase power system risk and affordability in the future.

i. First Wave Tariff Reform

Customers have increasingly diverse load profiles, depending on their use of air-conditioning, energy efficiency, solar panels and other technology. However, despite these varying uses of the network, most Australian residential (and small business) network tariffs rely on volumetric charges (cents per kilowatt hour) which do not vary by time. Historically, the relative homogeneous energy use in the residential sector meant that weak pricing signals had little impact on customer outcomes. Over time however, with the introduction of new technologies, network cost recovery through a flat, anytime volume rate provided no signals to reward the reduce use of energy at peak times that drove the need for network augmentation expenditure. At the same time, the flat 'anytime' volume signals unintentionally resulted in cross-subsidies to customers installing solar PV from other users.

Recent analysis by NERA Economic Consulting (NERA) for the AEMC identified significant cross-subsidies between customers under current network tariffs[2] including a cross subsidy of approximately $683 per year for customers using air-conditioning at peak times. Further analysis by Energeia for the Network Transformation Roadmap found that without action on pricing reform, customer cross-subsidies would increase significantly disadvantaging those unable to takeup new technologies. As noted above, the electricity bill of a medium sized family who

[2] NERA, Economic Concepts for Pricing Electricity Network Services, A Report for the Australian Energy Market Commission, 21 July 2014

cannot take up distributed energy resources would be over $600 per annum worse off in 2050 due to increasing cross subsidies, compared to the Roadmap scenario.

The Network Transformation Roadmap recommended that by 2021, residential and small business customers are assigned to a new range of cost-reflective network tariffs, enabled by a high penetration of smart meters. It noted that the fairer system of prices could only be achieved in a reasonable timeframe with changes to tariff assignment policy. Existing Australian tariff assignment policy predisposes retailers to continue to assign customers to legacy tariffs unless the customer makes a conscious decision to adopt a different retail product which includes a cost reflective network tariff. However, waiting for customers to opt-in to new network tariffs fails to achieve timely take up of fair and efficient network tariffs, with 70% of customers remaining on legacy tariffs in 2026. By contrast, retailers assigning all customers to more cost-reflective network tariffs, *with a choice to opt-out*, results in less than 10% choosing to return to legacy tariffs and results in positive comparative economic benefit of $1.8 billion by 2026.[3]

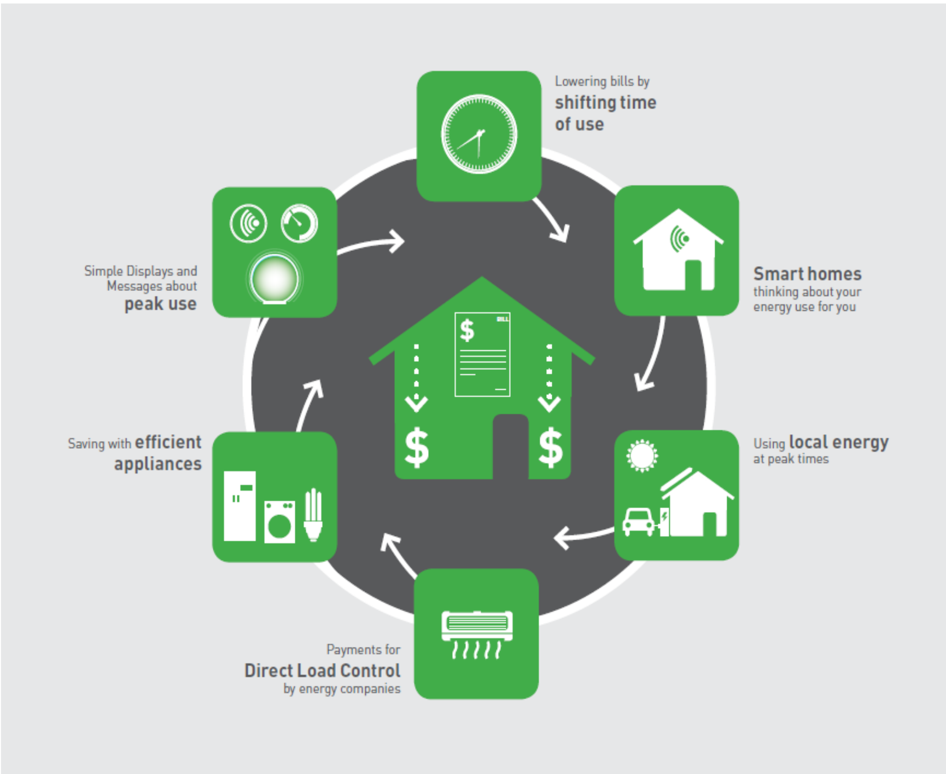

Figure iii: *Rewarding Customers for Smart Energy Use*

[3] CSIRO and Energy Networks Australia *Network Transformation Roadmap,* April 2017, p. 42

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ii. Second Wave Incentives

If first wave tariff reform is in place, it creates a market environment in which highly targeted *Second Wave incentives* are viable. In this context, customers (or their agents) could choose to 'opt in' to rewards for grid support in the right place at the right time, such as:

- *Incentive Payments for 'orchestration' of DER* (eg. battery discharge; smart inverters; load control; Home Energy Management platforms);
- *Advanced Network Tariffs for Behavioural Response* (eg. Critical Peak Price; Peak Time Rebates; or Nodal Pricing);
- *Transactive Energy* models of future electricity reform (eg. real time pricing in future in distributed energy markets).

As discussed above, in order to provide these incentives, the modernisation of the grid would be required including the technical capacity to actively manage the distribution network, identify constraints on hosting capacity and locationally value distributed energy resources.

Q8. - What opportunities are there to improve governance and regulation in the grid?

The two-year joint CSIRO/Energy Networks Australia Electricity Network Transformation Roadmap (ENTR) project suggests that the evolution of the electricity grid to integrate complex and diverse customer needs and distributed energy resources will challenge the traditional regulatory framework.

Key drivers that are relevant to improving governance and regulation in the grid include:

» Emergence of new technologies and new business models, providing capacity for greater competition and services;

» The development of off grid solutions and competition across a range of traditional network services; and

» The potential for the current regulatory framework to unintentionally stifle delivery of customer valued services.

Therefore, the Roadmap has identified a number of opportunities that should be explored that could improve the current regulatory approach, including for instance:

» Moving to more of a consumer centric, and less of a regulator-centric framework. This can include, for example, trialling of 'customer settlement' approaches.

» Trialling and introduction of new approaches to setting regulatory revenues including Total Expenditure (Totex) regulation as applied in the United Kingdom; or stronger incentives for direct outputs that are valued by customers;

» Reform of customer protection frameworks to ensure they remain fit for purpose; and

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» Development of competition tests. As the scope for competition for network services expands, the regulatory regime will need more dedicated mechanisms and processes to recognise and define the boundaries of regulation and competition.

Q9. - What opportunities are there for consumers to benefit from the modernisation of the grid? How can we ensure that these benefits are able to be shared equitably by all consumers?

The Electricity Network Transformation Roadmap forecasts that individual customers will determine how over $200 billion in system expenditure will be spent over the next three decades, with millions of customer owned generators likely to supply 30-50% of Australia's electricity needs. By implementing a series of no regrets measures, CSIRO developed scenarios that predicted 10 million participants using the grid as a platform for energy exchange, customers saving over $414 per year on average, total savings of $101 billion in system expenditure and zero net emissions for the electricity sector by 2050. These initiatives can also improve affordability compared to alternative scenarios.

The roadmap also seeks to enable the animation of innovative new markets to improve services for customers. By 2050, the roadmap foresees the potential for up to two-thirds of customers to takeup distributed energy resources, with their investments partly supported by a new market for network support services. In return for orchestration of DER at key times of the year, network incentives of up to $1.1 billion per year would be available by 2027 to customers or their agents, reaching approximately $2.5 billion per year by 2050.

Q. 10 - What sort of community attitudes or concerns will need to be addressed in order to successfully modernise the electricity grid?

As noted above, electricity customers and the Australian community have a range of concerns which must be balanced and met in the modernisation of the electricity system including: concern for energy security and reliability;; concern for affordability of electricity services; and support for sustainability measures, including timely action to mitigate climate change. In addition to the traditional 'trilemma', the Committee should also consider:

- there is increasing customer appetite to 'take control' of their electricity use, embrace new technology and experience a personalised service;
- there is increasing concern for the equity and fairness of the electricity transformation, including the need to protect vulnerable customers or those unable to participate in new market offerings.

The Electricity Network Transformation Roadmap identifies the need for electricity networks and other service providers to understand shifting customer value drivers and concerns. The grid must evolve to a trusted service platform that enables customers to access the expanding market of electricity services and products.

To assist this process, networks will build on recent initiatives to increase customer orientation as a key focus to future service delivery. As such, networks need to:

» enhance relationships with customers by building improved data analytics capabilities and a deeper understanding of increasingly diverse customer needs;
» seek to expand information services to enhance interactions with customers; and
» play a greater role in the delivery and connection of an expanding range of innovative products and services to customers.

Two resources may be of interest to the Committee related to the electricity sector's future efforts to genuinely engage with customers on key issues:

- The *Customer Engagement Handbook* (released by Energy Networks Australia in 2016) has been designed to provide practical guidance to energy network businesses in fostering transparent dialogue with their customers. Potential opportunities to progress engagement practices across the industry have also been identified and circulated in a complementary document, *Sharing Customer Engagement Practice*. The Handbook includes references to further resources and case studies of engagement activities drawn from Australian energy network businesses.[4]
- The *Electricity Network Tariff Reform Handbook* released by Energy Networks Australia in May 2016 identifies desired outcomes of distribution network tariff reform for customers and identifies the key capabilities and prerequisites to achieving tariff reform. It highlights the role of customer engagement and supporting devices and decision tools, in addition to recommending a behavioural science approach to the preferences of customers. By drawing from both Australian and international examples, the Handbook identifies good practice across the stages of tariff design and implementation.[5]

4 Energy Networks Australia, *Customer Engagement Handbook,* July 2016 available via www.energyworks.com.au
5 Energy Networks Australia, *Electricity Network Tariff Reform Handbook,* May 2016 available via www.energyworks.com.au

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Q. 11 - What options are there for addressing geographical barriers to achieving a truly national grid?

Energy Networks Australia makes the following response to this question:

i. **National policy and regulatory frameworks are vital**

Australia's electricity networks provide a platform of connectivity enabling significant efficiency and economy productivity for customers in one of the world's largest and most decentralised electricity systems. Energy Networks Australia supports a more nationally consistent approach to the National Electricity Market, as noted in response to Question 1 and 2. This is more, rather than less, important given the rapid emergence of new distributed markets and the decentralisation of electricity services and technology. Energy retailers, aggregators and new market actors are entering the market and unnecessary discontinuity in regulatory and market frameworks between States is likely to represent barrier to entry.

Finally as noted above, there is strong consensus among stakeholders that political dispute in the sector has undermined the necessary stable and enduring policy settings required to enable better outcomes for customers. This has been evidenced by poor coordination in carbon and energy policy; inconsistent State and Federal Government frameworks; and inaction on agreed COAG Energy Council reforms.

ii. **Increased connection should be supported by customer value**

Clearly, however, the best outcomes for customers do not require a physical connection to every customer in Australia, nor the removal of every constraint on the transfer of power between nodes within the network. Core features of connection frameworks and regulatory investment tests remain appropriate to ensure efficient cost-sharing and timely delivery to end-use customers for the services they value.

iii. **Greater transmission infrastructure is likely to be required**

In its National Transmission Development Plan released in December 2016, AEMO concluded that:

- Without new transmission infrastructure, the Large Scale Renewable Energy Target (LRET) targets are at risk in the next 5 to 10 years. AEMO identified that current inter-regional and intra-regional transmission constraints and the low power system inertia conditions in South Australia would see significant amounts of "spill" or wasted output from wind turbines. New interconnection would help to avoid retailers paying the LRET penalty price.

- AEMO found Victoria required investment of between $1 billion to $3 billion to facilitate the connection of new renewable generation to accommodate the Victorian Renewable Energy Target. The report identified at least four significant network limitations where single circuits would require duplication or other works to reduce generation curtailment and meet VRET target, or in some cases avoid load curtailment when support from neighbouring states is insufficient.

- There were six potential interconnector scenarios which would be likely to have a positive Benefit to Cost Ratio (BCR) based on a preliminary assessment. The six scenarios include improved interconnection to New South Wales (mid to late 2020s), between South Australia and Victoria or South Australia and New South Wales (2021); and a second Bass Strait interconnector (2025); Synchronous Condensors in South Australia (2021); or combinations of the above.

AEMO emphasised in the NTNDP that its assessment was not intended to replace the need for the regulatory standard assessment for Transmission investment. For instance, ElectraNet recently initiated its analysis of Interconnector options and non-network solutions for South Australia. ElectraNet's study is assessing the potential benefits of solutions for system security of consumers and producers of electricity through:

- allowing the Rate of Change of Frequency (ROCOF) standard to be met without constraining flows over the Heywood Interconnector;

- further reducing the risk and/or consequences of supply disruption following a separation or other event, through reducing RoCoF below the mandated standard;

- managing the challenges of declining system strength (fault levels); and/or

- allowing greater sharing of ancillary services across regions, resulting in an overall lower cost of providing system stability.

3. *"International experiences and examples of electricity grid modernisation in comparable jurisdictions."*

Q. 12 - What are the key similarities and differences between the electricity system in Australia and those of other countries?

There are many similarities between Australia's electricity system and international markets including in relation to key transformation drivers. For the Network Transformation Roadmap, Accenture were commissioned to review international transformation approaches in the report: *Insights from Global Jurisdictions, New Market Actors & Evolving Business Models*.[6]

Accenture identified six transformation drivers (or 'fault lines') which were impacting jurisdictions in a common manner:[7]

Figure iv: *Accenture's 6 Global Fault Lines*

Australia's electricity system has historically been well regarded internationally. During a time of energy transformation, however, in comparison to international jurisdictions Australia is notable for:

- its significant reliance on market frameworks to achieve energy reliability and security;
- the use of an energy-only market to signal new entrant investment through high prices;

6 Available at the Energy Networks Australia website www.energynetworks.com.au
7 Accenture, *Insights from Global Jurisdictions, New Market Actors & Evolving Business Models*, November 2016.

- the extent of multiple and overlapping State and Federal government policy and regulatory measures impacting on markets, technical operation, reliability and system security frameworks, particularly given the size of its population base.

Q. 13 - How does Australia compare with other countries in the rate of adoption of variable electricity generation and other new technologies?

As noted in a recent report for the Network Transformation Roadmap, the penetration of Distributed Energy Resources (DER) in Australia is acknowledged as being towards the highest levels throughout the world and with faster levels of growth.

> *Australia leads the world for example in the penetration of rooftop solar photovoltaic (solar PV) cells, with a penetration rate of roughly 15% of households on average with some states above 30%. This can be compared to Belgium, with the next highest level of penetration, with 7% average penetration. Other forms of DER are also gaining prominence as costs begin to fall, for example there is now significant interest in installation of batteries at the household level driven by Australia's relatively high electricity costs*[8].

It is equally recognised that South Australia features among the world's highest levels of variable renewable energy in its power system, with implications for system security due to the loss of synchronous generation and system strength.

Energy analyst David Leitch has recognised that the Denmark is one of the few markets with comparable levels of variable renewable energy share to South Australia, yet it benefits from significantly greater interconnection and a market which is substantially larger to support generation diversity. With over 40% of renewable generation on its system, Electranet has undertaken significant studies on high penetration renewable scenarios with AEMO, assessed the role of large scale storage and interconnection benefits to system security.

Figure v: *Summary of Jurisdictions Wind And PV Share by David Leitch*

Selected grids	China	NEM	California	Texas	Ireland	Germany	Portugal	Sth. Aust	Denmark
Consumption TWh	5911	198	295	351	26	495	52	13	34
Wind & PV share	4%	8%	14%	15%	19%	21%	23%	42%	42%

Sourced from David Leitch: Wind and solar: A comparison of Denmark & South Australia[9]

It is significant to note that the Network Transformation Roadmap projects that, in just over a decade, both Western Australia and Victoria could exceed 40% in renewable energy. Internationally, the 2015 IRENA Technology Brief indicated renewable energy

8 CSIRO and Energy Networks Australia 2017, Electricity Network Transformation Roadmap. Synthesis Report: Future Market Platforms and Network Optimisation. p. 18.
9 David Leitch in Renew Economy *Wind and solar: A comparison of Denmark & South Australia,* 3 March 2017

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could provide an average of 44% of global energy by 2030.

Transmission networks are highly focussed on how to support the development of large-scale renewable generation. Many are well positioned to accommodate sizeable increases in new renewable generation without impacting on network stability and some are progressing connection hubs to lower connection costs and address increasingly decentralised supply from renewable sources.

Q. 14 - How does Australia compare with other countries in progress towards electricity grid modernisation?

Australia's progress to grid modernisation can be assessed in a number of diverse ways.

In terms of the connection of small scale distributed energy resources, Australia's grid is advanced by international standards. Most networks have focused on developing intelligent network capability with improved data, network modelling, monitoring and control capability. Improved outage and network management systems have also been employed to enhance network operations and provide an improved customer service.[10] These improved edge-of-the-grid capabilities are enabling better information flow and multi-directional energy flows enabling customers to sell services to networks and other market actors.

However, as noted above there are significant capability gaps which must be addressed to meet the challenges of customer driven transformation. Distribution networks remain relatively passive systems - with relatively low levels of sensing and monitoring at lower voltage levels and low penetrations of the advanced metering infrastructure required to support fairer and more efficient pricing and incentives.

The modernisation of Australia's electricity system has also had comparatively less governmental coordination than seen in other jurisdiction, such as New York, California and the United Kingdom.

As Accenture observe in the report quoted above:

> *While the Australian market generally compares favourably with other jurisdictions in terms of meeting the challenges faced so far – especially in terms of adapting within the existing structures – it is not clear that the current approach of incremental reforms will deliver the outcomes needed. Without a longer term vision and 'whole of market' approach Australia may not be optimally prepared for the challenges we now face.*[11]

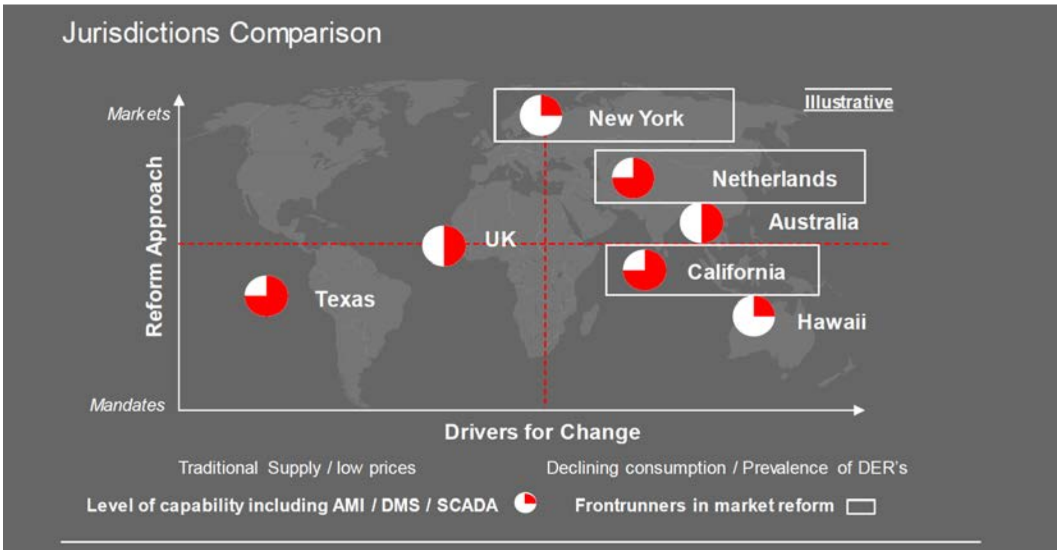
The current NEM Security Review chaired by Professor Alan Finkel AO does provide the opportunity for the COAG Energy Council to progress a more coordinated approach to the modernisation of the electricity system. This work program can be informed by the recent work of the CSIRO and Energy Networks Australia in the

10 CSIRO and Energy Networks Australia 2017, Electricity Network Transformation Roadmap. Synthesis Report: Future Market Platforms and Network Optimisation. p. 18

11 Accenture, Insights from Global Jurisdictions, New Market Actors & Evolving Business Models, November 2016.

Electricity Network Transformation Roadmap.

The Committee may wish to have regard to the Accenture report commissioned for the Roadmap, *Insights from Global Jurisdictions, New Market Actors & Evolving Business Models* which includes an overview of developments in six jurisdictions in modernisation. These are summarised briefly in Figure vi below, drawn from page 23 of the Report.



	APAC	AMERICA				EUROPE	
	Australia	NY	CA	TX	HI	UK	NL
Ambition	Low	High	High	Low	High	Medium	High
Drivers	High	Medium	High	Low	High	Medium	Medium
Motivation	Medium	High	High	Low	High	Medium	High
Capability	Medium	Low	High	High	Low	Medium	High

Figure vi: Accenture comparison of jurisdictions energy market reform

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Q. 15 - What are examples of best-practice governance and regulation in other countries

Energy Networks Australia encourages the Committee to consider the following examples in response to this question:

- The New York State's reform program, Renewing the Energy Vision (or REV) for its ability to conceive and consult diverse stakeholders on a comprehensive energy transition plan which relies on animating new distributed energy markets. This remains highly relevant to Australia; and
- Ofgem's examination of energy regulatory reform, such as the review undertaken with the UK Government, *Smart, Flexible Energy System - a call for evidence*. This highlights the potential for the economic regulator to undertake consultative horizon-scanning and timely reform of regulatory frameworks.

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APPENDIX

Additional Information - Electricity prices and network costs

In response to discussion at the initial roundtable hearings of the Committee, Energy Networks Australia has provided some further background information on electricity prices and network costs.

Retail electricity bills are made up of a number of components:

Wholesale costs reflecting electricity generation costs and purchased by retailers in competitive markets;

- Network costs reflecting the cost of the transmission and distribution networks that are regulated by the Australian Energy Regulator (AER);
- Retail costs including operating costs such as billing and marketing and a profit margin for risk in providing retail services; and
- Environmental policy costs mandated by Commonwealth, State and Territory governments, such as the Renewable Energy Target and the various state and territory feed-in tariff and energy efficiency schemes.

Changes in any one of these components flows through into retail electricity bills.

Between 2008 and 2013, a number of drivers led to the significant increases in network charges. Increases in network costs were overwhelmingly driven by the demands of the market and government policies, including:

a. forecasts of rising demand for electricity at peak times, largely driven by the use of energy intensive appliances such as air-conditioners, requiring more transmission and distribution capacity that is only used for a small fraction of time.
b. the need to replace aging infrastructure, given that much of Australia's electricity infrastructure was built in the 1960s and 1970s with a working life of 30 - 40 years.
c. the need to meet State government mandated reliability standards, which was a significant driver of costs for network businesses that lay largely outside their direct control.
d. the higher cost of sourcing the required investment as a result of the Global Financial Crisis, which saw debt margins double in capital markets.

It is widely recognised that the outlook for network costs has moderated in the last few years due to changes in these same factors, with:

- an outlook of flat or declining peak electricity demand in many locations;
- opportunities to avoid like-for-like replacement of existing infrastructure where more economically efficient;
- the reform of State Government reliability standards in key jurisdictions to correct the prescriptive features introduced in the 2000s;

- improved financial market conditions and reform of cost of debt methodologies in the AER regulatory determinations to reduce the exposure to temporal volatility.

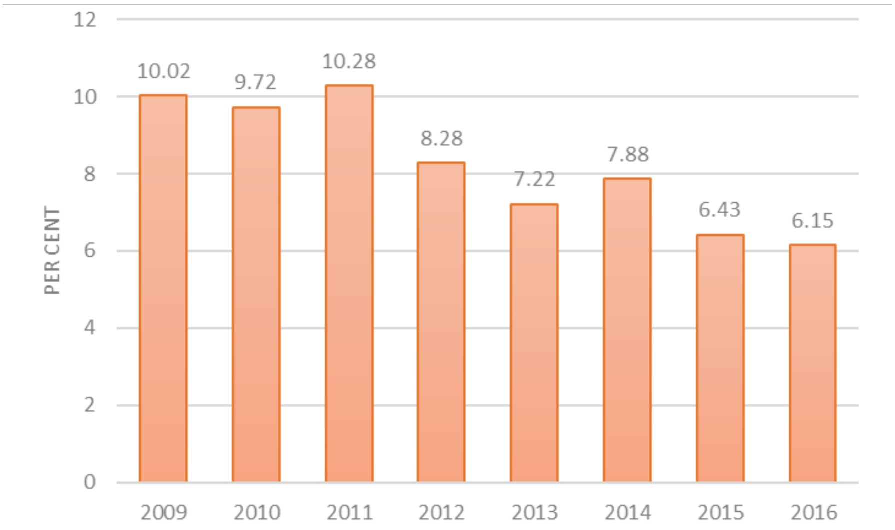
The AER's revenue and pricing determinations made in 2012–15 provide for maximum revenue that networks can recover from customers is on average 9 per cent lower than recoverable revenue in the previous regulatory periods.

The return on capital is the largest revenue component for electricity networks. The Global Financial Crisis in 2007 resulted in a significant increase of financing costs, which led to an increase in network revenues and network prices. The cost of capital has fallen substantially as capital markets improved and long-term debt costs have recently been at historic lows.

The AER's regulatory determinations made since 2012 reflect lower costs of financing due to reductions in the risk-free rate and the debt risk premium. The overall cost of capital in electricity determinations declined from a peak of over 10 per cent in 2011, to just above 6 per cent in 2016 (Figure 2).

The cost of capital is updated annually to reflect changes in debt costs. Therefore, an increase in return on debt may increase the cost of capital, which may result in an increase in network revenues and network prices (the reverse is also true).

Figure 2. Overall cost of capital in electricity determinations.



Source: Energy Networks Australia analysis