27 January 2017

Committee Secretary
Select Committee into the Resilience of Electricity Infrastructure in a Warming World
Department of the Senate
PO Box 6100
Parliament House
CANBERRA ACT 2600

By email: electricity.infrastructure.sen@aph.gov.au.

Resilience of Electricity Infrastructure in a Warming World

Dear Committee Secretary,

Thank you for your letter of 2 December 2016 regarding the inquiry into the role of storage technologies and localised, distributed generation to provide Australia's electricity networks with the resilience to withstand the increasing severity and frequency of extreme weather events driven by global warming.

Energy Networks Australia welcomes the opportunity to make a submission to this inquiry. In addition to addressing challenges of adaptation to climate change, electricity networks provide a critical enabling role in emissions abatement the need for Australia to transition towards a low emissions economy.

Transitioning to this future has implications for all parts of the energy supply chain and presents a very significant range of technical, economic and regulatory challenges. Without a well-planned approach with timely action by governments to create policy and regulatory cohesion, Australia's energy system is unlikely to efficiently and securely integrate the diverse technologies, large scale renewable energy sources and customer owned distributed energy resources.

Our submission draws on our recent research and analysis in this area and provides the Senate Select Committee with a number of key recommendations for Government to endorse and support.

Please don't hesitate to contact Brendon Crown, Executive Director, Economic Policy or myself on (02) 6272 1555, if you would like to discuss any aspect of the attached submission.

Yours sincerely,

John Bradley
Chief Executive Officer

Resilience of Electricity Infrastructure in a warming world

Response to Senate Committee – Jan 2017

Energy Networks Australia

Energy Networks Australia

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Executive Summary

Energy Networks Australia welcomes this opportunity to make a submission to the Senate Select Committee into the Resilience of Electricity Infrastructure in a Warming World.

Energy Networks Australia 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 ensuring safe, reliable supply of energy to support the Australian economy and the everyday lifestyle of individuals.

Electricity networks are providing a critical enabling role in emissions abatement, in addition to addressing challenges of adaptation to climate change.

Transmission and distribution systems are enabling a relatively rapid transition of energy generation from centralised, carbon-intensive power stations, to increasingly decentralised, low or zero carbon sources of supply, while minimising risks to the safety, reliability and quality of supply valued by customers.

The implications of climate change for Australia's electricity networks are significant with the potential for sea level rise, increased frequency and severity of extreme weather events and related risks, including storms, cyclones, heatwaves and bushfires. Given the long life of energy network assets, investment decisions made today must incorporate risk assessments from a whole diverse range of factors including future climate change. The way energy networks are operated and maintained will also need to be reviewed to maximise their resilience to climate change.

The energy network sector is also responding to the need for Australia to transition towards a low emissions economy.

Australia leads the world in the uptake and connection of distributed energy resources, such as rooftop solar. However, the next decade is likely to see a further step change in the adoption of new distributed energy technologies, with further penetration of rooftop solar, and increased investment in energy storage and electric vehicles.

It is likely that more decentralised energy resources could generate up to 50% of all electricity – at the opposite end of the system from its initial design. Transitioning to this future has implications for all parts of the energy supply chain and presents a very significant range of technical, economic and regulatory challenges.

Without a well-planned approach with timely action by governments to create policy and regulatory cohesion, Australia's energy system is unlikely to efficiently and securely integrate the diverse technologies, large scale renewable energy sources and customer owned distributed energy resources. Inconsistent and volatile State and Federal government frameworks on carbon policy, pricing, consumer protection, market design or regulation will result in electricity services to customers which are higher cost, less secure and inhibit customer choices.

Energy Networks Australia has recently partnered with Australia's national Science agency CSIRO to develop an integrated set of milestones and actions that are necessary for an efficient and timely transformation. The Electricity Network Transformation Roadmap (Roadmap) is supported by expert analyses, scenario analyses and quantitative modelling and describes a set of "no regrets" actions aimed directly at a customer oriented transformation of the sector.

Energy Networks Australia would urge the Senate Select Committee to recognise:

» the likely customer-led transformation of the energy sector to one which is decentralised, with 30-50% of Australia's electricity needs being supplied by millions of customer owned generation and storage devices.
» the importance of energy networks as a critical enabler of climate change mitigation, but also in terms of ensuring security and reliability for the power system as well as delivering fairness and value to customers for the services provided.
» the challenges networks face, not only in increasing resilience in adaptation to impacts of climate change, but also in enabling the necessary transition to a decentralised, low emissions energy system.
» the necessary transition to an affordable, reliable zero emissions energy sector is possible, but requires and outcome-focussed transition plan.
» the greatest single risk to an efficient and secure transition is government policy and regulatory cohesion.

The Committee should endorse the following measures:

» Governments, both State and Federal commit to a consistent and stable carbon policy, including a trading scheme for generator emissions, enabled by agile network connection and integration of large and small technologies.
» Governments work with existing institutions and the energy sector to develop new frameworks and services for achieving system security with diverse generation and energy technologies and retail focus on physical and cyber security.
» Governments work with existing institutions and the energy sector to encourage incentives for efficiency and innovation through implementing fair and efficient demand based tariffs, enabling stand-alone systems and microgrids and modernising regulatory and competition frameworks.
» Governments facilitate frameworks which develop essential information tools for a cost effective integrated grid, through open standards, extended monitoring, advanced planning and feeder hosting analysis and the mapping and locational value of feeder hosting analysis.

1. Climate Change and Electricity Networks

Role of electricity networks in enabling decarbonisation of the electricity system

A customer-led transformation of the energy system requires careful balancing of a range of factors in order to deliver the best possible outcomes for customers over the long term.

Energy Networks Australia members recognise the important role they play in the transition to a low emission generation future at least cost while delivering high levels of energy security and reliability. At the same time networks must enable new customer choice over how they want to use the grid, while providing appropriate customer protections and avoiding unfair impacts from vulnerable customers.

Finally adapting transmission and distribution networks to allow for an increasingly diverse and decentralised mix of energy resources needs to provide a highly reliable energy balance for a wide range of operating conditions.

As discussed below, there are a range of technical considerations required to achieve the transition to a secure and stable electricity system which enables deep decarbonisation:

» Transmission networks play a key role by ensuring that power system security can be retained in a system with much lower levels of system inertia.
» Distribution systems will also provide a platform for multilateral energy exchange including significant fleets of customer owned renewable and other energy resources.

Distributed energy resources available for utilisation include embedded generation sources (such as rooftop solar PV or micro gas turbines), distributed storage, flexible demand response (including commercial, industrial and residential-scale resources such as hot water systems, smart air-conditioning and pool pumps) and third party aggregators of behind-the-meter resources such as 'Virtual Power Plants' smart homes.

Risks to electricity infrastructure from extreme weather events

A number of national and international initiatives have concluded that energy network infrastructure and services are potentially highly vulnerable to changing climatic conditions, particularly changing frequency and intensity of extreme weather events, such as drought, heatwaves, bushfires, and extreme rainfall.[1]

Climate change can affect infrastructure in different ways. Higher temperatures and longer, more intense heat waves skew electricity use. Higher temperatures also reduce the relative efficiency of transmission lines. There is also the potential for higher temperatures place additional stress on the system increasing the risk of outages.

Hotter, longer heatwaves could increase peak load days, longer dry spells and lightning strikes increase the risk of bushfire ignition from transmission lines and hotter conditions may impair water use for generators.

Tropical Cyclones can have a devastating effect on electricity networks in specific parts of Australia. Projections indicate there may be an increase in the proportion of tropical cyclones in the more intense categories (3-5) due to climate change.[2]

One of the biggest challenges facing infrastructure owners is managing the impacts of climate change on assets to ensure continuity and reliability for service to customers at lowest cost. Some changes in climate might not produce material change in some parts of the network for decades, where it may introduce new impacts in other areas which were previously not relevant.

Australian network companies are experienced in operating assets in a range of weather conditions and have well developed business continuity and emergency plans to ensure effective response to a range of events that can affect both transmission and distribution networks. Nevertheless, resilience to climate change is likely to require modified approaches to network planning, risk analysis and contingency management

Climate Risk and Resilience Manual

Energy Networks Australia developed a Climate Risk and Resilience Manual in September 2014 – available for use by energy network businesses in the assessment of climate change risk and the development of adaptation plans. The Manual contains practical guidance on:

» establishing the base line climate and asset context;
» climate modelling and interpretation of future climate projections;
» identification of climate risks and undertaking a probabilistic risk assessment; and
» climate adaptation planning.

For instance, it provides a stepwise risk-based process to identify climate effects, infrastructure and service impacts; metrics for risk measurement; trigger or thresholds for asset sensitivities and responses.

[1] Refer Energy Networks Australia, Climate Risk and Resilience Manual, 2014
[2] https://www.environment.gov.au/climate-change/climate-science/impacts/qld

The Manual builds on other research and supporting evidence, including:

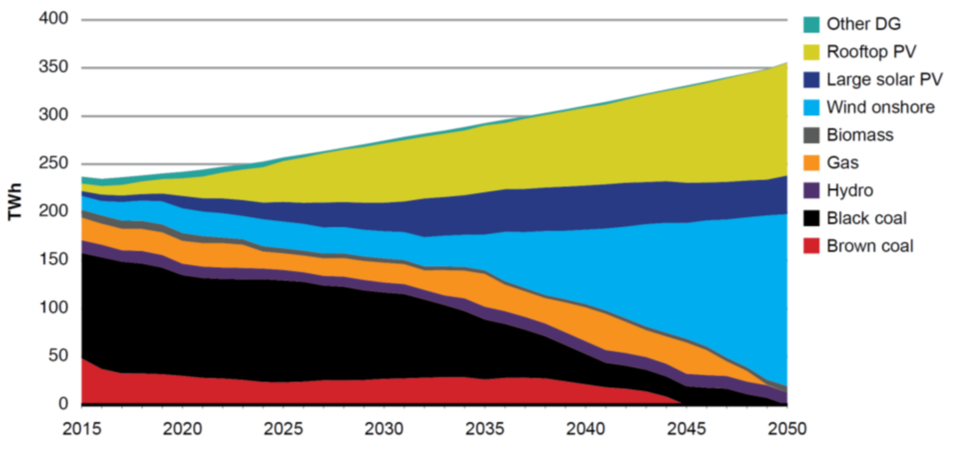
- the Attorney General's Department and the Critical Infrastructure Program for Modelling and Analysis
- the Australian Energy Market Commission findings on Extreme Weather Events (2010).

2. The Feasibility of Deep Decarbonisation – Zero Net Emissions in electricity

CSIRO energy system analysis for the Network Transformation Roadmap confirmed it is possible for the electricity sector to maintain a reliable, stable grid while achieving zero net emissions by 2050, in line with the aspiration of the COP 21 Paris Agreement. The analysis concluded that Australia's electricity sector could exceed its share of current national carbon abatement targets, achieving 40% below 2005 levels by 2030, however, an integrated set of measures will be required including stable enduring carbon policy frameworks and incentives to enable 'orchestration' of millions of distributed energy resources.

Energy system modelling undertaken for the Roadmap identified the generation mix as summarised in the Figure below, as a plausible projection of generation sources required to meet wholesale energy requirements and zero net emissions by 2050. The analysis assumes a primary role for storage in balancing the output of intermittent Variable Renewable Energy.

Figure 20: Electricity output by generation type to 2050



The generation modelling is not intended to be an optimised analysis of comparative technical solutions to achieve a wholesale portfolio scenario, and ultimately each NEM region will need to consider all of the possible combinations of solutions. While battery storage is forecast to provide the dominant new source of energy balancing, there are a diversity of potential solutions which could be employed as alternatives while still achieving zero net emissions depending on their changing economic potential.

For instance, some of the other options for energy balancing which may provide such solutions in a low or zero net emissions system include: 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.

It is recognised that power system security with this generation mix, with very low levels of native inertia will require careful analysis of system stability and security risks during the transition of the generation portfolio. Energy system modelling undertaken to date for the Roadmap does not evaluate system security at a granular level specific to individual NEM regions. Such 'stress testing' analysis of system strength and credible contingency events would be required and is a recommended part of the work program identified in the Roadmap. A range of technical solutions exist 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.

3. Distributed Energy Resources and Electricity Networks

Distributed Energy Resources and energy transformation

Australia already leads the world in terms of uptake and installation of distributed energy resources such as rooftop solar, with approximately 15% of customers having installed rooftop Solar PV and approximately 30% in Queensland and South Australia[3]. However, the next decade is likely to see a further step change in the adoption of new distributed energy technologies, with further penetration of rooftop solar, and increased investment in energy storage and electric vehicles. Over time, it is likely that more decentralised energy resources could generate up to half of total electricity requirements – at the opposite end of the system from its initial design.   The Australian Energy Market Operator has forecast the potential for rooftop solar PV output to exceed South Australia's minimum electricity demand within a decade –

[3] APVI Solar Map, available at apvi.org.au

which will transform operational conditions, both because of the *location* of the generation source and its *technical properties,* such as voltage stability in variable weather conditions[4].

Importantly however, the transformation of the sector is not being driven by utilities or governments, but by customers as they embrace new technologies, take control of their energy use and support action on climate change. By 2050, it is estimated that customers or their agents - not utilities - will determine how over $200 billion in system expenditure is spent and millions of customer owned generators, supplying 30-50% of Australia's electricity needs.

This take-up of distributed generation is likely to have far reaching effects for the overall generation mix in Australia. Drawing on advanced energy system modelling of technology adoption to 2050, Electricity Network Transformation Roadmap program forecasts the potential for Australia's grid to enable fundamental changes:

- 29GW of installed solar capacity (a 500% increase from 2016) as well as 34GWh of battery storage on the network over the 10 years to 2027.
- More than 1 in 3 customers to have onsite distributed energy resources by 2027.
- Further substantial increases over the following 25 years to 2050, with solar PV capacity increasing to 72GW, with a comparable increase in storage to 87 GWh.
- More than 2 in 3 customers will have on-site distributed energy resources by 2050.

Transitioning to this future has substantial implications for all parts of the energy supply chain and presents a very significant range of technical, economic and regulatory challenges. Australia's electricity system has the capacity to manage the fundamental challenges of rapid energy transformation.

However, without a well-planned transition, including timely action by governments to create policy and regulatory cohesion, Australia's energy system is unlikely to efficiently and securely integrate the diverse technologies, large scale renewable energy sources and customer owned distributed energy resources.

There is a critical need for a clear transition plan, or 'Roadmap' to navigate this transformation.

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4 AEMO, National Electricity Forecasting Report, 2016

4. Distributed Energy Resources and Network Resilience

Future resilience benefits from Distributed Energy Resources

The inquiry is looking at the role of storage technologies and localised, distributed generation to provide Australia's electricity networks with the resilience to withstand the increasing severity and frequency of extreme weather events driven by global warming. Many network businesses are already integrating new technologies, including distributed energy resources, as part of its strategies for mitigating the impacts of extreme weather events. The following section outlines several examples where new distributed energy resources and other technologies are already being used to provide network resilience to extreme weather events.

Standalone Power Systems and Microgrids

Microgrids have the potential to disconnect from the main grid and operate in an "islanded mode" during severe weather events or be completely separate from the grid so that up stream impacts from extreme weather events do not impact those connected to the microgrid.

Microgrids (and stand alone power systems for individuals) are being considered by many distribution networks because of the benefits they may provide in terms of managing the network before, during and after extreme weather events.

This is particularly the case for rural networks. For example, over the last year Horizon Power built stand-alone power systems for several customers around Esperance as a cheaper alternative to restoring grid infrastructure after bushfires hit the region in 2015.

However, microgrids and standalone power systems also have the potential to deliver lower costs for all customers with modifications to existing regulatory arrangements.

In its rule change request to the Australian Energy Market Commission, Western Power estimates lower network costs of over $380 million could be achieved over the next 10 years if stand alone power systems could be installed as an alternative to replacing network assets. In addition to lower costs, Western Power estimates that this would also provide more reliable outcomes for over 2,700 customers across the network.

Analysis for Energy Networks Australia found that almost $700 million could be saved by supplying a proportion of future rural connections with a stand alone power system between now and 2050. Up to 27,000 new rural farm connections required between now and 2050 would be more efficiently supplied via a Stand Alone Power System rather than being connected to traditional grid infrastructure under current regulations.

It is estimated that by 2020, most small businesses or farms located greater than 3km from the existing grid will be lower cost if connected as a standalone power system rather than as a new grid connection. Larger, irrigation based agriculture customers will need to be more than 8km from the grid in order for a standalone power system to be viable

In addition to avoiding network expenditure, off-grid stand alone power system arrangements are likely to encourage additional investment in over 2GW of solar PV and over 7.5GWh of battery storage across Australia between now and 2050.

Despite the benefits, current regulatory arrangements mandate networks to provide a conventional and more expensive 'grid connected' service. This is likely to inhibit customers establishing a standard network connection through a Network Service Provider using a Stand Alone Power System.

Smart grids and resilience

The increasing use of other 'smart grid' technologies is also recognised as increasing the capacity of electricity systems to better manage extreme weather events, both in Australia and overseas.

In 2012, Superstorm Sandy left 8.5 million people without power in 21 US states. It is now often credited with changing the face of America's grid, driving investment in smart-grid technologies to improve resilience. The results of investment in new technologies were seen in the recent outcomes from Hurricane Matthew in Florida, which resulted in widespread outages.

Florida Light and Power recently reported that prior investment in new technologies resulted in fewer outages and faster restoration times:

- Automated switches prevented at least 25,000 outages.
- "Hardened" feeders which had been designed to withstand more severe weather conditions performed 1.5 times better than other feeders - no poles with hardened feeders sustained any damage.
- With more than 4.8 million smart meters, Florida Light and Power was able to identify which customers were impacted in real time and schedule faster, less expensive responses.[5]

Similar technologies are also in use in Australia. Smart grids provide more granular information for better situational awareness in response planning. Investment in intelligent network switching design also allows for better network segmentation (reducing response complexity).

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[5] Energy Networks Australia "After the Storm – Resilience of Major Grids", 13 October 2016

5. Energy Transformation and the need for Integration

We understand from the terms of reference, that the inquiry is investigating measures to hasten the rollout of new technologies in order to:

- » create jobs in installation, manufacture and research of storage and distribution technologies
- » stimulate household and business demand for storage technologies
- » anticipate the rapid deployment of localised distributed generation through changes to market rules
- » drive the reduction in technology costs through economies of scale
- » seize on the opportunities to be a global leader in deploying storage technologies because of Australia's high fixed electricity tariffs and significant penetration of rooftop solar.

Vision for an integrated system

Energy Networks Australia partnered with Australia's National Science agency CSIRO to develop an integrated set of milestones and actions that are necessary for an efficient and timely transformation which predominantly looks at opportunities to integrate the likely customer driven expansion of power system investment through distributed energy resources, with the existing grid. These integrated actions are geared toward delivering the following benefits for customers:

- » Achieving deep decarbonisation in accordance with the aspiration of COP 21, including meeting and exceeding emissions reductions in the electricity sector of 26 to 28% below 2005 levels by 2030 and achieving zero net emissions in the electricity sector by 2050.
- » Retention of the security and reliability essential to the lifestyle and employment in a period of unprecedented change in technology customer electricity uses.
- » Enabling customer choices and providing fair incentives, with a majority of customers in 2050 utilising distributed energy resources and 'paid' $2.5 billion per annum by networks in exchange for grid support services.
- » Cumulative total system savings (across the supply chain) of $101 billion by 2050 through fully realising complementary benefits of centralised and distributed resources.
- » Reduced network investment due to the ability to 'orchestrate' distributed resources, saving approximately $16 billion by 2050.
- » Better and fairer outcomes for customers – by 2050
  - – network charges are expected to be approx. 30% lower compared to 2016
  - – average households are expected to save around $414 in their annual electricity bill

- a medium family who cannot take up distributed energy resources is better off by over $600 per annum through lower network costs and the removal of cross subsidies.

Risks of poorly co-ordinated transition

CSIRO analysis modelling indicates that without a well planned approach to navigate this transformation, Australia's energy system will be unable to efficiently and securely integrate the diverse technologies, large scale renewable energy sources and customer owned distributed energy resources. This will potentially result in the costly duplication of energy investments.

As the penetration of distributed energy resources is likely to increase substantially, the customer driven transformation will still require management of the grid at granular, locational elements within the distribution network. Globally, there is a recognition of a number of challenges when integrating distributed resources into network operation:

» There is acknowledgement that system reliability may become an issue needing significant additional active management when VRE penetration levels exceed 30%, depending on location.

» Management of the increasingly extreme evening ramp is already an emerging issue in some places. This results from the very rapid changes in demand that occurs in the late afternoon as people return home from work, and the relatively sharp drop off in supply from solar PV as its contribution reduces relatively rapidly during the early evening.

» There are also a range of technical issues, including
  - oversupply and curtailments of DER leading to fluctuation in supply
  - ancillary services shortages
  - localised voltage spikes, and overvoltages resulting from load rejection;
  - flicker
  - reverse flow and resulting safety issues.

The role of distribution network management will become increasingly important and a number of actions required to modernise the grid and develop market platforms so that networks can optimise the benefits (and address the challenges at minimal cost) from the increased penetration of distributed energy resources at the localised level.

6. A Roadmap for Energy Transformation

Distribution businesses are already adapting their businesses to meet customer driven changes to the energy landscape. Many of the impact of these changes arise in small locational parts of the network.

Networks are increasing their capacity for monitoring and control; and adopting simple, relatively inexpensive solutions wherever possible, such as 'tapping down' the distribution transformer voltage. In other cases, it may be necessary to augment customer service mains to reduce impedance or install bi-directional voltage regulators.

However, as noted elsewhere in our response, the likely future uptake of distributed energy resources will require more substantial policy and regulatory response if the benefits of integration are to be realised and passed on to customers. An integrated energy system has the potential to:

» achieve decarbonisation at least cost to customers without jeopardising power system security and performance
» enable customer choice and control through incentives in dynamic new markets, while providing appropriate customer protections and avoiding unfair impacts on vulnerable customers.

The following areas identified in the roadmap help to achieve these outcomes:

» A clear, enduring long term carbon policy.
» A modernised electricity grid.
» Advances in technical enablers including technical standards and workforce development.
» Better pricing and incentive frameworks through orchestration and market design.
» Flexibility in the regulatory framework to encouraging alternatives for new and existing grid connection.

The need for a clear, enduring long term carbon policy

Energy Networks Australia supports the development of an enduring, stable and nationally integrated carbon policy framework based on a market mechanism to deliver greenhouse gas reduction in line with our international obligations. Work commissioned by Energy Networks Australia showed that the 2030 abatement target in the stationary energy sector could be achieved under a different range of policy settings but that the lowest impact on residential bills occurred when an emission intensive scheme was adopted. The generation mix in 2030 changed from being coal dominant currently to becoming more divers with renewables, gas and coal all contributing more equally. The level of renewables increased in all scenarios to reach between 74.500 and 80,000 GWh in 2030 representing approximately 30% of the energy mix. This demonstrates that growth in renewable generation will occur without a new large scale renewable energy target for 2030 and beyond.

The Roadmap provides analysis out to 2050 and recognises the need for the network to play its role in delivering a more sustainable electricity system with reduced greenhouse gas emissions.

The unexpected pricing and security events in South Australia in 2016 have increased the attention given to delivering low cost, secure, reliable electricity as Australia decarbonises. However, there is currently no enduring, clear long-term climate policy. There is also a lack of integration between the electricity energy sector planning processes and climate policy. These barriers to efficient decarbonisation will be exacerbated if distributed energy resources are not utilised to support system balancing, facilitated by network optimisation systems.

If these threshold issues are not addressed, CSIRO's analysis indicates the electricity sector will deliver less abatement than it is capable of and utilise a narrower and subsequently more sub-optimal set of resources to accommodate increased renewable penetration.

The Electricity Network Transformation Roadmap recommends actions and milestones which are projected to deliver 69 MtCO2-e more abatement to 2050, achieved at similar cost by 2050 compared to the counterfactual scenario). In the road transport sector, adoption of electric vehicles reduces emissions by 22 MtCO2-e per year by 2050.

Grid Modernisation

As noted above the transformation of the energy sector will require substantial improvements in grid architecture. There is a need for networks to enhance capabilities to better integrate and connect growing numbers of owners of distributed energy resources and provide more transparent information to market participants.

New markets or incentives will be required to help customers understand where and how they can deploy different types of distributed energy resources for broader market benefit

There is also likely to be a growing need for the coordination of energy flows across the electricity system, particularly so as customers and their agents or aggregators seek to aggregate loads from localised levels to provide wholesale or transmission market services.

Technical enablers – workforce and standards

The roadmap also identifies the need for technical and workforce enablers that will be required to transition the market. The Roadmap notes that the development of future standards on an open platform will provide key stakeholders more opportunity to develop and apply new technologies, enabling more product choice and encouraging greater innovation. Similarly, an adaptable workforce will provide many benefits including increased electrical safety, more functionality and value for customers and better adoption of a range of technologies

Better Pricing and Incentive Frameworks

Central to delivering key benefits to customers through the energy transformation is the need for better incentives and pricing frameworks which allow for the integration of customer owned distributed energy resources.

The roadmap demonstrates that by better integrate customer owned infrastructure with the existing grid, not only ensures all customers retain energy security and reliability and contribute to zero net emission in the electricity sector by 2050, but also delivers better results in the form of lower costs for customers. The roadmap modelling indicates that by 2050 better integration of distributed energy resources like rooftop solar and storage, along with other initiatives:

- means that $16 billion of network investment can be avoided by 2050, with $2.5 billion being paid annually to customers for the use of distribution energy resources as an alternative to traditional networks investment
- contributes to a 30% reduction in network charges, with corresponding savings in annual customer bills of around $414 per annum (compared with the roadmap counterfactual – business as usual – scenario).

A number of actions are required to deliver this over the next decade, including:

- a faster transition to more efficient pricing signals through cost reflective tariffs
- a fast tracking of infrastructure which will allow for more efficient pricing
- development of new pricing arrangements to reflect new and differentiated services
- removal of barriers for the development of new and differentiated services and pricing arrangements where it is appropriate and efficient to do so
- removal of barriers for networks to invest in microgrids or standalone power systems in relation to new or existing connections, where it is efficient to do so.
- market based approaches for providing efficient capacity as well as balancing and ancillary services
- advanced protection systems to enhance system operation, security and resilience
- open standards, extended monitoring, advanced planning and feeder hosting analysis and the mapping and locational valuation of distributed energy resources
- basic Network Optimisation Market Functions and the piloting of more Advanced Network Optimisation capabilities and functions.

7. The important role of gas

While it is recognised the Senate Inquiry terms of reference are focussed on electricity systems, Energy Networks Australia urges the Committee to take a holistic, systemic and technology neutral approach to energy transformation and decarbonisation. Specifically, the Committee is encouraged to recognise the following:

- Australia's gas sector currently provides a significant contribution to meeting Australia's energy requirements providing energy diversity and security benefits with low carbon intensity. In the future, electricity system modelling indicates it will provides a significant supporting role enabling increased penetration of variable renewable energy sources at transmission and distribution scale.

- The gas sector also faces its own carbon abatement pathway and internationally, there is an increasing focus on the role of gas in a deeply decarbonised energy system.

Further information on these topics is provided below.

Gas systems today

There are 4.7 million households connected to the gas distribution network (and a further 1.7 million on bottled gas), representing 67% of the total number of households in Australia. These households rely on gas to provide safe, reliable and cost-effective space heating, hot water and cooking.

The future economic role of gas will remain dependent on its competitive position as a fuel of choice, competing on price, sustainability, security and amenity. While there has been upward pressure on wholesale gas prices due to the internationalization of Australia's gas market, it is important to recognize the delivered cost to customers reflects other elements of the cost structure. Historically, gas distribution network costs can represent approximately 50% of the delivered cost to residential customers, compared to the wholesale cost proportion of about 20%. However, in many jurisdictions, these network costs are falling and the decrease in network costs have substantially offset increasing wholesale costs.

The role of gas in the future

Gas is currently a low emission fuel with significant capacity to support Australia achieve carbon abatement targets. It is estimated that the direct use of gas in the home has between one quarter to one-sixth the emissions of the same energy sourced from the electricity grid.[6] Gas used in power generation has approximately half the emissions of average generation[7].

Biogas

Biogas is generally produced from organic waste with different processes designed to process different fuel stocks, although the main route is through the use of a digester. The biogas produced – methane, just like natural gas - can then be injected into the gas distribution network. This process is commercially available and widely deployed within the UK and Germany. It has been estimated that in the UK[8], by the end of 2015, the established anaerobic digesters and biogas facilities had the capacity to inject 2

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[6] Energy Networks Association (2015), *Australia's Bright Gas Future – competitive, clean and reliable*, accessed from: www.energynetworks.com.au
[7] Department of the Environment (2014), *National Greenhouse Accounts Factors.*
[8] NationalGrid (2016), *The future of gas: supply of renewable gas*, February 2016, available from: http://www2.nationalgrid.com/UK/Industry-information/Future-of-Energy/Gas/

TWh/annum into the gas network, equivalent to the gas use of 155,000 homes. National Grid has also noted the potential capacity for in excess of 20 to 35 TWh of energy output by 2035, or the equivalent of over 2.7 million homes.

Within Australia, there are a number of biogas digestors operational such as the Jandakot 'Biogass' Facility[9] in Western Australia. This produces biogas which it then stores for producing electricity for use on site. ARENA[10] is also supporting a project to complete national biomass feedstock mapping resources. The AREMI platform will enable the Rural Industries Research and Development Corporation (RIRDC) to geospatially map existing and projected biomass resource data alongside other parameters such as existing network and transport infrastructure, land use capability and demographic data. When this project is completed, it will provide a reliable source of information for biogas project proponents to use.

The use of biogas results in zero net CO_2 emissions as the biomass is recognised as a renewable energy source. Producing biogas from organic waste and injecting that biogas into the gas distribution network – either as a mixture or by itself - will result in even lower emissions from the direct use of gas in the household.

Hydrogen

Hydrogen provides another alternative to lowering emissions from the use of gas. Currently, bulk hydrogen is often produced through steam re-forming of methane. This separates the hydrogen atoms from the carbon atoms to produce hydrogen gas and CO_2 as a byproduct. This CO_2 can be collected and sequestered in suitable geological storage reservoirs using a process called carbon capture and storage (CCS). These technologies are proven at commercial scale and numerous studies have been completed[11] to identify suitable geological storage sites within Australia.

The UK Committee on Climate Change[12] notes that "*hydrogen production with CCS has been clearly identified as the lowest-cost route to low-carbon hydrogen.*" Producing hydrogen through steam methane reforming - combined with CCS - achieves a near zero emissions future for gas.

Currently, the Japanese government is championing hydrogen fuels as part of their commitment to the 2020 Summer Olympic Games in Tokyo. This has resulted in renewed interest in producing hydrogen from brown coal from the Latrobe Valley through the Kawasaki Hydrogen Road[13]. While this process uses brown coal instead of natural gas for the production of hydrogen, both processes sequester the CO_2

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[9] Biogass (2016), *Commercial and Industrial Bioenergy. Now In Australia*, accessed from: http://www.biogass.com.au/

[10] ARENA (2016), *The Australian biomass for bioenergy assessment project*, accessed from: http://arena.gov.au/project/the-australian-biomass-for-bioenergy-assessment-project/

[11] For example, Carbon Storage Taskforce (2009), *Australia's potential for the geological storage of CO2*, September 2009, accessed from: http://www.industry.gov.au/Energy/Documents/cei/cst/Aus_Potential_co2_Brochure.pdf

[12] UK Committee on Climate Change (2016), *Next steps for UK heat policy*, October 2016, accessed from: https://www.theccc.org.uk/wp-content/uploads/2016/10/Next-steps-for-UK-heat-policy-Committee-on-Climate-Change-October-2016.pdf

[13] http://global.kawasaki.com/en/stories/hydrogen/

byproduct and produce clean hydrogen, which could be injected into the networks or exported (to Japan).

Hydrogen can also be produced from bioenergy, or from using surplus renewable energy to electrolyze water. Both these technologies are technically viable and being actively demonstrated. For example, the National Renewable Energy Laboratory[14] is completing a wind-to-hydrogen project where electricity produced from wind turbines and photovoltaic arrays are linked to electrolyzers to split water into hydrogen and oxygen. This hydrogen can then be stored on site for refuelling or can be used to generate electricity using an internal combustion engine or fuel cell.

Modern gas networks are able to transport hydrogen, either in its pure state or as a mixture with methane (whether that is from fossil or organic sources). The H21 Leeds city gate project[15] has proved, via a desktop study, that the Leeds gas network in the UK is large enough to convert to hydrogen. The project is now seeking to develop a roadmap to hydrogen to provide higher level of confidence in the feasibility of hydrogen conversion by addressing any remaining technical, regulatory, commercial gaps.

[14] National Renewable Energy Laboratory (2016), *Hydrogen & Fuel Cell Research – Wind-to-Hydrogen Project*, accessed from: http://www.nrel.gov/hydrogen/proj_wind_hydrogen.html
[15] KPMG (2016), *Energising the North – a report for Northern Gas Networks*, April 2016, accessed from: http://www.northerngasnetworks.co.uk/wp-content/uploads/2016/04/Energising-the-North-report-final.pdf