Australian Energy Market Commission

Distribution Market Model

APPROACH PAPER
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This paper sets out the Commission's proposed approach to exploring how the evolution to a decentralised market for the provision of electricity services at the distribution level may occur.

Inquiries

Australian Energy Market Commission
PO Box A2449
Sydney South NSW 1235

E: aemc@aemc.gov.au
T: (02) 8296 7800
F: (02) 8296 7899

Reference: SEA0004

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About the AEMC

The AEMC reports to the Council of Australian Governments (COAG) through the COAG Energy Council. We have two functions. We make and amend the national electricity, gas and energy retail rules and conduct independent reviews for the COAG Energy Council.

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Executive Summary

The uptake of rooftop solar photovoltaic systems, battery storage, electric vehicles and other technologies at the distribution level in Australia's electricity sector is having an impact on the way that consumers have traditionally been supplied with and use electricity. Technological innovation is making the functions these technologies perform cheaper and more accessible to a wider range of users. This change is greatly expanding the choices that consumers have to manage their energy needs and can potentially deliver significant efficiency benefits and reliability improvements in the delivery of electricity services.

These 'distributed energy resources' present both opportunities and challenges to distribution network businesses. Distributed energy resources can be used to help distribution network businesses meet their regulatory obligations to provide a safe, secure and reliable distribution network, for example by providing reactive power, voltage support or network loading control, or helping to reduce peak load. However, as penetration levels increase, the aggregate technical impact of distributed energy resources can also affect the operation of distribution networks, for example by causing reverse power flow and voltage instability.

As distribution networks shift from facilitating one-way flows to more dynamic, two-way flows of electricity, distribution network businesses are fundamentally changing how they think about, invest in and operate their networks. While the focus of distribution operations to date has been on the provision of a reliable and safe supply to consumers, the need to more actively manage distribution system operations is likely to increase as more distributed energy resources and distributed generation are installed, and two-way electricity flows increase. This may mean that distribution systems need to be more actively managed, like transmission systems are currently.

More generally, there is a need to facilitate cooperation between various parts of the supply chain to maximise the value of the multiple services that can be provided by distributed energy resources.

For these reasons, distributed energy resources have the potential to alter the structure and dynamics of the traditional electricity supply chain. To enable these developments to occur in a manner consistent with the National Electricity Objective, changes may be needed to the National Electricity Market design or regulatory arrangements. For example, the efficient adoption of distributed energy resources may require the provision of price signals or the imposition of standards so that third parties do not bear increased costs as a result of another party installing these technologies.

At the same time, distribution networks may need to adapt to accommodate an increased amount of distributed energy resources and the various capabilities of these technologies. In the longer term, more fundamental changes to market design and the regulatory framework may be needed to enable distribution network businesses to move from being asset owners and operators to being providers of market platforms that send signals to incentivise the efficient integration of distributed energy resources, or for other parties to take on this role.

Nevertheless, we do not know what the future will look like. It may involve high levels of distributed energy resources. Alternatively, technology developments and climate change policies may result in a future with more use of grid-scale renewable generation and storage, rather than at consumer premises. Energy policy and associated regulatory frameworks need to be flexible and resilient enough to respond to whatever the future may bring in a way that is technology neutral, facilitates consumer choice and maximises efficiency. Where there are barriers or constraints to consumers exercising their choices, the Commission's preference is to address those barriers rather than using regulatory instruments to impose technology-based solutions on consumers.

The Commission is undertaking the Distribution Market Model project as part of its technology work program to explore how the evolution to a decentralised market for electricity services at the distribution level may occur. The project will consider what changes to the regulatory framework, distribution system operation and market design more broadly might need to occur to accommodate this evolution.

This paper sets out the scope and context for the project, and the Commission's proposed approach. The Commission welcomes written submissions from stakeholders on any aspect of this approach paper by 19 January 2017, as well as individual meetings with interested stakeholders. The Commission will hold a series of public workshops in early 2017 before publishing a final report setting out a range of possible distribution market design options and their advantages and disadvantages, taking into account stakeholder views on this approach paper, in early to mid-2017.

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1 Introduction

1.1 Objective of this project

This project forms part of the Australian Energy Market Commission's (AEMC or Commission) technology work program, which seeks to explore whether the energy market arrangements are flexible and resilient enough to respond to changes in the availability and cost of energy technologies.[1] It builds on the analysis undertaken by other projects in the technology work program, including the Integration of Storage report, which was published in December 2015.

The Distribution Market Model project is intended to be a forward-thinking, strategic piece to help inform the Commission’s analysis of rule changes submitted to it by stakeholders in response to emerging issues, and its advice to governments.[2] Its purpose is to examine how distributed energy resources might drive an evolution to a more decentralised provision of electricity services at the distribution level, the incentives or disincentives for business model evolution, and whether changes to the regulatory framework, distribution system operation and market design more broadly are needed to enable this evolution to proceed in a manner consistent with the National Electricity Objective (NEO).

To achieve this objective, the Commission will explore:

- the technical opportunities and challenges presented by distributed energy resources;
- what, if any, new roles, price signals and market platforms are required to optimise the development, deployment and use of distributed energy resources;
- how the role of distribution network service providers (DNSPs) may need to adapt to facilitate a transition to a more decentralised market for electricity services;
- whether the existing electricity regulatory framework impedes or encourages innovation and adaptation by DNSPs to support the efficient uptake and use of distributed energy resources; and
- whether changes to the existing distribution regulatory arrangements, or the design of a new market, are necessary to address any impediments to business model evolution.

The project is not intended to be a prediction of or pathway for future regulatory reform, but rather an exploration of the possible distribution market design options that may be available to harness the opportunities presented by distributed energy

1 See http://www.aemc.gov.au/Major-Pages/Technology-impacts

2 Related rule changes and reviews currently under consideration by the Commission are set out in section 1.4.

resources, while addressing any technical impacts as they arise. The availability and uptake of distributed energy resources is enabling electricity customers to make decisions that serve their own interests and what they value as a user, or producer, of electricity. These choices are driving investment in, and deployment of, particular technologies. The Commission considers that consumer choices should continue to drive the development of the energy sector, but that market design and regulatory frameworks may need to be modified to better align individual decisions with the long-term interests of consumers more generally.

The purpose of this approach paper is to:

- communicate the objective and scope of the project;
- establish the 'starting point' - that is, what the role of DNSPs is under the current market design;
- set out the Commission's analysis of the technical opportunities and challenges presented by distributed energy resources;
- describe the Commission's framework for how the opportunities and challenges of an increased uptake of distributed energy resources will be assessed; and
- seek feedback from stakeholders on each of the above items.

1.2 Key terms

The term **distributed energy resource** is used in this paper to refer to an integrated system of *smart energy equipment* co-located with consumer load. By 'smart', we mean it has the ability to respond automatically to short-term (e.g. within a trading period - 30 minutes, or dispatch period - 5 minutes, or an even shorter period) changes in prices or signals from wholesale markets or elsewhere in the supply chain. 'Energy equipment' could include a range of technologies, including battery storage, electric vehicles, rooftop solar photovoltaic (PV) systems, or household appliances such as refrigerators and dishwashers.

Thus, the term 'distributed energy resource' captures any energy technology that is equipped with a smart controller, for example smart thermostats and possible futuristic technologies such as frequency-responsive refrigerators or dishwashers that wait for a low price period before commencing their cycles. It is not the equipment itself that is smart, but its controller: an air-conditioner with a smart thermostat is considered to be 'smart', but it is really just a normal air-conditioner with a smart controller.

This definition does not capture energy equipment that operates passively, for example a rooftop solar PV system that generates and feeds power into the grid when the sun shines, rather than in response to short-term changes in prices or signals from elsewhere in the supply chain. The Commission has decided to exclude such equipment from the definition of distributed energy resources because the mechanisms to address the issues raised by the passive operation of these technologies, such as tariff structures or export constraints on distribution networks, are limited in their ability to promote efficient coordination across all elements of the supply chain. Further, with the right incentives from market mechanisms, it will become worthwhile to make passive energy equipment 'smart'.

Distributed energy resources are distinct from **distributed generation**, a term used in this paper to describe smart energy equipment that is connected to the distribution network at a dedicated connection point, for example a solar farm.

> **Question 1** Do stakeholders agree with these definitions, or have any views on the project scope as a result of these definitions?

1.3 Project scope

Part of this project will examine whether changes to the regulatory framework will be required to facilitate an increased amount of distributed energy resources and provide appropriate incentives for the ways in which these resources can be used. By 'regulatory framework', we are referring to the National Electricity Law (NEL) and National Electricity Rules (NER), which together establish the arrangements that underpin the operation of the National Electricity Market (NEM), and relevant legislation and regulation at the jurisdictional level. The NEL and NER also govern the economic regulation of electricity TNSPs and DNSPs. They apply in all National Electricity Market (NEM) jurisdictions, that is, the ACT, NSW, Queensland, South Australia, Tasmania and Victoria.[3]

This project does not explicitly consider aspects of the National Energy Customer Framework - that is, the National Energy Retail Law (NERL) and National Energy Retail Rules (NERR) - that may be relevant to the consideration of the impact of distributed energy resources on distribution market design.[4]

This focus of this project is on the technical and regulatory challenges of distributed energy resources on distribution networks. It does not comprehensively consider the design of transmission-based markets (including the wholesale electricity market) or retail markets. Nevertheless, there are interactions between distributed energy resources and other markets that need to be considered. For example, while distribution market design should enable the efficient use of distributed energy resources in distribution markets, it should also enable the participation of distributed energy resources in transmission-based markets. Other AEMC projects may also be

3 Note that Western Australia has not yet adopted the National Electricity Law framework, and that in the Northern Territory only NER chapters 6, 8, 9, 10 and 11 (with derogations) apply.

4 We note that the consumer protection issues raised by distributed energy resources are being explored through other projects. This includes the COAG Energy Council's work on appropriate consumer protections for "behind-the-meter systems", see http://www.coagenergycouncil.gov.au/publications/energy-market-transformation-%E2%80%93-consultation-processes and the AEMC's work on consumer protection issues to be explored through the 2017 annual retail competition review.

relevant to these considerations, for example the 'five minute settlement' rule change and the 'non-scheduled generation and load in central dispatch' rule change.[5] This project therefore considers other markets to the extent that distributed energy resources can participate in, and affect, those markets.

The Commission is of the view that distribution networks are not fundamentally different to transmission networks. Of course, they share the same laws of physics and comprise the same fundamental components: lines, transformers, protection systems, etc. In this way, a distribution system with distributed energy resources can be considered to be a transmission system on a smaller scale, with household battery storage systems in place of large-scale pumped storage, and solar PV systems in place of large generators.

The technical and policy issues that arise for distribution networks from the connection and operation of distributed energy resources and distributed generation are therefore likely to be similar to, or the same as, those that have already been seen in transmission networks. For example, power system stability has historically been an issue to be considered by AEMO at the transmission level only, but with greater penetration of distributed energy resources, possible sources of and solutions to power system stability are needing to be considered at the distribution level. Transmission system operators have been optimising the flow of electricity to balance supply and demand across their networks for years, so it is not inconceivable that this may need to occur at the distribution level as more distributed energy resources are installed.

So, rather than developing options from scratch, the Commission considers that it is preferable to consider how our existing understanding of transmission network operation translates to distribution, and whether particular responses that may be practicable and appropriate at the transmission level can and should be applied at the distribution level.

Nevertheless, there are some key differences between electricity distribution and transmission networks, summarised below.

- Distribution networks typically have an order of magnitude more lines, transformers and connection points than transmission networks, and distribution networks operate at lower voltages and power flow ratings.
- Distributed energy resources and distributed generation are more numerous and have a greater tendency to be co-located than transmission-connected generation and load. There are millions of residential and small business consumers (many already with solar PV systems), but only few hundred transmission-connected generators and loads.
- Distribution networks are largely radial, whereas transmission networks are meshed.

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5 See http://www.aemc.gov.au/Rule-Changes/Five-Minute-Settlement and http://www.aemc.gov.au/Rule-Changes/Non-scheduled-generation-in-central-dispatch

- Distribution power flows are currently almost exclusively in one direction - from the transmission connection point through to the consumer (although we note that this is changing) - while the direction of transmission power flows often reverses.

These differences mean that, while we may consider the same range of technical and regulatory solutions as on the transmission network, the relative costs and benefits of the options are likely to be different. Distribution and transmission frameworks should be consistent, but not necessarily identical.

Question 2	**Do stakeholders support this project scope? Is there anything that has not been flagged for consideration that should be? Is there anything that should be excluded from the project scope?**

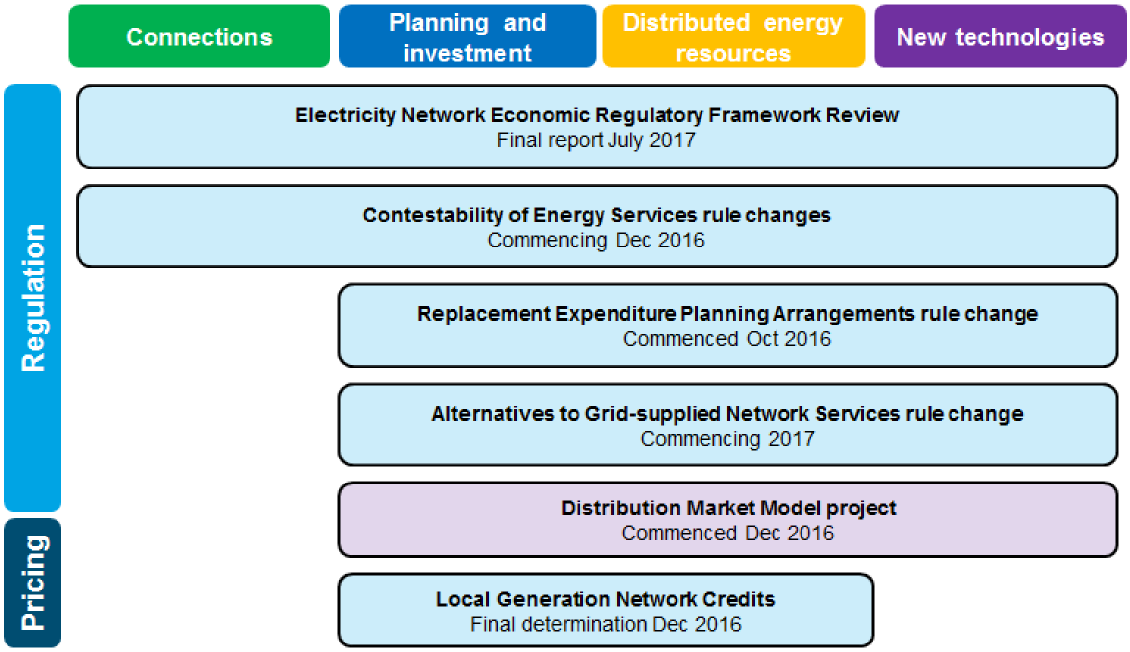
1.4 Related work

This project is intended to complement the range of work being undertaken by the Commission and other parties regarding distributed energy resources, distribution networks and interactions with the electricity regulatory framework. It is intended to be a forward-thinking, strategic piece to inform the Commission's analysis of rule changes and reviews, and its participation in external projects.

1.4.1 AEMC projects

The Commission is currently considering a range of rule change requests and reviews that together contemplate changes to the economic regulatory framework that underpins the operation of distribution networks. Figure 1.1 groups these projects into topic areas. The Commission is closely considering the interactions between these various projects and sharing knowledge between internal project teams where relevant. A description of each project can be found in appendix A.

Figure 1.1 Future of electricity networks - AEMC rule changes and reviews



1.4.2 External projects

The Commission is also aware of, and participating in, a range of work streams being undertaken by other organisations in this space. A description of these projects can be found in appendix A.

1.5 Structure of this paper

This paper is structured as follows:

- Chapter 2 provides the context for the Commission's consideration of this work, including the drivers that are likely to promote the development and deployment of distributed energy resources, and the role of the Australian Energy Market Operator (AEMO) and DNSPs under the current regulatory framework;
- Chapter 3 sets out the Commission's framework for how the technical impacts and associated regulatory challenges of increased uptake of distributed energy resources will be assessed through this project;
- Chapter 4 summarises the Commission's analysis of the key technical impacts that an increased uptake of distributed energy resources can present; and
- Chapter 5 sets out the Commission's next steps for this project.

2 Background

2.1 Project context

There is a degree of uncertainty about the future development and uptake of energy technologies such as solar PV, battery storage and electric vehicles in Australia over the coming decades. However, AEMO forecasts that:

- embedded solar PV uptake will triple by 2030, with 16GW of installed capacity across the NEM, which equates to approximately 50 per cent of projected average daytime demand;[6]
- by 2035/36, nearly 4GW of this rooftop PV capacity will have integrated battery storage, providing 6.6 GWh of energy storage potential;[7] and
- the number of electric vehicles will significantly increase, from around 2,000 vehicles currently to around 255,000 in 2030, providing a total charging load of around 1,800MW.[8]

The uptake of these technologies, and others, in Australia's electricity sector is having an impact on the way consumers have traditionally been supplied with and use electricity. Such technologies enable consumers to generate electricity in the distribution system, providing capabilities such as local generation, load shifting and load reduction. These capabilities can also be used to provide support to distribution networks, for example by helping to reduce peak load. When equipped with 'smart' functionality, such technologies have the ability to provide these capabilities, and others, in response to short-term changes in prices or signals from wholesale markets or elsewhere in the supply chain, to any party that may want them. Such 'distributed energy resources' have the potential to bring substantial benefits to consumers in terms of the cost of, and choice in, their energy service offerings.

Essentially, a distributed energy resource behaves like a dispatchable generator that is co-located with a consumer. This turns the conventional supply chain on its head, from generator -> transmission -> distribution -> consumer, to distributed energy resource -> distribution -> transmission -> distribution -> consumer. This partial up-ending of the supply chain means that distribution networks are now more actively managing generation in the distribution network than they were previously; in a manner akin to how transmission networks have traditionally operated.

This change in the way that electricity is supplied and consumed can present opportunities and challenges to the management of distribution networks. As is described in chapter 4, the aggregate technical impact of distributed energy resources on distribution networks is likely to increase as penetration levels increase, for example

6 AEMO, National Electricity Forecasting Report, 2016.

7 Ibid.

8 AEMO, Emerging technologies information paper, 2015.

by causing reverse power flow and voltage instability. Yet while distributed energy resources are causing some of these technical issues, they can also be part of the solution, for example by providing reactive power or voltage support to network businesses, or frequency regulation to AEMO.

This change may also affect the role and function of DNSPs, and the regulatory framework that governs their operation. There is a range of ways in which the opportunities of distributed energy resources can be harnessed, and the technical impacts addressed. It is the objective of this project to explore some of those possibilities.

2.2 Drivers of change

The Commission sees three main drivers that are likely to promote the development and deployment of distributed energy resources, and create the need or impetus for associated changes to regulatory arrangements, or the design of new markets. These drivers are described below.

2.2.1 Generation technological change

New generation technologies (especially wind turbines, solar PV, and power-scale batteries) have several characteristics that are quite different from conventional, thermal generation technologies:

- **Scale** - Much smaller generators are possible due to more limited economies of scale.
- **Fuel source** - Solar and wind resources are more widely distributed than fossil fuel resources, which are only readily available in certain locations.
- **Intermittency** - Solar and wind resources are variable and cannot be stored directly (unlike coal or other inputs). As such, solar and wind output is variable.
- **Flexibility** - Some non-thermal and smaller generators can respond much faster than most conventional generation.
- **Synchronous inertia** - New generation technologies may not be synchronised to the system frequency.

An increased penetration of technologies with these characteristics at the distribution level, including distributed energy resources, may create the need for changes to regulatory arrangements, or the design of new markets.

2.2.2 Information technology change

New information technologies such as the 'internet of things', blockchain and fast, cheap computing platforms will enable much more sophisticated control technologies, dispatch algorithms and settlement arithmetic. As consumers integrate more connected devices into their homes and install smarter meters, they will produce more and more data. This 'big data' and digital enablement offers consumers or their energy service providers access to much more information and the ability to control of a range of devices. Companies other than traditional energy retailers are seeing opportunities to bundle energy services with other product offerings, as in integrated smart homes. This transformation is driving changes in the capabilities and operation of distributed energy resources, and may ultimately drive market design changes.

2.2.3 Consumer attitudes

Consumers in many sectors are seizing the opportunity for 'disintermediation', that is - going direct to suppliers through web-based platforms (for example, AirBnB and Uber) rather than through traditional retail 'gatekeepers' (for example, real estate agents and taxi companies). If these attitudes extend across to the electricity market, it could increase consumer demand for distributed energy resources and for associated, flexible retail energy products. For example, Mojo Power is selling power to customers at the wholesale price (plus regulated network charges) and is earning its operating profit by charging a monthly subscription fee instead of a typical retail mark-up. Energy consumers are also showing interest in opportunities to engage in peer-to-peer trading with others on the distribution network, for example by selling excess electricity generation from a solar PV system directly to someone, perhaps a neighbour, who may wish to purchase it. Such opportunities could mean that consumers are bypassing the financial operations of the NEM entirely, which could have a considerable impact on future market design.

The Commission's annual retail competition review explores the impact of changing consumer preferences on competition in the retail energy market and energy products and service offerings.

2.3 What is the current role of a DNSP?

Distribution and transmission networks enable the power system to operate as a connected system; they link power stations to the end users who consume electricity. The essential role of a DNSP is to convey, and control the conveyance of, electricity from transmission networks or embedded generators to end-use customers. They perform a number of functions to fulfil this role, including network planning, development, ownership and operation, although it is not necessary for a single entity to perform all of these functions. DNSPs are subject to a range of obligations under NEM-wide and jurisdictional legal instruments to support the performance of these functions.

2.3.1 Technical regulation

DNSPs are required to comply with a number of obligations to support the secure, safe and reliable operation of the national grid for the benefit of consumers. For example:

- The NER places certain obligations on DNSPs to help maintain power system security and quality of supply.
- The NERR sets out the process by which small customers connect to the distribution network, and the relevant obligations of DNSPs.
- Jurisdictions, largely through licensing arrangements, place obligations on DNSPs to connect customers to, and supply customers through, their networks.
- Jurisdictions, either through the relevant state/territory government or economic regulator, determine the reliability standards that DNSPs are required to meet. In regulating these businesses, the Australian Energy Regulator (AER) is required to take the relevant jurisdictional reliability standards as an independent obligation on the business and determine the efficient expenditure required to meet this obligation.
- Jurisdictions, either through the relevant state/territory government or safety regulator, place obligations on DNSPs to provide and maintain a safe supply of electricity to consumers.

2.3.2 Current economic regulatory framework and emerging challenges

Like transmission networks, distribution networks are capital intensive and incur declining average costs as the number of customers served and energy supplied within an area increases. Networks in a particular geographic area are therefore often most efficiently provided by one supplier. For example, the cost of transporting electricity from generators to households is likely to be much higher if two or more businesses built poles and wires on every street. This is why electricity networks are often described as 'natural monopolies'. In the absence of regulation, network businesses could extract most or all of the benefits accruing throughout the electricity supply chain. To avoid this outcome, the NEL and NER establish a framework under which network service providers are economically regulated to encourage efficient investment and maintenance of infrastructure to meet reliability and quality of supply standards, while seeking to prevent monopoly pricing.

The economic regulatory framework in the NEL and NER is designed to incentivise DNSPs to meet their obligations at efficient cost. The subsections below set out some of the arrangements by which DNSPs plan for and invest in their networks, the incentives that encourage them to do so efficiently, and the challenges that are emerging in the operation of these regulatory instruments in light of the uptake of distributed energy resources. This is not a comprehensive description of all elements of the distribution economic regulatory framework. The Commission welcomes stakeholder feedback on other aspects of the existing regulatory framework that may be relevant to this project.

Regulatory investment test

The NER requires DNSPs to undertake a cost-benefit analysis of alternative options that could enable them to meet their obligations, where the expected value of the solution is above a certain threshold (currently $5 million). This required form of analysis is known as the regulatory investment test for distribution (RIT-D). For example, in meeting a reliability issue caused by rising peak demand, a DNSP may need to evaluate and choose between a range of possible solutions, such as paying an embedded generator for network support, paying for demand response at peak times or building additional network capacity.[9] The outcome of the RIT-D may be that the DNSP makes a network investment itself using capital expenditure or procures services from a third party or an affiliate business (subject to ring-fencing) using operating expenditure. The RIT-D includes prescriptive obligations on DNSPs to take into account non-network options as a means to address an identified need. Distributed energy resources and distributed generation are increasingly being seen as a means by which DNSPs can address a range of network needs, and there are several trials underway seeking to demonstrate this ability.

Incentive schemes

The regulatory framework provides DNSPs with incentives to provide services at a higher standard than mandated where the benefits of the higher standard outweigh the costs. For example, a DNSP may earn additional revenue through the service target performance incentive scheme for providing greater levels of reliability than the benchmark level determined by the regulator.

The NER also provides for a demand management incentive scheme and innovation allowance to be developed and applied by the AER. The objective of the scheme is to provide DNSPs with an incentive to undertake efficient expenditure on non-network options relating to demand management. The innovation allowance provides DNSPs with funding for research and development in demand management projects that have the potential to reduce long-term network costs.[10]

Service classification

The theoretical rationale for economic regulation of DNSPs typically only applies to the provision of the core network service – that is, the natural monopoly service of conveying and controlling the conveyance of electricity across a distribution network. However, the NEL and NER potentially allow for the economic regulation of all distribution services. The term 'distribution service' is broad, and is defined in the NER as a service provided by means of, or in connection with, a distribution system. For

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9 The Commission received a rule change request from the AER in July 2016 that seeks to increase the transparency of network asset replacement decisions by TNSPs and DNSPs, including by extending the application of the RIT-T and RIT-D to replacement projects. See section 1.4.1.

10 The AER is developing a new demand management incentive scheme and innovation allowance mechanism in light of a rule change made by the AEMC in 2015. See https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/demand-management-incentive-scheme-and-innovation-allowance-mechanism and http://www.aemc.gov.au/Rule-Changes/Demand-Management-Embedded-Generation-Connection-I#.

example, under this definition, a distribution service could be the use of a pole that is part of the distribution network to provide telecommunication services to a third party.

The NER requires the AER to determine how a distribution service should be classified, with the classification determining what form of economic regulation, if any, the service will be subject to. The AER's classification decisions cover the full spectrum of forms of regulation, from no economic regulation to full building block ("price") regulation. In classifying a distribution service, the AER is required to have regard to a range of factors, including the form of regulation factors set out in the NEL. Decisions about which services exhibit natural monopoly characteristics, and are therefore subject to regulation, are made by the AER when classifying distribution services, in accordance with the requirements set out in the NER.

The AER's classification of distribution services is likely to become more challenging over time as technology evolves. While the existing assets used to convey or control the conveyance of electricity in a distribution system are likely to continue to exhibit natural monopoly characteristics, technology advancements are likely to mean that substitutes for grid-supplied electricity will become more cost effective. These alternatives may not exhibit strong economies of scale or natural monopoly characteristics. For example, the installation of solar PV, a battery and a backup diesel generator at the premises of two customers may not be much less than double the cost of installing the same equipment at the premises of a single customer. Accordingly, it would not be necessary that a single firm installs new technologies at all customers' premises in order to maximise economic efficiency.

There may also be competition concerns if DNSPs are able to provide both core, monopoly network services and services that can be provided efficiently on a contestable basis. The Commission's Integration of Storage report recommended that the regulatory framework prevent DNSPs from providing contestable services 'behind the meter', unless the economically regulated arm of the business is appropriately ring-fenced from the business providing contestable services. Under such an approach, the economically regulated arm of a DNSP would be prevented from supplying battery storage devices at consumer premises and services to consumers by means of that device, but could use operating expenditure to pay third party providers, or an affiliate (subject to ring-fencing requirements) to procure network support services from such devices.

The Commission has received two rule change requests that concern the economic regulation of services provided by new energy technologies at the distribution level.[11] The Commission's rule making process for those rule change requests will explore the emerging challenges of the current service classification framework, and potential solutions to address them. The Commission will consider the issues and solutions raised through that rule change process, where relevant, to inform the broader, longer term issues that are being explored through this Distribution Market Model project.

11 See appendix A.1.2.

Ring-fencing

The regulatory framework attempts to preserve competition in contestable markets by placing restrictions on the activities that DNSPs can carry out, for example through ring-fencing. Ring-fencing is designed to limit the ability of a regulated monopoly service provider to foreclose on competition in an upstream or downstream market where it or one of its affiliates operates, and thereby extract a larger share of the benefits otherwise flowing to consumers. Such a foreclosure could occur if the regulated service provider is able to recover some or all of the costs of running its upstream or downstream business through prices for regulated services. Foreclosure could also occur if the regulated business is able to provide another type of advantage to its affiliated business that allows it to out-compete its rivals.

The AER published a national ring-fencing guideline on 30 November 2016.[12] It replaces the various state-based ring-fencing instruments that were originally designed to separate the provision of network services from the provision of retail and generation services. The AER's revised guideline seeks to address the risk that a DNSP will:

- cross-subsidise its provision of contestable services with revenue earned from their provision of regulated distribution services; or
- discriminate in contestable markets in favour of its own business units providing contestable distribution services or through one of its affiliate entities providing contestable electricity services, for example by providing an affiliate with access to information acquired through the provision of regulated services.[13]

Network pricing reform

In November 2014, the AEMC made a rule that requires DNSPs to set network tariffs that reflect the efficient cost of providing network services to individual classes of consumers.[14] Cost-reflective network tariffs allow consumers to compare the value they place on using the network against the costs caused by their use of it, which can result in significant savings for consumers and enable them to make more informed choices about what technologies they invest in. Consumers who choose to respond to network prices by reducing their consumption at times of greatest network utilisation will be rewarded through lower network charges and, over time, all consumers will benefit through lower network costs and lower average network charges. To comply with the new rules, DNSPs have introduced peak demand and time-of-use tariffs that will take effect in 2017. The implementation of cost-reflective pricing, and ongoing changes to network tariffs as distribution networks evolve, is necessary to support the

12 See http://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/electricity-ring-fencing-guideline-2016

13 AER, Ring-fencing guideline (electricity distribution), fact sheet, November 2016, p. 1.

14 http://www.aemc.gov.au/Rule-Changes/Distribution-Network-Pricing-Arrangements

efficient use of the network and allow consumers to continue to drive the way the energy sector develops.[15]

Question 3	Are there any other elements of a DNSP's role or current responsibilities that should be considered?

2.4 What are AEMO's powers and responsibilities at the distribution level?

As the power system operator for both the National and Wholesale Electricity Markets,[16] AEMO is responsible for maintaining power system security.

Chapter 4 of the NER sets out the arrangements for maintaining power system security. While the definition of 'power system' in the NER includes both transmission and distribution, the detailed obligations set out in Chapter 4 of the NER focus on power system security at the transmission level. Power system security at the distribution level has historically not been a direct concern for AEMO, given that there has not been much generation connected to the distribution network. However, with more distributed energy resources and more distributed generation, AEMO has recently needed to consider power system security more broadly. This includes how distributed energy resources could affect the security of the transmission network, as well as how the operation of distributed energy resources may need to be coordinated.[17]

AEMO, through its Future Power System Security program, has identified that its ability to model the power system effectively requires information and understanding of the electrical characteristics of all components of the power system that can have a material impact on its dynamic behaviour. Although small individually, distributed energy resources in aggregate can have a material impact on networks. AEMO is of the view that the representation of distributed energy resources in power system operational and planning tools will become more important as their penetration increases. It therefore considers that appropriate methods of representation and aggregation, and generation output forecasts for distributed energy resources, are vital inputs to power system operations.[18]

Question 4	Are there any aspects of the regulatory framework that are not set out in sections 2.3 or 2.4 but which should be considered through this project?

15 The AEMC's Electricity Network Economic Regulatory Framework Review identified network pricing reform as a preliminary priority for the 2017 report. See appendix A.1.1.

16 AEMO is responsible for operating the Wholesale Electricity Market for the South West Interconnected System of Western Australia.

17 AEMO has established a program of work to assess and address the technical challenges that are likely to emerge as the NEM generation mix continues to change and consumers become increasingly active in how their demand is met. See appendix A.2.5.

18 AEMO, Future Power System Security Program, Progress report, August 2016, p. 5.

2.5 Summary

In the Commission's view, the focus of distribution operations to date has been on the provision of a reliable and safe supply to consumers, with only a limited need to actively manage distribution system operations in the way that transmission systems are managed currently. However, as distributed energy resources and distributed generation become more widespread, and two-way electricity flows increase, the Commission considers that there will be a growing need for the operation of distribution systems with distributed energy resources and distributed generation to be more actively managed and coordinated.

Accordingly, this growing need will need to be accommodated when considering future market design options. It also raises the question as to what institution should be responsible for the active management of distribution system operations in the future, and whether a single entity should oversee all distribution system operations or a more tiered approach is preferable.

Question 5	**Should the coordination of distribution systems with distributed energy resources be centralised under the direct control of one body? Or should it be devolved and performed in a tiered manner?**

3 Assessment framework

This section sets out the Commission's framework for how the opportunities and challenges of an increased uptake of distributed energy resources will be assessed.

DNSPs, responsible for the secure, safe and reliable operation of their distribution network, have a range of options open to them to resolve a number of the technical impacts of distributed energy resources that are set out in section 4. Traditionally, network businesses have sought to address technical impacts by investing in new network equipment or building on existing capabilities. However, as noted in section 2.3.2, decisions about how to regulate the services DNSPs provide is becoming more challenging as technology evolves. While the assets used to convey or control the conveyance of electricity in a distribution system are likely to continue to exhibit monopoly characteristics, the emergence of distributed energy resources, distributed generation and other technologies means that the range of options to address their technical impacts is more diverse and possibly more cost effective than traditional network solutions. Similarly, distributed energy resources and distributed generation can be used to supply services that substitute for the services provided by the network itself.

There is also a range of ways in which the regulatory challenges presented by distributed energy resources can be addressed. The fundamental role of any market is to match buyers and sellers and to ensure, in aggregate, that supply matches demand. In electricity, this requirement is particularly acute, since electricity cannot be stored (on a network at least). The existing electricity market design, and the regulatory framework that governs it, is based on a linear supply chain, that is from generator -> transmission -> distribution -> consumer. The Commission has been amending the regulatory framework over recent years to reflect the changes brought about by distributed energy resources and distributed generation, including through the Power of Choice reforms and rule changes relating to the connection of embedded generation. More significant changes to this market design and the regulatory framework may be needed over the long term to enable DNSPs to move from being asset owners and operators of the distribution system to providers of market platforms that send signals to incentivise the efficient integration of distributed energy resources and better matching of supply and demand, or enabling other parties to take on this role.

Jurisdictions around the world are grappling with similar technical and regulatory challenges, and seeking to address them in a range of ways. Box 3.1 describes the approach the state of New York is taking to address these challenges.

Box 3.1 Reforming the Energy Vision

In April 2014, the New York Public Service Commission initiated the Reforming the Energy Vision (REV) initiative, stating six objectives:

- enhanced consumer knowledge and tools that will support effective management of total consumer electricity bills;
- market animation and leverage of ratepayer contributions;
- system-wide efficiency;
- fuel and resource diversity;
- system reliability and resiliency; and
- a reduction of carbon emissions.[19]

The drivers for implementing the REV initiative included, among other things, aging network infrastructure, emerging threats to a centralised power system, a potential increase in the number of electric vehicles and reducing electricity sector emissions.[20]

Part of the REV seeks to develop a market for the efficient procurement of distributed energy resources and other distributed energy services. Under this model, regulated distribution utilities also act as Distributed System Platform (DSP) operators who provide integrated system planning, grid operations and market operations. The intention is that technology innovators and third party aggregators will develop products and services that enable full customer engagement, the utilities will provide a platform that supports uniform market access to customers, aggregators and the distribution system, and the utilities will account for the impact of active load management in their grid planning and operations. The distribution utility will plan for assets upgrades and maintenance, while also producing a Distributed System Implementation Plan containing proposals for capital and operating expenditure to build and maintain its functions as the DSP, as well as information needed by third parties to plan for effective market participation.

The REV initiative incorporates three key components – regulatory reform by the New York Public Service Commission, public subsidies or financing by state-run agencies and direct investments by the state-owned utility (New York Power Authority). The first part of REV that focuses on regulatory reform has some similarities to this project. However, the scope of the REV extends much further into the subsidisation of

19 MDPT (MDPT Working Group) 2015, Report of the Market Design and Platform Technology Working Group, p. 14.

20 Department of Public Service (State of New York), Developing the REV market in New York: DPS staff straw proposal on track one issues, August 2014, p. 3.

particular investments/technologies and includes direct investments by the state-owned energy business. The Commission considers that these broader policy objectives are best considered by governments since they may result in trade-offs being made between different objectives on behalf of consumers.

Therefore, the focus of this project is on potential regulatory and market design reform to promote the efficiency of electricity supply in the long-term interests of consumers. We consider that, in any changes to energy market or regulatory design:

- consumer choice should drive the development of the sector;
- competition should be promoted to the extent possible;
- regulation should only be used where necessary to address market failure;
- risks should be allocated to parties that are best able to manage them; and
- particular technologies or business models should not be biased over others.

In 2001, the Commonwealth, State and Territory Governments of Australia recognised that effective operation of an open and competitive national energy market contributes to improved economic and environmental performance and delivers benefits to households, small business and industry.[21] An objective of the Australian Energy Market Agreement[22] is, among other things, to enhance the participation of energy users in the markets including through demand side management and the further introduction of retail competition, to increase the value of energy services to households and businesses.

The NEO refers to the promotion of efficiency for the long-term interests of consumers. The availability and uptake of distributed energy resources is enabling electricity customers to make decisions that serve their own interests and what they value as a user, or producer, of electricity. These choices are driving investment in, and deployment of, particular technologies. The Commission considers that consumer choices should continue to drive the development of the energy sector, but that market design and regulatory frameworks may need to be modified to better align individual decisions with the long-term interests of consumers more generally. For example, to the extent that consumers make decisions regarding distributed energy resources that impose costs on others, those costs should be signalled to the consumer so that the costs can be internalised and incorporated in the consumer's decision-making.

In this way, energy market design should enable the efficient uptake and operation of existing and new energy technologies while facilitating technological innovation, competition and consumer choice. Where there are barriers or constraints to consumers

21 See http://www.pc.gov.au/inquiries/completed/gas/documents/coagenergypolicydetails.pdf

22 The Australian Energy Market Agreement sets out the legislative and regulatory framework for Australia's energy markets, and provides for national legislation that is implemented in each participating state and territory. See https://scer.govspace.gov.au/files/2014/01/Final-Amended-AEMA-Dec-2013-signed.pdf

exercising their choices, our preference is to address those barriers rather than using regulatory instruments to impose technology-based solutions on consumers. The rules the Commission makes, and the advice it provides are therefore technology agnostic to the greatest extent practicable. The Commission's goal is to advise on and set a market framework that promotes consumer choice and can respond to any future scenario, including changes in technology.

Box 3.2 sets out a number of principles that the Commission has developed to guide its analysis of the technical and regulatory challenges raised by distributed energy resources, the possible market design and system operation options that may be available to address them, and their advantages and disadvantages.

Box 3.2 Principles of good market design

1. **Facilitate effective consumer choice.** Only a consumer itself knows its own preferences, and it expresses these preferences through its choices. Without consumer choice, there is no way for these preferences to be revealed and no way for the market to act on this knowledge. A market with consumer choice therefore promotes innovation and efficiency.

2. **Promote competition where feasible.** Competition promotes efficiency - both in the short-term by encouraging suppliers to offer at prices that reflect production costs, and in the long-term by encouraging investment and innovation that will support the provision of cheaper or more attractive products and services. However, no market is perfectly competitive, and this must be taken into account when considering market design. Similarly, it is important to consider those circumstances where the promotion of competition is impractical or not feasible.

3. **Regulate to safeguard the safe, secure and reliable supply of energy, or where it would address a market failure.** Any new market design must take into account the need to support the safe, secure and reliable supply of electricity to consumers. Regulation may be required to safeguard these outcomes. Regulation can also be used to address market failures. For example, if competition is not feasible, it may be necessary to regulate natural monopolies to encourage them to provide the services demanded by their customers at the lowest sustainable cost. Regulation will need to evolve over time as the market develops so that it is proportionate to the market failure it is designed to address.

4. **Promote price signals that encourage efficient investment and operational decisions.** Efficiency is promoted when prices reflect the marginal cost of the provision of a particular product or service, as well as any positive or negative externalities. Prices and other signals can be used to promote efficient co-optimisation of distributed energy resources. The importance of the 'right' prices for distributed energy resources is particularly important because, by definition, they are 'smart' and so are able to respond to these prices. Distributed energy resources therefore

create both opportunities and threats - the opportunity of distributed energy resources responding to the right prices and the threat of them responding to the wrong prices.

5. **Ensure technological neutrality.** In a time of rapid technological change, it is particularly important to ensure technology neutrality in market design. Specifying arrangements for a particular technology in the regulatory framework may lock it in, whilst locking out evolving new technologies that might not even have been anticipated when market design was considered. This means that market design should consider *what* is supplied rather than *how* it is supplied.

6. **Prefer simplicity and transparency.** Investment in and operation of distributed energy resources will be predicated on consumer decisions. To make efficient decisions, the consumer must understand the impact of each decision. A framework that promotes simplicity and transparency is then able to support efficient decision making. Simplicity is also a way to keep transaction costs to a minimum.

Question 6	**Do stakeholders agree with the Commission's framework and these principles of good market design? Is there anything that the Commission has missed, or is unnecessary?**

A range of potential market design options are possible - from centralised control over the installation and use of distributed energy resources, to a market-based approach where prices and other signals drive investment and usage decisions. The Commission intends to explore a number of these options through the development of a final report on this project. In exploring possible future market designs, the Commission will weigh up the benefits advantages and disadvantages of each option against the market design principles above, and explore the trade-offs. For example, a model that is appealing in principle may be costly or impractical to achieve.

The Commission will also consider the characteristics of different network types. For example, the type and extent of the technical challenges raised by distributed energy resources may be different in distribution networks covering large, rural areas than those covering densely populated urban areas. As such, certain market design options may score differently against the market design principles for different network types.

The Commission expects that any ideal solution is likely to be an evolution of smaller amendments over time, not an immediate, wholesale change. The Commission will progress its thinking on these issues over the coming months.

Question 7	**Are there any other issues the Commission should have regard to in considering possible market design options?**

4 Technical impacts of distributed energy resources

As discussed in section 2.1, there is expected to be a large future demand for technologies such as solar PV, battery storage and electric vehicles over the coming decades. The impact of increasing levels of solar PV is most notable, and a prominent factor driving the evolution from a centralised electricity supply model to a distributed model.

At relatively low levels of penetration, distributed energy resources can largely be accommodated with little to no 'centralised' coordination by distribution network businesses, as distribution networks generally have spare capacity and some ability to adapt to address technical impacts as they arise. As penetration levels increase, the aggregate technical impact of distributed energy resources on distribution networks is likely to also increase. These impacts are likely to be more severe if the uptake and operation of distributed energy resources is uncontrolled. However, there are a range of ways in which these technical impacts can be addressed, if they arise.

This section summarises the Commission's analysis of the key technical impacts that an increased uptake of distributed energy resources can present. These technical impacts are similar to, if not the same as, those experienced in transmission networks as a result of the connection of large-scale, intermittent generation sources such as wind. They are also broadly consistent with those identified by the ENA and CSIRO in the Network Transformation Roadmap.[23]

4.1 Voltage stability

Voltage stability can be defined as "... the ability of an electric power system, for a given initial operating condition, to regain a state of operating equilibrium after being subject to a physical disturbance, with most system variables bounded so that practically the entire system remains intact".[24] Distributed energy resources do not currently provide voltage or reactive power support, which can lead to voltage instability. For example, excess generation supply due to solar PV penetration can cause a voltage rise on the distribution network, while increased uptake of electric vehicles (i.e. excess load) could result in voltage drops. Voltage rises and drops can damage, trip off or stall electrical equipment.

4.2 Frequency stability

Frequency stability can be defined as "… the ability of a power system to maintain steady frequency following a severe system upset resulting in a significant imbalance between generation and load. It depends on the ability to maintain/restore equilibrium

23 ENA, Electricity Network Transformation Roadmap, Interim program report, December 2015, pp. 71-84.

24 P. Kundur et al, Definition and Classification of Power System Stability, IEEE/CIGRE Joint Task Force on Stability Terms and Definitions, vol. 1401, p. 1387, 2004.

between system generation and load, with minimum unintentional loss of load. Instability that may result occurs in the form of sustained frequency swings leading to tripping of generating units and/or loads".[25]

Inverter-connected distributed energy resources have lower levels of inertia than synchronous plant. Increasing penetration of distributed energy resources can, by displacing synchronous plant, reduce grid inertia and frequency response, which can result in high rates of change of frequency and potential loss of synchronism. No distributed energy resources currently provide frequency control ancillary services. Tripping of these resources during frequency disturbances could make the problem worse, particularly if the area or suburb behind a feeder became isolated.

Frequency stability is not a distribution issue in itself, but rather an issue that needs to be considered at a system-wide level by AEMO. However, increased penetration of distributed energy resources means that possible sources of and solutions to frequency stability may need to be considered by AEMO at the distribution level.

4.3 Harmonics

Harmonic currents in the power system refer to non 50 hertz currents caused primarily by power electronics. The impacts of harmonics include excessive heating, nuisance tripping, protection mal-operation and interface with communications. Inverter connected distributed energy resources can inject harmonic currents. Modern inverters have relatively low levels of total harmonic distortion.

4.4 Flicker

Flicker is a symptom of voltage fluctuation, which can be caused by disturbances introduced during power generation, transmission or distribution. Typically it is caused by the use of large fluctuating loads, i.e. loads that have rapidly fluctuating active and reactive power demand. Increased penetration of distributed energy resources and distributed generation fuelled by intermittent sources can result in unacceptable limits of flicker. Flicker is more prevalent on electrically weak networks with large concentrations of distributed energy resources and distributed generation, and low fault levels.

4.5 Power factor

Distributed energy resources with no reactive power support will mean that the rest of the grid will need to supply reactive power, which may result in a lower grid power factor. A lower power factor means the rest of the grid must supply more reactive power relative to real power, therefore it is transporting power towards the load less efficiently.

25 Ibid.

4.6 Thermal overloading of equipment

Existing distribution conductors and transformers are rated for a few central generating plants supplying energy in one direction to radial loads. Therefore, a distribution feeder would be rated for the maximum demand of the loads on that feeder. However, if a feeder has distributed energy, during times of low load, the surplus generation is fed back to the grid. This reverse power flow may exceed equipment ratings.

4.7 Islanding and reclosing

Distribution networks were originally designed on the basis that there were no distributed energy resources on the network. So, following isolation of the main supply, there was no risk that parts of the network would remain energised. Many existing reclosing devices are not capable of reliably detecting distributed energy resources. If these are not detected then the network could still be live, causing safety issues and unsynchronised switching that results in abnormal voltages and currents on the system.

4.8 Protection

The protection of the electricity network is designed to ensure safety and reliability of the network. The increased penetration of distributed energy resources can cause a number of protection issues. For example, distributed energy resources could reduce fault levels to a point where the delineation between a fault and a load could be challenging. So, the reduction of a fault level may result in the existing protection no longer detecting a fault. If the fault is not cleared, this could cause a danger to anyone in the vicinity and damage to equipment.

Question 8	**Do stakeholders agree with the Commission's assessment of the technical impacts of distributed energy resources set out above in sections 4.1 to 4.8?**

4.9 Opportunities and possible solutions

In the Commission's view, imbalances between supply and demand at a local level on distribution networks give rise to many of the technical impacts set out above. These imbalances can arise for a range of reasons. For example, the technical characteristics of distributed energy resources allow them to ramp up and down quickly. More active customer participation in response to a signal, for example a particular tariff, may mean that blocks of load suddenly shift in a coordinated fashion. This can give rise to a number of the technical impacts set out above. So, while an imbalance of local supply and demand is not a technical issue in itself, better alignment and management of local supply and demand would offer one way to resolve a number of these technical impacts.

There are a number of 'traditional' ways to address the supply/demand balance and therefore the technical issues set out above, including:

- network based solutions, for example installing static var systems,[26] and possibly charging customers with distributed energy resources for that equipment;
- technical solutions, for example requiring distributed energy resources to have reactive power and low voltage ride through capabilities (for example through standards); and
- operational solutions, for example preventing or reducing exports from distributed energy resources into the grid.

However, it is also possible to use market-based signals to incentivise customers with distributed energy resources to maintain the supply/demand balance by generating or consuming at certain times, or to address a technical impact by providing network support such as reactive power. Pricing signals, if appropriately designed, can be used to manage the installation and use of distributed energy resources and the technical impacts they present, while enabling consumers more choice and control over how they use their distributed energy resource.

Some combination of network, technical, operational or market-based solutions may be required to address the supply/demand balance. In any case, it will be important to consider is whether the solution should be mandated (and if so, by whom), or whether consumers themselves (or their agents) should be able to choose from the range of potential solutions.

Question 9	**Do stakeholders agree with the Commission's preliminary assessment of these opportunities, and possible solutions to address the technical impacts of distributed energy resources?**

Question 10	**Do stakeholders have any initial views on who should be responsible for managing these opportunities, or implementing possible solutions to the technical impacts?**

As noted in section 1.4, the AEMC and other parties are undertaking a number of projects that consider the technical impacts of distributed energy resources on distribution networks, and the possible technical, regulatory and market solutions that may be available to address those impacts. The Commission welcomes stakeholder feedback on the technical impacts outlined above and other relevant issues to inform its consideration of the range of possible options to mitigate these impacts.

26 Static var system can be utilised to manage network voltage by generating or absorbing reactive power.

5 Next steps

5.1 Submissions and stakeholder consultation

The Commission invites written submissions on the questions set out in this approach paper, or any other aspect of it, by **19 January 2017**. The Commission also welcomes one-on-one meetings with interested stakeholders in lieu of, or in addition to, a written submission. Please contact Claire Richards, (02) 8296 7878, if you would like to arrange a meeting.

5.2 Final report

The Commission intends to hold a series of public workshops in early 2017 before publishing a final report on this project, having regard to submissions and other input from stakeholders, in early to mid-2017. The Commission may also hold a workshop or public forum to communicate its thinking on the range of issues being explored and get feedback from stakeholders to help inform its development of the final report. The final report will set out the range of potential market design options that the Commission has explored to address emerging regulatory and technical issues, including:

- the roles and functions that must be undertaken in any future distribution market;
- the advantages and disadvantages of each option, and their relative costs and benefits;
- what would need to be done in a regulatory sense to implement each option; and
- the advantages and disadvantages of each option in relation to the Commission's proposed market design principles and the NEO.

A Related projects

A.1 AEMC projects

A.1.1 Electricity Network Economic Regulatory Framework Review

In August 2016, the COAG Energy Council tasked the Commission with monitoring developments in the energy market, including the increased uptake of distributed energy resources, and providing advice on whether the economic regulatory framework for electricity networks is sufficiently robust and flexible to "continue to achieve" the national electricity objective (NEO) in light of these developments. The Commission is required to publish its findings annually, with the first report due on 1 July 2017.

The Commission published an approach paper on 1 December 2016 setting out how it intends to conduct the task and its proposed information sources.[27] The paper also sets out the Commission's preliminary views on the areas that will be the focus of the 2017 report, which are:

1. continued implementation of network pricing reform;
2. the ability of networks to utilise increasingly diverse supply options; and
3. different network operating models, i.e. this project.

The 2017 annual monitoring report will draw on findings of this project to support its analysis of the third focus area.

A.1.2 Contestability of Energy Services rule changes

The COAG Energy Council submitted a rule change request in September 2016 seeking changes to the distribution service classification framework and service classification definitions in the NER to "enable the contestable provision of services from emerging technologies".[28] A subsequent rule change request was submitted by the Australian Energy Council in October 2016 seeking amendments to a number of aspects of the NER to "support the development of competitive markets in services which are or should be contestable".[29] These rule change requests focus on the regulation of services provided by assets that are able to provide value streams in both contestable and regulated markets, for example battery storage technologies. The Commission is due to commence consultation on these rule change requests in December 2016.

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27 See http://www.aemc.gov.au/Markets-Reviews-Advice/Electricity-Network-Economic-Regulatory-Framework

28 See http://www.aemc.gov.au/Rule-Changes/Contestability-of-energy-services#

29 See http://www.aemc.gov.au/Rule-Changes/Contestability-of-energy-services-demand-response

A.1.3 Replacement Expenditure Planning Arrangements rule change

In July 2016, the AER submitted a rule change request that seeks to increase the transparency of network asset replacement decisions by electricity transmission and distribution network service providers.[30] The rule change request seeks to achieve this by amending the NER to:

- explicitly require network service providers to include information in their annual planning reports on:
  - planned asset retirements and de-ratings (with guidelines to be prepared by the AER to determine the class of assets required to be reported on);[31] and
  - options to address network limitations arising from these retirements and de-ratings; and
- extend the application of the RIT-T and RIT-D to replacement projects.

The AER considers these changes to the NER are necessary given the current environment of low electricity grid demand growth combined with non-network alternatives increasingly providing viable alternatives to network solutions. The Commission commenced consultation on this rule change request in October 2016.

A.1.4 Alternatives to Grid-supplied Network Services rule change

In September 2016, Western Power submitted a rule change request that seeks to address a perceived lack of clarity in the NER about the ability of network businesses to receive regulated revenue for using non-network options, particularly stand-alone power systems, to help "meet their objectives of delivering safe, reliable and affordable electricity services to their customers."[32] The Commission has started considering this rule change request and will commence public consultation on this rule change request in 2017.

The Commission also made a submission to the COAG Energy Council's consultation on the regulatory implications of stand-alone energy systems in the NEM.[33]

A.1.5 Local Generation Network Credits rule change

In July 2015, the Commission received a rule change request from the City of Sydney, Total Environment Centre, and the Property Council of Australia seeking to amend the NER to require DNSPs to calculate the long-term economic benefits that embedded generators provide to distribution and transmission networks, and pay embedded

30 See http://www.aemc.gov.au/Rule-Changes/Replacement-Expenditure-Planning-Arrangements#

31 Broadly, the AER defines a de-rating as a reduction in the capacity of a network asset.

32 See http://www.aemc.gov.au/Rule-Changes/Alternatives-to-grid-supplied-network-services

33 See http://www.aemc.gov.au/Major-Pages/Market-transformation

generators a local generation network credit that reflects those estimated long-term benefits.[34] The Commission made a draft determination in September 2016 to not implement local generation network credits, but instead require DNSPs to complete an annual system limitation report providing certain information that would enable providers of non-network solutions to focus on locations where they could defer or reduce the need for DNSPs to invest in the network. A final determination is due to be published on 8 December 2016.

A.1.6 System Security Work Program

The Commission initiated a review into system security in July 2016, and is considering a number of rule change requests on aspects of power system security.[35] The Commission is working with stakeholders and AEMO to develop a comprehensive set of potential solutions to address identified issues.

A.1.7 Generating System Model Guidelines rule change

In November 2016, AEMO submitted a rule change request that seeks to revise the requirements of AEMO's generating system model guidelines to make sure that they remain relevant and effective for new and emerging technologies, and adequately address other aspects of the power system such as embedded generation, voltage support equipment, and control and protection systems for accurate planning, operation and analysis.[36] The Commission has not yet commenced consultation on this rule change request.

A.2 External projects

A.2.1 ENA and CSIRO: Electricity Network Transformation Roadmap

The Energy Networks Association (ENA), together with the CSIRO, is developing a roadmap that sets out a pathway for the transition of electricity networks by 2025.[37] The objective of the roadmap is to position network businesses and the energy supply chain for the future as consumer needs evolve. The roadmap framework involves five domains, including one on 'next generation platforms', which is exploring the future of power system operation and what operating platforms may be required to allow for "full optimisation and coordination of the diverse range of connected demand side services". The ENA and CSIRO are due to publish a draft roadmap in December 2016.

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34 See http://www.aemc.gov.au/Rule-Changes/Local-Generation-Network-Credits#

35 See http://www.aemc.gov.au/Major-Pages/System-Security-Review

36 See http://www.aemc.gov.au/Energy-Rules/Generating-System-Model-Guidelines#

37 See http://www.ena.asn.au/electricity-network-transformation-roadmap

A.2.2 AER: National distribution ring-fencing guideline

The AER published a national electricity distribution ring-fencing guideline on 30 November 2016.[38] The purpose of the guideline is to support the development of competitive markets for energy services and efficient investment in network and customer services seeking to eliminate the advantage a DNSP or its affiliates may otherwise have in providing contestable services. It replaces the various state-based ring-fencing instruments that were originally designed to separate the provision of network services from the provision of retail and generation services. The guideline has been developed in collaboration with the AEMC and state government industries, and in consultation with relevant stakeholders.

A.2.3 COAG Energy Council: Energy market transformation

The COAG Energy Council has initiated a market transformation program to make sure regulatory frameworks are "fit for purpose to cope with the effects of emerging technologies and to enable consumers to benefit from innovative services while mitigating any risks."[39] As part of this program, the COAG Energy Council has released three consultation papers seeking feedback on issues relating to stand-alone energy systems, consumer protections and registration systems for battery storage. The AEMC has made submissions to all three.[40] The issues and solutions raised through the market transformation program are relevant but separate to this Distribution Market Model project.

A.2.4 Standards Australia: Standards and the future of distributed electricity

Standards Australia is, in consultation with stakeholders, producing roadmaps for metering and storage to determine how standards may need to change as these technologies are taken up more rapidly. It has also partnered with the ENA to develop a roadmap on standards and the future of distributed electricity.[41] The purpose of the roadmap is to assess the current state of standardisation in all areas relevant to distributed electricity, and identify those standards that need to be updated as a priority to support the "multiple and diverse possible futures in the generation, distribution and use of electricity". The Commission is engaging in the development of these roadmaps.

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38 See http://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/electricity-ring-fencing-guideline-2016

39 See http://www.scer.gov.au/current-projects/energy-market-transformation

40 See http://www.aemc.gov.au/Major-Pages/Market-transformation

41 See http://www.standards.org.au/OurOrganisation/News/Pages/Future-of-distributed-energy-discussion-paper-released.aspx

A.2.5 AEMO: Future Power System Security program

AEMO has established a program of work to assess and address the technical impacts that are likely to emerge as the NEM generation mix continues to change and consumers become increasingly active in how their demand is met. The Future Power System Security program seeks to identify opportunities and challenges to power system security and stability that could arise in the long-term, and promote solutions as soon as practicable where appropriate.[42] The Commission is working with AEMO and stakeholders to develop a comprehensive set of potential solutions that take into consideration issues raised by consultation across its own system security work program.

42 See https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability