ESSENTIAL SERVICES COMMISSION

THE NETWORK VALUE OF DISTRIBUTED GENERATION

Distributed Generation Inquiry Stage 2 Draft Report

October 2016

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CHAIRPERSON’S INTRODUCTION

What network benefits do residential and other small-scale solar installations create? What about other forms of distributed generation? How large are those benefits and how might investors in distributed generation be remunerated for the benefits they create?

These questions are not new but the search for answers is becoming more pressing as our energy system confronts generational changes on multiple fronts simultaneously. Some changes are driven by regulation, some by technology, others by commercial opportunities. Perhaps most importantly, in exercising their power of choice as individual market participants, energy users are increasingly demanding new services from their service providers. Energy users are wanting services that will support new energy technology, new business models, ‘transactive platforms’, or ‘real time pricing’ of distributed energy resources. Admittedly, this is not the terminology most customers use, but these are the possibilities that they are increasingly interested in exploring.

Households, companies, regulators, governments and industry are attempting to understand how the energy system of the future might look, and how to bring it about in an orderly manner. Our inquiry sits within this broader context and we are mindful of the many possible futures that lie ahead. Alternatively stated, in responding to the questions above, we are seeking to develop a response that is ‘future proof’ — that is, a regulatory response that is independent of, and can coexist with, any scenario that unfolds in the times ahead.

Answering these questions has required that we think more deeply and more profoundly about the nature of network value, and what its characteristics mean for how it should be remunerated. Quite explicitly, we have sought to position our analysis within the context of a changing industry, having particular regard for emerging technology trends and what they mean for network value.

Our analysis demonstrates that distributed generation can and does provide network value. It also confirms some important characteristics determining that value. Namely, network value is highly variable. It varies by location, it varies across the hours of the day, and it varies based on when within the lifecycle of the relevant network assets it is being measured. Sometimes value can be created by small numbers of distributed generators. In other circumstances larger tranches are required. It seems highly unlikely that a feed-in-tariff regime could be designed to efficiently reflect this variability in network value.

We now have an exhaustive dataset on the network value of distributed generation in Victoria today. We have also advanced our thinking on a range of key topics, including the performance of DG (in terms of network value) when deployed with various emerging technologies, and the question of valuation methodologies. The main results are contained in this paper, and we will release more detailed results in the weeks and months to come.

Importantly, our analysis confirms that the capabilities of distributed generation are evolving rapidly. As energy storage and various ‘smart’ technologies (such as modern inverters and energy management systems) become more widely available, it will be increasingly plausible to optimise ‘old-fashioned’ solar photovoltaics for the purposes of network benefits. Our analysis shows that network-optimised distributed generation can be significantly more valuable than predecessor systems. We find that distributed generation has a legitimate claim as a provider of grid services. And, the strength of this claim is growing.

In light of these findings we have concluded that the most effective approach to answering the questions posed above is to think about network value is in terms of the existing, but still evolving, market for grid services. Network value is a grid service and it should be remunerated as such. While mechanisms already exist in the national energy framework for remunerating grid services, we find that they do not lend themselves to remunerating small-scale providers of these services.

In this paper, we identify the potential for a market-based mechanism to be established through which small scale service providers were remunerated by network system operators for the grid services they provide. Establishing such market mechanisms requires careful planning and therefore this paper concludes by calling for submissions to help inform the next stage of our work — namely, identifying the principles and mechanisms that would most effectively and efficiently underpin a market for grid services provided by small-scale distributed generation.

This draft report recognises that distributed generation is just one source of network value. Other notable sources include various demand management options. On that basis, we propose that a new market-based mechanism should adopt 'non-discrimination' as a foundational principle. That is, a new market-based mechanism should be able to accommodate other sources of grid services (beyond distributed generation) in the future.

Dr Ron Ben-David
Chairperson

GLOSSARY

Ancillary services	Services and resources that are required to operate the network on an on-going basis, such as services to control voltage and frequency or to restart the network after an incident.
Behind-the-meter	The realm of energy consumption, generation and services occurring on the 'customer side' of the meter (for instance, at a customer's residential premises). This can be contrasted with activities on the 'network side' of a customer's meter.
Capacitor bank	A grouping of connected capacitors that store electrical energy.
Co-generation	A type of distributed generation system designed to generate electricity and useful heat jointly.
Current	An electric current is the flow of an electric charge at a defined rate.
Demand response	Measures to reduce or 'reshape' electricity demand with the intent of reducing the cost of operating the electricity system (either in terms of generation, wholesale market or network costs).

Dispatchable generation	Generation whose output can be controlled, and which therefore can be dispatched according to the instructions of an operator. This can be contrasted to passive generation, the output of which cannot be actively controlled by an operator.
Distributed generation	Refer to section 3.2.
Expected unserved energy	The forecasted amount of energy that is required by customers but cannot be supplied due to the failure of a critical piece of network equipment.
Firmness	A shorthand means of referring to matters relating to the reliability of generation, which may include intermittency, predictability, dispatchability.
Flicker	Changes to the output of lighting caused by rapid voltage fluctuations. Also describes a pattern of frequent sudden changes in voltage.
Grid services	A broad term encompassing the full suite of services that are required for the safe, reliable and efficient operation of the electricity network. This may include network support services, ancillary services, or other forms of network services.

Gross output

The total electricity generated by a distributed generation system, which is equal to the electricity consumption that supports the local generator ('own-use'), the local customer's load and internal power losses plus the remaining power exported from the generation site.

Harmonics

Currents or voltages in the electricity grid with frequencies different to an ideal electrical waveform, which can be associated with power quality problems.

Intermittent generation

Generation whose output is a function of the supply of primary energy (i.e. fuel), rather than demand for electricity. Common forms of intermittent generation are solar PV, wind generation and run-of-river hydropower. This can be contrasted to non-intermittent generation sources such as coal-fired power stations and gas turbines.

Inverter

Apparatus that converts the direct current (DC) output of solar photovoltaic panels into alternating current (AC). Inverters used in conjunction with solar panels may also have additional functionality to control active and reactive power output.

Islanding

The capability of distributed generation to maintain power to a location when external grid supply of electricity is cut.

Low voltage

The normal voltage for supply to small customers: 415 volts three phase or 240 volts single phase.

Micro-embedded generator	A generating system connected to an AS4777 compliant three-phase or single-phase inverter that produces no more than 10kW single-phase and 30kW three-phase.
Microgrid	Distributed energy resources within a defined boundary that can act as a single controllable entity. A microgrid may be able to connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode.
Net output	The portion of a distributed generator's output that is surplus to the 'on site' demand at the location of the generator and which is therefore exported into the grid.
Network augmentation	A modification or upgrade to an existing network for the purposes of increasing the capacity to supply load or to increase reliability of supply. Augmentations are distinct from projects intended to replace existing network infrastructure due to infrastructure assets reaching the end of life.
Network optimised	The attribute, as it applies to a generation resource, of being fully optimised for the purposes of creating network benefits. Encompasses both reliability and timeliness (i.e. coincidence with peak demand).
Network support facilities	Facilities offering services to relieve network congestion, typically purchased by distribution businesses. Such facilities are commonly electricity generators.

Output profile	The pattern of electricity produced across time by a generation technology, such as solar PV systems.
Passive generation	Generation whose output cannot be actively controlled by an operator. This includes most forms of solar PV (assuming the array does not include control systems or energy storage).
Power	Power is the rate, per unit time, at which electrical energy is transferred by an electric circuit. Apparent power is the product of line voltage and current.
Power factor	Total power includes real and apparent power. Power factor is the ratio of real power (kilowatts or kW) to apparent power (kilo volt-amps or kVA).
Power quality	The quality of electricity supply with respect to voltage and frequency stability and the absence of harmonic voltages and currents which can damage electrical equipment
Reactive power	Reactive power is power where the current is completely out of phase with the voltage and which delivers no net energy to the customer. Reactive power has an important influence on voltage.
Small-scale	For the purposes of this inquiry, small-scale refers to distributed generation of below 5 MW capacity

Third party aggregator	An entity that aggregates the supply from a number of distributed generators and transacts on their behalf. The transactions may be for the supply of energy, via the electricity wholesale market, or conceivably may occur with a network business for the provision of grid services.
Tri-generation	A type of distributed generation system designed to generate useful heat, cooling and electricity jointly.
Value of Customer Reliability	The value of expected unserved energy in dollars per megawatt-hour at any given customer connection point in the network, for example supplied from a zone substation.
Voltage	The amount of potential energy between two points on a circuit.

ACRONYMS

AC	Alternating current
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
AMI	Advanced metering infrastructure
APR	Annual planning report
CAPEX	Capital expenditure
CEC	Clean Energy Council
CESS	Capital Expenditure Sharing Scheme
COAG	The Council of Australian Governments
DAPR	Distribution Annual Planning Report
DG	Distributed generation
DMIA	Demand Management Investment Allowance
DMIS	Demand Management Investment Scheme
DNSP	Distribution Network Service Provider
DSES	Demand-Side Engagement Strategy

DRM	Demand Response Mechanism
DSO	Distributed System Operator
DUOS	Distribution Use of System
EBSS	Efficiency Benefit Sharing Scheme
ENA	Energy Network Association
EIA	Electricity Industry Act
FCAS	Frequency Control Ancillary Services
FiT	Feed-in Tariff
IPART	Independent Pricing and Regulatory Tribunal
kVA	kilovolt-amp
kW	kilowatt
kWh	kilowatt hour
LGC	Large-scale Generation Certificate
LGNC	Local Generation Network Credit
LRET	Large-scale Renewable Energy Target
LRMC	Long Run Marginal Cost
MLF	Marginal Loss Factor
MVA	Megavolt-amps
MVAr	Megavolt-amps (reactive)
MW	Megawatt - measure of electrical power
MWh	Megawatt hour – measure of electrical energy

NSCAS	Network Support and Control Ancillary Services
NEM	National Electricity Market
NER	National Electricity Rules
NIC	National Infrastructure Commission (UK)
NLAS	Network Loading Ancillary Service
NPV	Net Present Value
OPEX	Operating Expenditure
PFiT	Premium Feed-in Tariff
PV	Photovoltaic
REPEX	Capital expenditure for the purposes of replacing assets due to end of serviceable life
RET	Renewable Energy Target
REV	Reforming the Energy Vision
RIT-D	Regulatory Investment Test – Distribution
RIT-T	Regulatory Investment Test – Transmission
RMI	Rocky Mountain Institute
SGAF	Small Generation Aggregation Framework
SFiT	Standard Feed-in Tariff
SRAS	System Restart Ancillary Service
STPIS	Service Target Performance Incentive Scheme

TOSAS	Transient and Oscillatory Stability Ancillary Service
TOU	Time of Use
TUOS	Transmission Use of Service
TNSP	Transmission Network Service Provider
TSS	Tariff Structure Statement
VCAS	Voltage Control Ancillary Service
VCR	Value of Customer Reliability
VCEC	Victorian Competition and Efficiency Commission
ZSS	Zone substation

CONTENTS

SUMMARY

INTRODUCTION

In September 2015, the Essential Services Commission ('the Commission') received a terms of reference under section 41 of the *Essential Services Act 2001* to carry out an inquiry into the true value of distributed generation.

In December 2015, we released a paper outlining our proposed approach to the inquiry. In that paper, we proposed to the Government that the inquiry be split into two parts, corresponding to the separate challenges of determining the *energy value* and the *network value* of distributed generation.

In August 2016, the Commission submitted to the Government its final report on the energy value of distributed generation. This report showed that the energy produced by distributed generation has a value based on the wholesale value of electricity, and that this value varied across time and by location. Since distributed generators typically displace conventional fossil fuel based generation, they can also reduce emissions of greenhouse gases. The Commission found that operators of small-scale distributed generation systems could be paid a tariff that reflected their location and the time of day at which they supply electricity to the system, as well as a payment for environmental value.

In addition to these benefits associated with energy supply, distributed generation may provide network benefits, particularly if it reduces peak demand in a predictable way. Following the publication of the Commission's discussion paper into the network value of distributed generation in June 2016, this draft report presents the Commission's initial findings into the network value of distributed generation.

SCOPE OF INQUIRY

As required by the terms of reference, this stage of the inquiry will:

1. Examine the value of distributed generation for the planning, investment and operation of the electricity network; and any environmental and social values caused by changes in the way the grid is managed because of distributed generation.
2. Assess the adequacy of the current policy and regulatory frameworks governing the remuneration of distributed generation for the identified *network value* it provides.
3. Make recommendations for any policy or regulatory reform required to ensure effective compensation of the *network value* of distributed generation in Victoria.

The terms of reference state that the inquiry will not consider the policy and regulatory frameworks governing the costs of connecting distributed generation to the network. This is taken to mean that the terms of reference exclude consideration of all costs associated with initiating and maintaining the connection between distributed generation and the network (i.e. encompassing maintenance and augmentation costs associated with having distributed generation connected to the network). This means that the inquiry is focused on understanding the potential benefits produced by distributed generation.

The Commission's task is to identify the various direct and indirect benefits that may be attributed to distributed generation and, to the extent possible, place a monetary value on those benefits. Its task is then to provide advice to Government on how those monetary values might be reflected in remuneration to distributed generators.

The terms of reference do not anticipate the Commission assessing policy options for promoting investment in distributed generation. Nor do they anticipate assessing alternative policy options for achieving the indirect effects that were identified as having been derived from investment in distributed generation.

PURPOSE OF THIS REPORT

Through this draft report, the Commission seeks to respond to the following questions arising from the terms of reference:

- What are the economic, environmental and social benefits that distributed generation can provide to the operation of electricity networks (distribution and transmission)?
- Can a monetary value be attributed to these identified benefits?
- How does the existing state and national regulatory framework reflect the network value of distributed generation?
- What reforms are needed, if any, to ensure the effective calculation and remuneration of the network value of distributed generation?

THE COMMISSION'S APPROACH

The Commission has taken the following approach to this stage of the inquiry:

- define distributed generation for the purposes of the inquiry
- define the circumstances in which distributed generation can provide network benefits
- develop and apply a methodology for quantifying and valuing the network benefits of distributed generation
- analyse how the existing national and state regulations reflect the network value of distributed generation, and
- explore potential reform options, if required.

Definition of distributed generation

For the purposes of this inquiry, we define distributed generation as:

- distributed generation below 5MW in capacity
- distributed generation from any source or fuel type, and

- including battery storage, both standalone and integrated with another distributed generation technology.

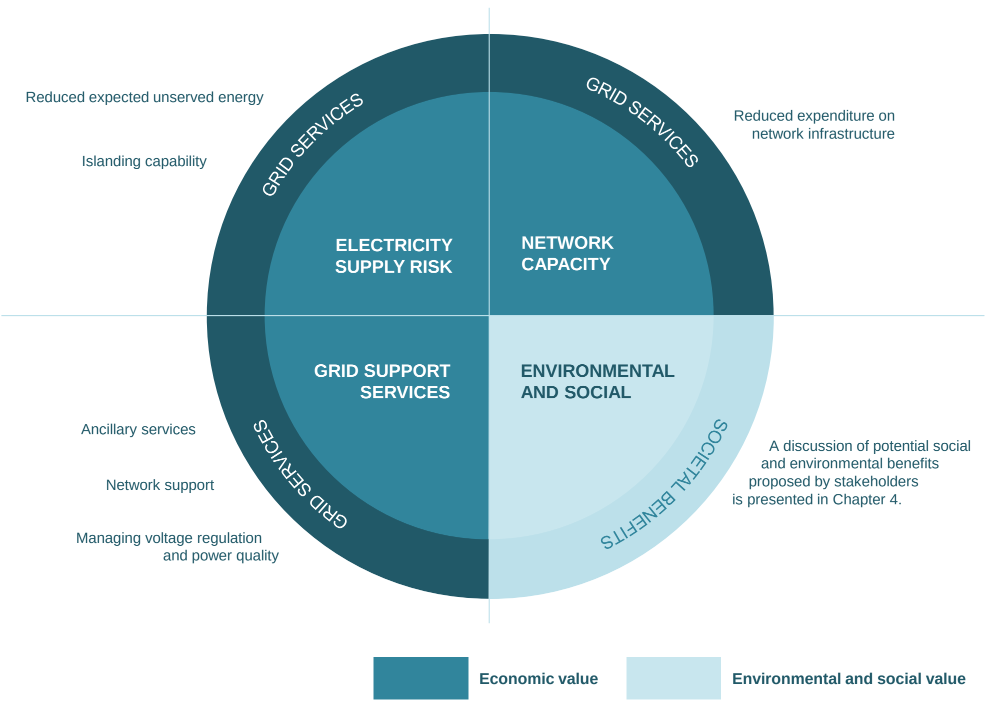
For this stage of the inquiry we distinguish between network-led and proponent-led distributed generation. We have sought to examine how these different categories of distributed generation are accommodated within the regulatory framework. We define the two categories as:

- **network-led** distributed generation, which is procured by a network business, and
- **proponent-led** distributed generation refers to systems that are installed by third parties independently of the decision making of the network business.

Circumstances in which distributed generation may provide network benefit

The Commission has identified four categories of network benefit that may arise as a result of investment in distributed generation, along with a range of potential benefits in each of these categories. We conceived the categories relating to economic benefits as 'grid services'. These are outlined in Figure S. 1 below.

FIGURE S. 1 NETWORK BENEFIT CATEGORIES AND POTENTIAL BENEFITS



Source: ESC

Distributed generation may also impose costs on the network, relating either to initial connection of the system or to maintaining the connection. In some cases, this may include reinforcing the network to handle bi-directional flows, where a sufficient volume of distributed generation has been installed in a given section of the network to make this necessary. However, consideration of costs is outside the scope of the inquiry and so has not been included in the valuation exercise. These costs are already taken into account by distributed businesses when submitting their regulated revenue requirements to the Australian Energy Regulator.

Valuation methodology

Economic value

The Commission's approach for valuing the network benefits of distributed generation is based on a number of steps. First, we analysed each network benefit category to gauge the materiality of each potential benefit with respect to calculating network value. Where benefits were unlikely to be material, we conducted case studies to test this finding. Where material benefits were likely, we developed calculation methods to quantify and then value that benefit.

We consulted with network businesses and members of the distributed generation industry to ensure the robustness of the methodology. Finally, we applied the calculation methods, largely relying upon publicly available data published by distribution businesses.

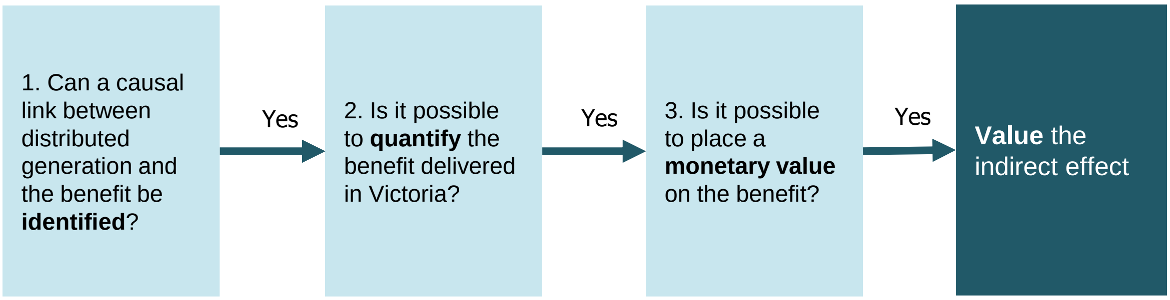
We identified that the key economic benefit provided to electricity networks by distributed generation is through reducing network congestion. We therefore focused on developing a methodology that quantified and valued the benefits caused by reducing network congestion: deferrals of network augmentation projects and reductions in the value of potential unserved energy.

We sought to identify for each zone sub-station in Victoria the value provided by the existing fleet of distributed generation. We also sought to develop a method that would allow us to calculate the value that different forms of new distributed generation may provide if installed in the future.

Environmental and social value

During our work on the energy value of distributed generation, we developed a three-part process for assessing the potential value of environmental and social benefits. We similarly applied this process when examining the network value of distributed generation. The process is outlined in Figure S. 2 below.

FIGURE S. 2 THREE-PART INDIRECT EFFECT TEST
Method for considering environmental and social value



Source: ESC

THE COMMISSION'S DRAFT FINDINGS

The economic value of distributed generation to electricity networks

Distributed generation can and does create network value. The main source of that value is the way distributed generation can reduce network congestion, which may defer the need to upgrade the network and thereby save costs. Reducing network congestion can also reduce the amount of expected unserved energy[1]. Distributed generation can also provide other network benefits but these are not currently material with respect to calculating network value for the purposes of this inquiry.

[1] Expected unserved energy is the forecasted amount of energy that is required by customers but which cannot be supplied due to the failure of a critical piece of network equipment.

Distributed generation is one of a number of means through which network value can be delivered. Other demand-side measures, such as demand response[2] and energy efficiency, may also give rise to network value. The potential network benefits provided by all these forms of demand-side measures can be collectively described as 'grid services'. However, because of the focus of this inquiry, we have concentrated on the value of the grid services provided by distributed generation.

The size of the network value of distributed generation is affected by:

- **Location** – the value varies based on the distributed generator's location within the network, specifically in terms of its proximity to areas of the network that are congested, or nearing congestion.
- **Time** – the value varies according to the extent to which the electricity generation coincides with the periods of peak demand within the section of the network to which the generator is connected.
- **Asset life-cycle** – the value varies based on when in the network operator's cycle of upgrade projects the value is being measured. (If the measurement is conducted annually, the value varies year-on-year, subject to the timing of network upgrade projects, as well as the supply and demand for energy in the area of the network to which it is connected).
- **Capacity** – the generation capacity of the distributed generation.
- **Optimisation** – 'optimisation' refers to the extent to which the generation is optimised for delivery of grid services, which is largely a function of being both predictable and responsive to the needs of the network. Commonly used industry terms applied to these qualities are 'firm' and 'dispatchable'. A system that is highly optimised for network benefits is one that reliably produces output at the time it is most needed by the network.

[2] Demand response refers to measures to reduce or 'reshape' electricity demand with the intent of reducing the cost of operating the electricity system (either in terms of generation, wholesale market or network costs). It can include 'shifting' or 'smoothing' demand, for example through adjusting the thermostat on refrigeration units or air conditioners.

The environmental and social value (networks)

Distributed generation may provide a benefit if it provides a lower cost alternative to network projects undertaken for the purposes of bushfire mitigation. This could occur in remote areas, where distributed generation could allow the linking network to be de-energised during high fire risk days, if this was a more efficient alternative to other bushfire mitigation steps, such as undergrounding wires. The Commission did not identify any regulatory impediment to this value being realised. We therefore did not assess the merits of greater investment in distributed generation relative to other forms of bushfire risk mitigation available to distribution businesses.

The Commission did not identify evidence that the network effects of the distributed generation installed in Victoria is creating additional social or environmental benefits.

Key technology trends

Distributed generation provides significantly more value when it is ‘firm’, meaning it can reduce pressure on the network in a controlled and reliable way. The greatest value occurs when the quantity of generation is matched to the needs of the network. To reduce congestion in a way that produces the greatest value may require larger quantities of generation capacity than small-scale distributed generators can provide individually. However, this value can be unlocked by larger distributed generation systems, or by multiple smaller systems acting in unison.

Technology is available to transform intermittent distributed generation, such as solar PV, into firm generation. Such technologies include energy storage (batteries), ‘smart’ inverters and energy management systems. This technology is not new, but it is becoming increasingly economic for small-scale distributed generation owners to install. If distributed generation proponents invest in technologies that increase the firmness of their generation, their potential to provide valuable grid services will also increase.

Technology is also emerging that enables coordination of large numbers of small-scale distributed generation installations. These technologies enable multiple distributed generation systems to be coordinated, or ‘orchestrated’, in order to deliver grid services at the times and in the locations they have the greatest value. The maturity and capability of this technology are currently being illustrated in Victoria through demonstration projects that are proceeding with the assistance of grants and allowances.

Investment in these technologies is likely to be driven, in part, by the decisions of energy customers rather than by traditional energy businesses such as network providers. We therefore consider it appropriate, given these technology changes, to examine whether small-scale distributed generators will have adequate opportunities to monetise the grid services they are capable of providing, now and into the future.

Regulatory framework

The primary purchasers of grid services are large, monopoly network businesses, which have access to more information than individual small-scale distributed generation proponents, who may often be residential households. In these circumstances, network businesses are likely to have considerable bargaining power. Conversely, procuring grid services from multiple small-scale providers may be challenging for network businesses, particularly from the perspective of risk allocation and transaction costs.

Some of these factors are acknowledged by the national regulatory framework that applies to monopoly network businesses and which contains:

- incentives for network businesses to appropriately apportion their expenditure between traditional network upgrade projects, such as upgrading the ‘poles and wires’, and non-network solutions, such as using grid services to defer upgrades of the existing network infrastructure
- requirements that network business provide a level of information about opportunities for the provision of grid services, and
- processes network businesses must follow when deciding how to respond to network constraints, including undergoing a tender process before undertaking major upgrades of the network.

The framework is not orientated towards ensuring small-scale providers of grid services are able to efficiently participate in the market for grid services. It does not contain any mechanisms designed to ensure network businesses calculate the network value of small-scale distributed generators on an individual basis, nor to ensure they make payments on the basis of that value.

Distributed generation within the Victorian market for grid services

Unlike other jurisdictions in the National Energy Market (NEM), Victoria has advanced metering infrastructure (AMI), or 'smart meters', which allow grid services to be deployed more easily and at lower cost than is possible under traditional analogue metering. This is because smart metering enables near to real-time remote monitoring of electricity flows to and from customers. Providers in Victoria can therefore provide accurate and timely grid services without the need to install additional metering infrastructure.

For reasons including but not limited to the roll out of AMI, there may be opportunities in Victoria for the development of a well-functioning market for grid services that are not currently available in other jurisdictions.

So that small-scale providers of grid services in Victoria, including distributed generation, have adequate opportunities to participate in the market for grid services, we believe it important to identify the principles and measures for enabling a well-functioning market in Victoria.

Network value and the feed-in tariff

Because of the characteristics of network value, a broad-based feed-in tariff is unlikely to be an appropriate mechanism to support the participation of small-scale distributed generation in a market for grid services. The value of the grid services that distributed generation can provide is too variable – between locations, across times, and between years – to be well suited for remuneration via a broad-based tariff.

If a broad-based network value feed-in tariff (FiT) was calculated with sufficient granularity to reflect the underlying network value it would be disproportionately complex and costly to implement. If it were made simple enough to implement, it would be inadequately reflective of value and could lead to payments to distributed generators who were not providing benefits, while at the same time, not sufficiently rewarding those who were.

A well-functioning market for grid services in Victoria

In the interests of enabling a well-functioning market for grid services, the Commission is seeking input from stakeholders on:

- the appropriate means to measure the effectiveness of the market for grid services in Victoria
- the appropriate principles to guide the ongoing development of the market for grid services in Victoria, including any regulatory interventions that might be contemplated to that end
- the opportunities or circumstances that exist in Victoria to support the emergence of a well-functioning market for grid services, and
- the practical measures that might be considered to assist small-scale grid service providers to participate in the market for grid services, to the extent they are capable of delivering value in that market.

Stakeholder input may take into account the nature and pace of technology and market developments as well as measures that may be in place in international jurisdictions. Stakeholders are encouraged to consider the following in making their submissions:

- market access opportunities for small-scale grid services providers, including efficient transaction and settlement
- the availability of information for small-scale grid services providers, in particular the granularity and 'dynamism' of pricing for grid services
- the allocation of risk between network businesses, grid service providers, and third parties
- risks associated with an increasingly dynamic market for grid services
- the costs and benefits associated with any potential regulatory intervention to enable markets for grid services, and
- regulatory oversight.

The Commission will hold public consultation and targeted meetings with stakeholders to explore these issues.

Input from stakeholders will inform the Commission's final recommendations to Government in February 2017.

Stakeholders are invited to make submissions in writing to DGInquiry@esc.vic.gov.au by Monday 12 December 2016.

DRAFT FINDINGS

Draft Finding 1: Network value of distributed generation

Distributed generation can and does provide network value. The value is primarily derived from reductions in network congestion, which can lead to the deferral of network augmentation expenditure and reduce the quantity of expected unserved energy. Distributed generation can also provide other network benefits but these are not currently material with respect to calculating network value for the purposes of this inquiry.

Draft Finding 2: Network value is highly variable

The size of the network value of distributed generation is affected by:

- **Location –** the value varies based on the distributed generator's location within the network, specifically in terms of its proximity to areas of the network that are congested, or nearing congestion.
- **Time –** the value varies according to the extent to which the electricity generation coincides with the periods of peak demand within the section of the network to which the generator is connected.
- **Asset life-cycle –** the value varies based on when in the network operator's cycle of upgrade projects the value is being measured. If the measurement is conducted annually, this means the value varies year-on-year, subject to the timing of network upgrade projects, as well as the supply and demand for energy in the area of the network to which it is connected.
- **Capacity** – the generation capacity of the distributed generation.
- **Optimisation** – 'optimisation' refers to the extent to which the generation is optimised for delivery of grid services, which is largely a function of being both predictable and responsive to the needs of the network. A system that is highly optimised for network benefits is one that reliably produces output at the time it is most needed by the network.

Draft Finding 3: ‘Firm’ distributed generation has significantly more network value than ‘intermittent’ generation

Distributed generation can provide significantly more network value when it is ‘firm’. The greatest value is created when distributed generation can provide firm output in capacity increments that match the extent of the network congestion.

Draft Finding 4: Technology can transform intermittent generation into firm generation

When intermittent distributed generation systems are supplemented with additional technologies – such as energy storage (batteries) and energy management technologies – they may be capable of operating as firm generators, which would increase their potential value. Technology also exists to coordinate, or ‘orchestrate’, multiple small-scale distributed generators in order to produce larger increments of firm generation and thereby maximise their network value.

Draft Finding 5: Social and environmental benefits of network effects

Distributed generation may provide a benefit if it provides a lower cost alternative to network projects undertaken for the purposes of bushfire mitigation. This could occur in circumstances where deploying distributed generation in a remote area, and thereby enabling the linking network to be de-energised during high fire risk days, was a more efficient alternative to other bushfire mitigation steps, such as undergrounding wires. The Commission did not identify any regulatory impediment to this value being realised.

Draft Finding 6: Sources of grid services

Reducing network congestion is a form of ‘grid service’. Network congestion can be reduced by a number of means, of which distributed generation is only one. Measures implemented for the purposes of remunerating distributed generation for the provision of grid services could be designed in a way that does not preclude the remuneration of other means of delivering grid services, such as demand response.

Draft Finding 7: A well-functioning market for grid services

Distributed generation in Victoria could be remunerated for its network value through a well-functioning market for grid services, assuming the market for grid services provided adequate opportunities for the participation of small-scale grid service providers, including distributed generation.

Draft Finding 8: A broad-based feed-in tariff is unlikely to be an appropriate mechanism to remunerate network value

A broad-based feed-in tariff is unlikely to be an appropriate mechanism to support the participation of small-scale distributed generation in a market for grid services. If a network value FiT was calculated with sufficient granularity to reflect the underlying network value it would be disproportionately complex and costly to implement. If it were made simple enough to implement, it would be inadequately reflective of value and could lead to payments to distributed generators who were not providing benefits while, at the same time, not sufficiently rewarding those who were.

Draft Finding 9: Opportunities for the grid services market in Victoria

For reasons including but not limited to the roll out of advanced metering infrastructure, there may be opportunities in Victoria for the development of a well-functioning market for grid services that are not currently available in other jurisdictions. This inquiry presents an opportunity to identify the principles and measures by which a market space can be developed in Victoria that provides adequate opportunities for small-scale grid service providers, including distributed generators, to be remunerated for the grid services they are capable of providing.

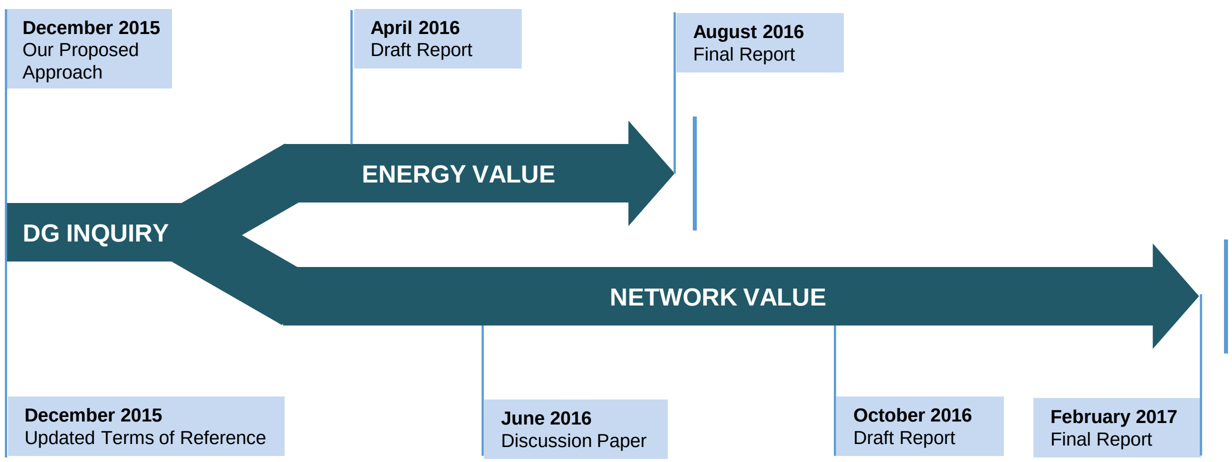
1 INTRODUCTION

1.1 BACKGROUND

In September 2015, we received terms of reference under section 41 of the Essential Services Commission Act 2001, to carry out an inquiry into the true value of distributed generation (the inquiry).

In December 2015 we published a paper outlining our proposed approach to the inquiry. In that paper, we proposed to the Government that the inquiry be split into two parts, corresponding to the separate challenges of determining the true *energy value* and the true *network value* of distributed generation. We also proposed extending the timelines of the inquiry. The Government accepted the proposed changes and issued revised terms of reference in December 2015. The inquiry structure is outlined in Figure 1.1. The full (revised) terms of reference can be found in Appendix A.

FIGURE 1.1 INQUIRY STRUCTURE



In August 2016, the Commission submitted to the Government its final report on the energy value of distributed generation.[3] This report showed that the energy produced by distributed generation has a value based on the wholesale value of electricity, and that this value varies across time and by location. Since distributed generators typically displace conventional fossil fuel based generation, they can also reduce emissions of greenhouse gases. In its energy value report, the Commission found that operators of small-scale distributed generation systems could be paid a tariff that reflected their location and the time of day at which they supply electricity to the system, as well as a payment for environmental value.

In addition to these benefits associated with energy supply, distributed generation may provide network benefits, particularly if it reduces peak demand in a predictable way. In June 2016 we published a discussion paper on the network value of distributed generation. In response, we received 14 submissions.

1.2 PURPOSE

This draft report sets out the Commission's draft findings with regard to the *network value* of distributed generation, as well as a discussion of reform options focused on facilitating remuneration of owners of distributed generation for the value of the network benefits they provide.

1.3 STRUCTURE OF THIS REPORT

This draft report is divided into the following chapters:

- chapter 1 contains the introduction
- chapter 2 sets out the context and scope of the inquiry

[3] The Victorian Government responded to the final report on the energy value of distributed generation, accepting most of the Commission's findings. Department of Environment, Land, Water and Planning (DELWP) 2016, *Victorian Government Response to the Essential Services Commission's Energy Value of Distributed Generation Final Report*, October, accessible at http://www.delwp.vic.gov.au/__data/assets/pdf_file/0019/355330/VictorianGovtResponseESC.pdf

- chapter 3 outlines the framework the Commission has developed to identify and analyse the network benefits of distributed generation
- chapter 4 presents the results of the analysis to identify and quantify the network value of distributed generation
- chapter 5 outlines how the current regulatory framework reflects the network value of distributed generation
- chapter 6 outlines the Commission’s initial findings in relation to focus of potential reforms, and
- chapter 7 details the next steps.

2 CONTEXT AND SCOPE

2.1 CONTEXT OF THE INQUIRY

Distributed generation is a growing segment of the market for the supply of electricity. Current small-scale distributed generation capacity in Victoria is estimated to be approximately 930 megawatts (MW).[4] By way of comparison, total electricity generation capacity in Victoria is estimated at 13,200 MW.[5]

Most distributed generation that is currently installed in Victoria is small-scale solar photovoltaic (PV) generation, but distributed generation can come in a range of sizes and be powered by a variety of sources, including wind, biomass and natural gas.

Distributed generation typically supplies some, or in some cases all, of the electricity demand at the place it is installed, with excess electricity exported to the grid. In 2015, electricity generation in Victoria from small-scale solar (PV) was estimated to be 1,043,000 megawatt hours (MWh),[6] with a further 188 MWh[7] from small-scale wind power.

[4] Small scale distributed generation refers to systems with a capacity of less than 100 kilowatts (kW). The data are Commission estimates based on Victorian data for eligible small-scale solar PV, wind and hydro under the Small-scale Renewable Energy Scheme from the Clean Energy Regulator (CER) 2016, *Postcode data for small-scale installations*, March, and additional data provided by Victorian DNSPs for the purposes of this inquiry.

[5] The Commission's estimate based on existing in service scheduled, semi-scheduled and non-scheduled generation nameplate capacity in Victoria from AEMO data, and data from the Clean Energy Regulator 2016 and Victorian DNSPs for small-scale systems.

[6] Based on data from Clean Energy Regulator 2016, *Postcode data for small-scale installations,* March; and estimated by the Commission using yearly Victorian solar PV electricity production provided by ACIL Allen for the inquiry.

[7] Based on data from Clean Energy Regulator 2016, *Postcode data for small-scale installations,* March; and estimated by the Commission using yearly Victorian wind power electricity production provided by ACIL Allen for the inquiry.

2.2 SCOPE OF THE INQUIRY

The terms of reference state that the inquiry will:

1. Examine the value of distributed generation including: the value of distributed generation for the wholesale electricity market; the value of distributed generation for the planning, investment and operation of the electricity network; and the environmental and social value of distributed generation.
2. Assess the adequacy of the current policy and regulatory frameworks governing the remuneration of distributed generation for the identified value it provides.
3. Make recommendations for any policy or regulatory reform required to ensure effective compensation of the value of distributed generation in Victoria. These recommendations should have regard to the most appropriate policy and regulatory mechanisms for compensating the different benefits of distributed generation, including their practicality and costs.

The terms of reference state that the inquiry will not consider the policy and regulatory frameworks governing the costs of connecting distributed generation to the network. This is taken to mean that the terms of reference exclude consideration of all costs associated with initiating and maintaining the connection between distributed generation and the network (i.e. encompassing maintenance and augmentation costs associated with having distributed generation connected to the network). This means that the inquiry is focused on understanding the potential benefits produced by distributed generation.

Although the terms of reference exclude consideration of the elements of the regulatory framework governing costs of connection, for the purposes of the inquiry it is important that the Commission understands how the costs of connecting distributed generation to networks are accounted for. We understand that these costs comprise two elements:

- **Individual connection costs** – the costs of connecting a specific distributed generator to the network. This process, including the contribution that individual distributed generators should make to the cost of connecting, is underpinned by elements of the National Electricity Rules (NER) and Victorian specific guidelines.[8]

- **Aggregate connection costs –** the costs associated with modifying the infrastructure and operation of the network to accommodate distributed generation.

Network businesses forecast the level of aggregate connection costs during the process of developing their five-yearly regulatory determination proposals. These forecasts are based on their assessment of the amount of distributed generation that will be connected to their networks during the regulatory period. These costs, once approved by the Australian Energy Regulator (AER), are recovered from all electricity consumers.

Based on this understanding of how the costs of connecting distributed generation are dealt with, the Commission will assume, for the purposes of this inquiry, that the costs to distribution businesses of connecting distributed generation and using the network are already accounted for.

The Commission's task in this inquiry is to identify the various direct and indirect benefits that may be attributed to distributed generation and, to the extent possible, place a monetary value on those benefits. Its task is then to provide advice to the Government on how those monetary values might be reflected in remuneration to distributed generators.

The calculation of monetary value in this inquiry is limited to the potential direct and indirect benefits of investment in distributed generation. The inquiry does not examine:

- an expansion of the feed-in tariff (FiT) to cover other actions customers may take to reduce their energy consumption
- other strategies that may be implemented to reduce the emissions intensity of energy supply, and
- other steps that may be taken to reduce demands on the network.

[8] See chapter 5 for a discussion of these mechanisms.

The terms of reference do not anticipate the Commission assessing alternative policy options for promoting investment in distributed generation or assessing alternative policy options for achieving the indirect effects that were identified as having been derived from investment in distributed generation.

2.2.2 GUIDING PRINCIPLES OF THE INQUIRY

We have adopted three broad principles to guide our work in identifying value through this inquiry. These principles are:

- **Simplicity.** The benefits must be readily convertible into a mechanism that is simple to understand (and administer) by all relevant market participants.
- **Behavioural response.** Any mechanism for rewarding distributed generation for any network benefit it provides, must align signals for investment in, and use of, distributed generation with the benefits (direct and indirect) identified in this inquiry.
- **Materiality.** The benefits being investigated must be large enough to have a material impact on payments made to the distributed generator.

In conducting the inquiry, the Commission also has regard to its objectives under the *Essential Services Commission Act 2001*, which are to promote the long term interests of Victorian consumers with regard to the price, quality and reliability of essential services.[9]

2.3 STAKEHOLDER FEEDBACK ON THE SCOPE OF THE INQUIRY

We received 14 submissions to our discussion paper, with the majority (13) from organisations across the energy sector (retailers, network owners and operators, energy industry groups).

[9] *Essential Services Commission Act 2001* (Vic).

With regard to the scope of the inquiry, the main issues raised in the submissions were:

- ‘behind-the-meter’ demand reduction from distributed generation has the same benefit as demand reduction from other technologies/activities, and
- the need to consider the costs imposed by distributed generation on the network.

DISTRIBUTED GENERATION AND DEMAND REDUCTION

A number of submissions pointed out that distributed generation is not the only technology or activity that can provide the benefit of peak demand reduction. They suggested that making payments to distributed generation on the basis of network benefits while not making payments to other forms of demand reduction technologies and activities would favour distributed generation above other demand reduction measures. Stakeholders argued that if distributed generation is more expensive than other forms of demand response, then any payment mechanism that favours distributed generation over other technologies could increase overall costs.

The fundamental source of network benefit provided by distributed generation is its capability to reduce network congestion by reducing network peak demand. The value of reduced peak demand is not tied to any particular technology – any technology, tool or approach that reduces network congestion may produce network value in a similar fashion to distributed generation. A reduction in network congestion has value however it is achieved. The terms of reference make clear that this inquiry is focused exclusively on identifying the network benefit (and value) of distributed generation. However, in developing our findings with regard to potential changes to the regulatory framework, we have been mindful that distributed generation is only one form of demand response.

THE COSTS OF DISTRIBUTED GENERATION

Submissions from network businesses suggested that the Commission should identify and calculate the costs that distributed generation can impose on the network. They questioned the appropriateness of paying a distributed generator for network benefit, while it does not also face the full costs of being connected to the network.

As the Commission has indicated, the terms of reference exclude consideration of the costs that distributed generation may impose on network operators. We nonetheless acknowledge that the addition of distributed generation to the network can result in costs to network businesses, both to establish the initial connection and to ensure the network can adequately maintain that connection. In some cases, this may include reinforcing the network to handle two-way flows, where a sufficient volume of distributed generation has been installed in a given section of the network to make this necessary.[10]

However, given that these costs are outside the scope of the inquiry, they have not been included in the valuation exercise. Hence, the results of the valuation exercise do not necessarily indicate the appropriate payments that might be made to distributed generators based on network value. Were a mechanism developed to facilitate payments for network value – on the basis of a 'price for grid services', for instance – a separate exercise would be required to identify an appropriate basis and size for such payments.

[10] For instance, Powercor has proposed to install around 90 bi-directional regulators on its rural feeder network where feeders have high levels of forecast distributed generation. These installations are scheduled to occur between 2016-2020, CitiPower and Powercor 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation - Proposed Approach Paper,* February, p. 5.

3 OUR APPROACH

3.1 INTRODUCTION

This chapter provides our definition of distributed generation and explains our approach to measuring its network value. It sets out how we identified potential network benefits provided by distributed generation, and the methods we used to assess their scale and monetary value.

It outlines the two broad contexts in which this measurement applies:

- the effect of distributed generation on the planning and management of Victoria's electricity network, and
- the environmental and social effects that might flow on from any changes to the network caused by distributed generation.

3.2 DEFINITION OF DISTRIBUTED GENERATION

'Distributed generation' can refer to any electricity generation that is connected to the electricity distribution system. This can be contrasted to 'central generation', which refers to generation systems connected to the transmission network and which are typically large scale.[11] Distributed generation can come in varying sizes and be powered by a variety of fuel sources.

[11] Examples of central generation include the coal fired power stations located in the Latrobe Valley.

In this inquiry, we define distributed generation as:[12]

- **Distributed generation below 5 MW capacity**. Distributed generators of this size are typically not stand-alone generators; they are normally installed in or on a host's property and supply electricity to the host's site.
- **Distributed electricity generation from any source or fuel type**. Electricity from distributed generation can be generated from a range of sources including wind, solar, biomass, hydro, diesel and natural gas. In Victoria, solar is most common.
- **Battery storage**. In our report on energy value we concluded that batteries provide a 'private value' insofar as they enable the distributed generator to avoid retail tariffs by storing any excess energy for later use. When assessing network value, batteries become more significant. We revisit the role, and value, of battery storage in this stage of the inquiry.

For this stage of the inquiry we also distinguish between network-led and proponent-led distributed generation. We have sought to examine how these different categories of distributed generation are accommodated within the regulatory framework. We define the two categories as:

- **network-led** distributed generation is that which is procured by a network business, and
- **proponent-led** distributed generation refers to systems that are installed by third parties independently of the decision making of the network business.

3.3 CONCEPT OF VALUE

In our Stage 1 draft report we set out the concept of value that we are using in this inquiry.[13] This section describes this concept in the context of network value.

[12] For further discussion of the definition of distributed generation, please refer to our earlier report: Essential Services Commission 2016, *The Energy Value of Distributed Generation - Distributed Generation Inquiry Stage 1 Final Report*, August, p. 26.

[13] Essential Services Commission 2016, *The Energy Value of Distributed Generation - Distributed Generation Inquiry Stage 1 Draft Report*, April, p. 27.

FOCUS ON 'EXTERNAL' EFFECTS

The first distinction we make is between the 'internal' and 'external' effects of distributed generation. 'Internal effects' refers to anything that only affects the investor in distributed generation, without any intervention from government. This could include the benefit that the distributed generation owner gets from reduced power bills, or the enhanced wellbeing they experience as a result of having taken steps to help the environment. Because the benefits of internal effects accrue directly to the investor, they are excluded from our analysis in this inquiry.

'External effects' of distributed generation are those that are experienced by parties other than the investor in distributed generation. These other parties could include other people, communities, organisations or the physical environment in which the distributed generation unit operates.

DIRECT AND INDIRECT EXTERNAL EFFECTS

There are two types of external effects. The first are 'direct external effects'. Direct external effects are those that manifest in the electricity network when, for example, a distributed generator produces electricity or when they export their surplus electricity into the grid.[14]

The second type is 'indirect external effects'. Indirect effects are those that flow on from the direct effects. If those effects enhance the wellbeing of someone or something, then those effects can be said to generate benefits.

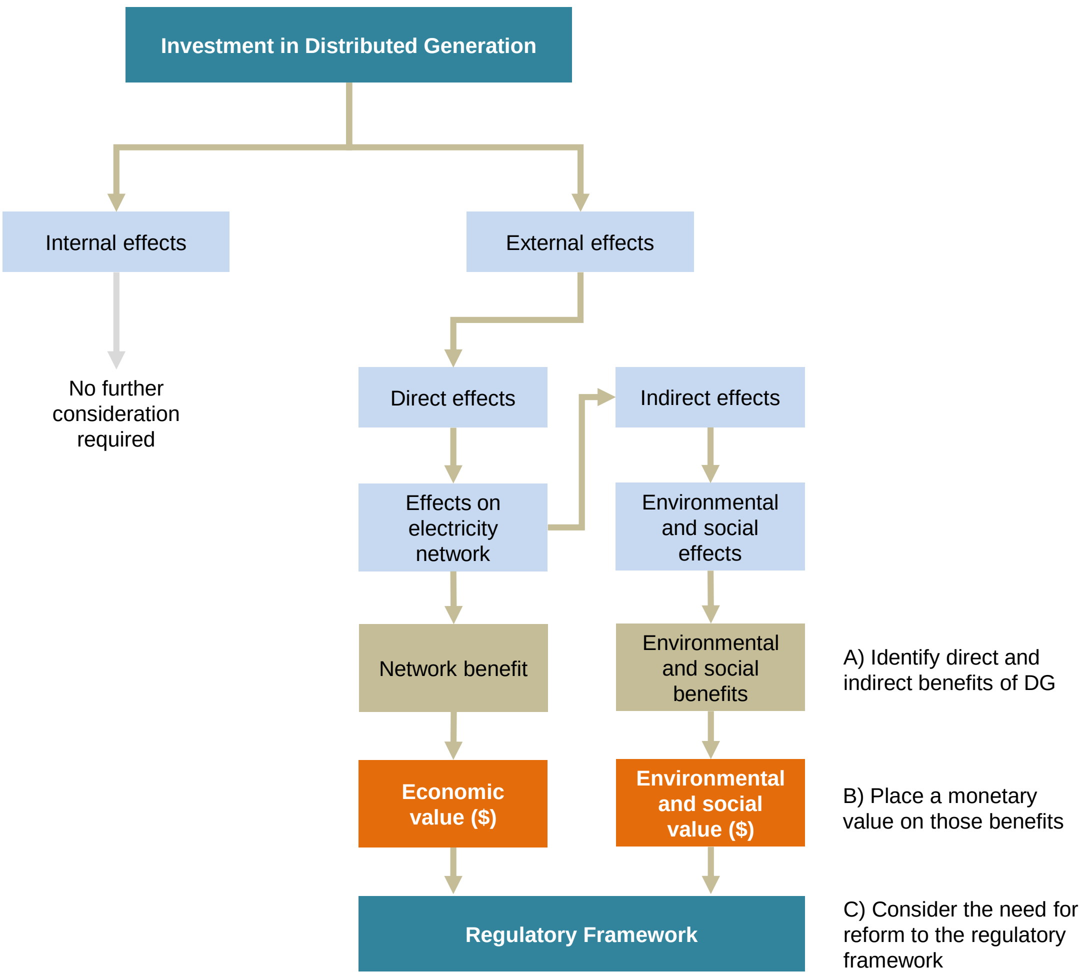
By definition, benefits have a positive value. For example, if distributed generation leads to a reduction in expenditure on network infrastructure, then this could produce a benefit to network businesses. To the extent the reduction in costs is reflected in lower network tariffs, this would produce a benefit to electricity consumers.

[14] A separate series of Commission reports examines the value of distributed generation electricity: Essential Services Commission 2015, *The Energy Value of Distributed Generation – Distributed Generation Inquiry – Our Proposed Approach*, December; Essential Services Commission 2016, *The Energy Value of Distributed Generation – Distributed Generation Inquiry Stage 1 Draft Report*, April; Essential Services Commission 2016, *The Energy Value of Distributed Generation – Distributed Generation Inquiry Stage 1 Final Report*, August .

Measuring that value is not straightforward. However, because this review focusses on identifying how value (or 'true value') might be reflected in remuneration to distributed generators, we confine our approach to defining value in monetary terms only.

We set out this typology of effects as it applies in the network stage of the inquiry in Figure 3.1.

FIGURE 3.1 TREATMENT OF NETWORK VALUE IN THIS INQUIRY



Source: ESC

Typically, an investor in distributed generation cannot, all things being equal, gain a return on the benefits enjoyed by other parties via the indirect effects of that investment. (Economists usually refer to situations such as these as externalities or spill-overs). One purpose of this review is to identify and quantify the value of the indirect benefits of investment in distributed generation. Specifically, the terms of reference for this inquiry request that we identify and evaluate the environmental and social value derived from distributed generation.

Identifying the environmental benefits of distributed generation is conceptually more straightforward. Following further discussions with the department,[15] we have defined the term 'social' to cover benefits that manifest themselves in domains such as: health, justice, safety and amenity. These all pertain to the well-being of individuals and communities (and potentially their productivity).

In our role in assessing the 'true value' of distributed generation we do not examine matters such as: the optimal profile for future investment in distributed generation; how the benefits of that investment might be maximised; whether the benefits could be delivered by alternative means; or the cost of delivering them.

3.4 IDENTIFYING POTENTIAL NETWORK BENEFITS

Distributed generation can provide benefits to electricity networks in a number of ways. In terms of economic network benefits, distributed generation may alter the way network businesses build and maintain their electricity networks. Consequently, cost savings may be partially or fully passed on to customers, who may also benefit if distributed generation reduces the 'expected unserved energy' in an area of the network.[16]

The first step in the analysis involved identifying the range of potential benefits that distributed generation may provide to networks. Drawing upon stakeholder

[15] Department of Economic Development, Jobs Transport and Resources, Victorian Government

[16] Expected unserved energy is the forecasted amount of energy that is required by customers but which cannot be supplied due to the failure of a critical piece of network equipment.

submissions and a review of Australian and international literature,[17] the Commission identified four broad benefit categories that may either result in economic, environmental or social value (see Figure 3.2). These categories are:

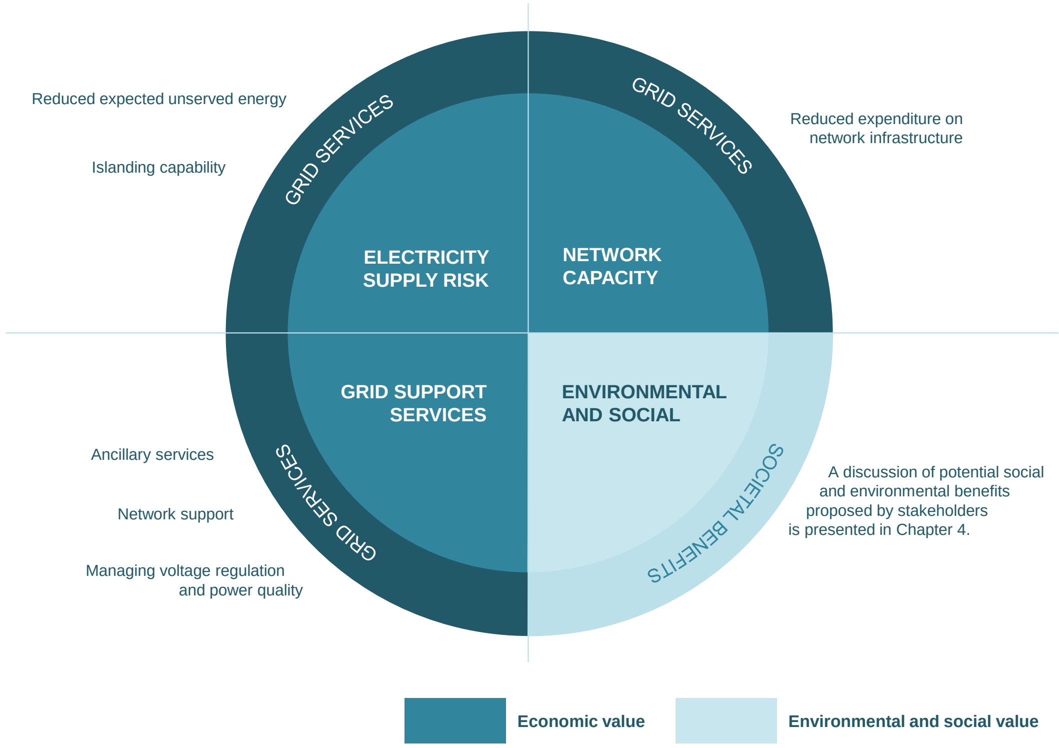
- **Network Capacity** – the effect of distributed generation on improving the capacity of the network, which may defer the need to build or replace network infrastructure or improve the current capacity of the network and thereby relieve network congestion.
- **Electricity Supply Risk** – the effect of distributed generation in improving the continuous supply of electricity and resilience of the grid.
- **Grid Support Services –** the effect of distributed generation on services required to enable the reliable operation of the grid, such as voltage regulation.
- **Environmental and Social** – where distributed generation leads to changes in the way the network is managed, this may also cause flow-on, or indirect, social and environmental benefits.

Within each of these broad categories are a number of more specific potential benefits, listed in Table 3.1.

[17] Papers reviewed by the Commission include: EY 2015, *Evaluation Methodology of the Value of Small Scale Embedded Generation and Storage to Networks*, Clean Energy Council, July; Frontier 2015, *Valuing the impact of local generation on electricity networks*, February; Rocky Mountain Institute eLab 2013, *A Review of Solar PV Benefit & Cost* Studies, September.

FIGURE 3.2 NETWORK BENEFIT CATEGORIES

Potential network benefits by category



Source: ESC

TABLE 3.1 DESCRIPTION OF POTENTIAL NETWORK BENEFITS

Benefit category	Potential network benefit	Description of potential benefit
Network Capacity	Reduced expenditure on network infrastructure	Network congestion arises when part of a network approaches the limits of its capacity to supply sufficient electricity during periods of peak demand. Network businesses generally build or replace network infrastructure to improve the capacity of the network and relieve network congestion. Congestion can occur, and be relieved, within both the distribution and transmission networks.[18] Distributed generation can relieve network congestion by reducing peak demand or increasing the supply capacity at specific points throughout the network. This could defer the need for network businesses to invest in upgrading network infrastructure.

[18] Our discussion of the benefit of reduced network congestion encompasses the way this benefit manifests at the transmission level, thereby incorporating the benefit that some studies seek to approximate through calculating avoided Transmission Use of Service (TUOS) charges.

Benefit category	Potential network benefit	Description of potential benefit
Electricity Supply Risk	Reduced expected unserved energy	To meet service standards, the network must be able to deliver electricity under certain standards, including under adverse conditions or where there is network congestion. The 'expected unserved energy' is the forecasted amount of energy that is required by customers but cannot be supplied due to the failure of a critical piece of network equipment. Distributed generation can generate electricity at a time of peak demand to reduce the amount of expected unserved energy faced by the network.
	Islanding capability	Distributed generation can provide islanding capability for consumers (or a group of consumers). This may lead to private benefits to consumers, and potentially further reliability for the network.
Grid Support Services	Ancillary services	Services and resources are required to operate the network on an on-going basis. Some of these services relate to controlling frequency or restarting the network after an incident. AEMO procures such services to support the operation of the grid through a variety of markets, specifically being Frequency Control Ancillary Services (FCAS), Network Support Control Ancillary Services (NSCAS), and System Restart Ancillary Services (SRAS) markets. Dispatchable distributed generation can be contracted by a network business to provide ancillary services.
	Network support	During network peak periods, DNSPs sometimes purchase generation from network support facilities such as backup diesel engines. Distributed generation could potentially avoid or reduce the costs of such network support.
	Managing voltage regulation and power quality	Network businesses operate equipment and conduct maintenance to regulate voltage levels through the network (by adjusting taps on transformers or upgrading them entirely). The operation of the network is also impacted by power quality, which can be impacted by fluctuations in voltage and harmonics faced by a distribution system. Distributed generation may assist in the management of voltage regulation, either through exported energy into the grid or via control of its network interfacing equipment (i.e. inverter). Certain technologies of distributed generation could also provide benefit by working with the network to manage issues such as those related to power quality.
Environmental and Social	Bushfire risk mitigation	Stakeholders suggested that distributed generation may reduce bushfire risk, by limiting or avoiding the use of above-ground electricity assets (such as poles and wires) on high fire risk days in high risk areas.
	Amenity and aesthetic benefit	Stakeholders suggested that distributed generation could reduce the need to build poles and wires, which may increase amenity and aesthetic in the surrounding area.
	Customer empowerment	Stakeholders suggested that distributed generation that allows for the ability to consume electricity without the need for the grid (to go 'off-grid') can provide that customer with a sense of empowerment.

Source: ESC, Jacobs

3.5 ASSESSING ECONOMIC BENEFITS FOR VALUATION

Having identified the potential economic benefits of distributed generation, we proceeded to identify which benefits were sufficiently extant and material with respect to calculating network value for the purposes of this inquiry to warrant further examination. We used a three-part test similar to the approach we use to examine potential social and environmental benefits of distributed generation.[19] The three-part test operates as follows:

a. **Identification** – Is it possible to establish a causal link between a potential network benefit and distributed generation?
b. **Quantification** – If a benefit can be attributed to distributed generation, what is the scale of that benefit and is it material with respect to calculating network value for the purposes of this inquiry?
c. **Valuation** – For material benefits, is it possible to place a monetary value on the benefit?

By applying this test we sorted the potential benefits into three categories. The first category applies to those potential benefits that we found, on the basis of currently available data, regulatory settings and/or maturity of existing technologies, we could not attribute to distributed generation. We did not proceed to calculate the value of these benefits and excluded them from further analysis. The rationale for this conclusion as it applies to each case is contained in chapter 4.

The second category contains benefits that may be attributable to distributed generation, but which, on the basis of our initial analysis, were not expected to lead to material value in the context of calculating value within this inquiry. For these benefits, we developed case studies or sample calculations to test whether our assessment of low-materiality was correct. The outcomes of these studies and calculations are contained in chapter 4.

The final category are those benefits that we found can be attributed to distributed generation, and which our initial analysis indicated may lead to material value across

[19] See approach developed through our final report on Energy Value. Essential Services Commission 2016, *The Energy Value of Distributed Generation - Distributed Generation Inquiry Stage 1 Final Report*, August.

the Victorian electricity network. For these benefits, we proceeded to develop methods designed to calculate the value that distributed generation provides. An explanation of these methods is provided in the following section and the results are presented in chapter 4. A summary of the results of our assessment of network benefits is presented in Table 3.2.

TABLE 3.2 SUMMARY OF POTENTIAL NETWORK BENEFITS

Category	Network benefit		Treatment
Network Capacity	Reduced expenditure on network infrastructure	✓	Quantifiable network value
Electricity Supply Risk	Reduced expected unserved energy	✓	Quantifiable network value
	Islanding capability	×	Excluded (a private benefit)
Grid Support Services	Ancillary services	×	Excluded (not reliably attributable)
	Network support	-	Non-material benefit with respect to calculating network value for the purposes of this inquiry
	Managing voltage regulation and power quality	-	Non-material benefit with respect to calculating network value for the purposes of this inquiry
Environmental and Social Benefit	Bushfire risk mitigation and reduction	×	Excluded (not attributable to existing systems)
		-	Future systems could provide benefit (if lower cost alternative to alternative mitigation measures)
	Various other potential benefits	×	Excluded (not reliably attributable, or are private benefits)

Source: ESC, Jacobs

3.6 METHOD FOR VALUING ECONOMIC BENEFITS

Having performed an assessment of the various potential network benefits of distributed generation, we focus our attention on establishing the monetary value of two key types of benefits:

1. reduced expenditure on network infrastructure[20]
2. reduced expected unserved energy.

[20] This includes reduced congestion in the transmission network, thereby incorporating the benefit that some studies seek to approximate through calculating avoided Transmission Use of Service (TUOS) charges.

Together, these two benefits flow from the wider benefit of reducing network congestion. The first benefit reflects the fact that reduced congestion may allow network businesses to defer or reduce their expenditure on the network. The second benefit is related to reducing the amount of expected unserved energy from a network, which decreases the likelihood of a power outage. The reduction in expected unserved energy has a monetary value based on a metric set by the Australian Energy Market Operator (AEMO). We co-developed a single method to calculate the value of both benefits with Jacobs Consultancy (section 3.6.1).

We commissioned Jacobs to quantitatively and qualitatively confirm that other benefits should be classified as non-material for the purposes of this inquiry. Table 3.3 summarises the calculation approaches used to assess potential network benefits.

TABLE 3.3 SUMMARY OF CALCULATION APPROACHES

A description of the calculation approach applied to determine the extent (or realisation) of an identified network benefit

Benefit	Calculation approach	Calculation description
Network Capacity		
Reduced expenditure on network infrastructure	'Probabilistic planning approach'	A specific valuation methodology applied to account for the amount of avoided network deferral in capital expenditure (CAPEX) and operating expenditure (OPEX). This is incorporated as part of the benefit of reducing network congestion, as per section 4.2. Avoided OPEX was estimated as a proportion of deferred CAPEX value. Avoided line losses were also estimated at the customer connection point. In these cases, adjustment factors have been incorporated and applied in the valuation method.
Electricity Supply Risk		
Reduced expected unserved energy	'Probabilistic planning approach'	Expected unserved energy is currently valued by AEMO using the Value of Customer Reliability (VCR). VCR is incorporated into the calculation applied to account for reduced expenditure on network infrastructure, and incorporated as part of the benefit of reducing network congestion. See discussion in section 4.2.
Islanding capability	No calculation (excluded)	No calculation required, as these potential benefits are excluded due to it being a private benefit to the DG investor. See discussion in section 4.3.4.

Benefit	Calculation approach	Calculation description
Grid Support Services		
Network support	Case-study	A test calculation to consider the extent of avoided costs of network support facilities (backup generation). See discussion in section 4.3.1.
Managing voltage regulation and power quality	Case-study	A test calculation performed to understand the extent that DG can manage voltage regulation for networks. See discussion in section 4.3.2.
Ancillary services	No calculation (excluded)	No calculation required, as these potential benefits are not reliably attributable to current DG. See discussion in section 4.3.3.
Environmental and Social		
Bushfire risk mitigation, amenity and aesthetic benefit, customer empowerment	Indirect benefits test	An indirect benefits test has been applied against each potential benefit. The test considers whether the benefit is attributable to DG, and whether it can be quantified and monetised. See discussion in section 4.4.

Source: ESC, Jacobs

3.6.1 REDUCING NETWORK CONGESTION – CAPACITY AND UNSERVED ENERGY

To assess the value of the benefits of reduced network congestion, we developed a method that mirrors the probabilistic planning method used by network businesses in Victoria to plan their network expenditure.[21] This section sets out the basis and scope of this method, and describes how it is applied.

PROBABILISTIC NETWORK PLANNING

To explain the valuation method applied in this inquiry, it is necessary to first explain the probabilistic planning approach used by network businesses in Victoria.

[21] There are various methods to calculate the value of network benefits, particularly regarding deferral of network upgrade projects, and these methods differ by the objective they seek to answer. The Commission reviewed a number of reports and studies that present and discuss various valuation methods, such as: The National Association of Regulatory Utility Commissioners (NARUC) 2016, *NARUC Manual on Distributed Energy Resources Compensation Draft*, July; EY 2015, *Evaluation Methodology of the Value of Small Scale Embedded Generation and Storage to Networks*, Clean Energy Council, July; Frontier 2015, *Valuing the impact of local generation on electricity networks*, ENA, February; Energeia 2016, *LRMC Methodology Paper,* The Institute for Sustainable Futures, March.

Under the national framework overseen by the Australian Energy Regulator (AER), the electricity network must be designed to minimise the total cost of the distribution network, the transmission network and the disruption to customers of any unserved electricity. A key element of the network's ability to meet this standard is whether it has the capacity to cope with increases in demand for energy into the future. Network businesses regularly assess whether their network is capable of meeting this demand, or whether it is reaching its supply capacity and therefore requires upgrading. Upgrades designed to expand the capacity of the existing network are typically referred to as 'network augmentations'. When network businesses augment their network, the cost is recovered from customers through the electricity distribution charges that form a portion of all customers' bills.

Network businesses, as monopoly businesses, must justify their expenditure to the AER. The approach used to justify the expenditure on network upgrades in Victoria, and to identify the time they should occur, is referred to as a 'probabilistic planning approach'.

This approach essentially has two objectives. First, it seeks to identify whether the network is becoming congested, which it does by requiring network businesses to conduct and publish annual forecasts of the power flows throughout their networks. Second, it seeks to identify whether the benefits of expanding the network's capacity are worth the expense of doing so. This decision is based on comparing the cost of the network upgrade with the value that customers place on the decreased likelihood of 'unserved energy' as a result of the upgrade. This approach recognises that in some instances, customers would prefer to risk experiencing an occasional blackout rather than have an increase in their bills.

WHEN IS UPGRADING THE NETWORK WORTH THE EXPENSE?

The demand for electricity may approach the supply capacity of the network for a few hours during a year. If a critical piece of network equipment (such as a transformer) fails during this period, the network will experience an outage. When network planners plan their network, they must actively consider this scenario. In other words, the key factor that relates to network planning is not the capacity of each network asset – such as a zone substation – while all equipment is operating as expected. Rather, the key factor is the capacity of that asset if one critical piece of equipment fails.

Each network asset in Victoria has a capacity rating based on this scenario – that is, a rated 'maximum capacity' in the event that a critical piece of equipment fails. This rating is referred to as the asset's 'N -1' rating (that is, its capacity 'minus one piece of critical equipment'). For some network assets, the annual forecast of demand for energy at that location will indicate that, from time to time, demand is forecast to exceed the N -1 rating for the asset.

The number of hours that the N -1 rating is exceeded, and the extent to which it is exceeded in each of those hours, determines the amount of energy that is 'at risk' if a piece of equipment fails. This quantum of energy is referred to as the 'energy at risk'. Under the framework for regulating electricity networks, the expected unserved energy at any location is calculated by multiplying the amount of energy at risk at any given point in the network by the probability of outage.

To construct a network in which there was no 'energy at risk' – that is, a network that would have absolutely no expected unserved energy – would be prohibitively expensive, and this expense would be met by all customers through their electricity bills. So that the network is constructed based on the needs of customers, the probabilistic planning approach is intended to ensure that network upgrades only occur when the benefits of reduced expected unserved energy are greater than the costs of the upgrade.

To identify the value of this reduced expected unserved energy, the Australian Energy Market Operator (AEMO) has undertaken studies of the willingness of customers to pay for the supply of energy in the event of an outage.[22] This measure is known as the value of customer reliability (VCR). [23]

The value of 'expected unserved energy' at any given point within the network – such as at a zone substation – can be calculated by multiplying the total volume of 'expected unserved energy' at that zone substation by the VCR published by AEMO.

[22] AEMO tested with stakeholders a range of modelling approaches, settling on a combination of a choice modelling (WTP) and contingent valuation techniques (WTA).

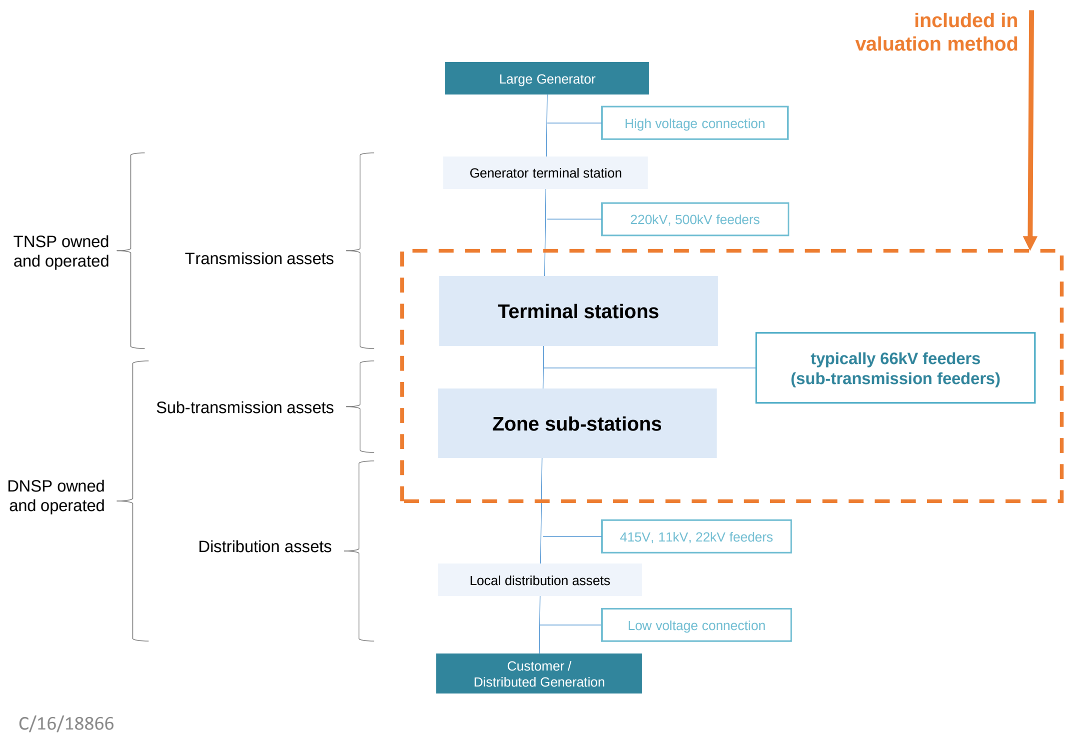
[23] Australian Energy Market Operator 2014, *Value of Customer Reliability final report,* November

An upgrade is worth the expense when the cost of the upgrade is less than the value of the expected unserved energy at that zone substation. In other words, the trigger point for an upgrade is when society values the increased risk of a blackout, under an N -1 scenario, as more costly than actually undertaking the upgrade.

SCOPE AND FOCUS OF OUR VALUATION METHOD

Our study examines the value of the network benefits produced by distributed generation. Distributed generation can influence the capital expenditure of network business at each level of the network. However, the extent of our valuation exercise is limited by the public availability of data and therefore has been focused on zone sub-stations, terminal stations and sub-transmission feeders (Figure 3.3). We did not apply a valuation method to low voltage distribution assets. There is insufficient data that is publicly available or robust enough to determine the value from distributed generation at low voltage assets.

FIGURE 3.3 SCOPE OF VALUATION METHOD, BY NETWORK ASSETS



Source: ESC, Jacobs

Although our method encompassed the effects of distributed generation at several levels of network asset, we represent the results in terms of the value provided at each zone substation. This equates to identifying the zone substation as the 'unit of analysis'. In practice, the value ascribed to each zone substation in our final results is the cumulative total of the value of reduced expected unserved energy and augmentation deferrals at that zone substation, plus an apportioning of the value produced at the sub-transmission feeders and transmission assets to which that zone substation is connected.

OUR VALUATION METHOD

The objective of our valuation method is to identify the value of the benefits produced by distributed generation in Victoria in a given year.[24] We examined a range of potential methods for undertaking this analysis, and ultimately used a form of counterfactual method that was best suited to the exercise. Following release of this report, we will publish a separate technical paper outlining the various methods considered and the implications of applying them in different contexts.

For the purposes of our analysis, we have applied the method primarily to 2017.[25] Our analysis is based on identifying the value of the benefits of distributed generation that is connected to the network at the start of 2017, plus any additional generation that the network businesses have forecasted will be added over the course of that year.

The method applies to all forms of distributed generation. In practice, the current fleet of distributed generation in Victoria can be divided into two categories based on the profile of its electrical output. The first category is solar photovoltaic (PV), which accounts for the majority of systems currently deployed in Victoria. In the second category, we grouped all other forms of distributed generation, which share the

[24] This can be contrasted to a method such as the Turvey Incremental, a form of which was employed by consultancy ENEA in a recent study for Powercor. The objective of ENEA's study was to determine whether and where additional distributed generation may provide benefits for the management of the network in Powercor's distribution area. Unlike our approach, ENEA's method is geared towards identifying the value of a tranche of additional distributed generation that is capable of deferring a network augmentation project by one year. As such, it should not be expected to produce similar results to our analysis. CitiPower and Powercor 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation – Discussion Paper, Stage 2 – Network Value*, July, p. 2-3.

[25] Because the source data, which comes from the distribution businesses annual planning reports, is provided in 5 year tranches, we have also conducted the analysis out to 2020, primarily for the purposes of evaluating the extent to which the value shifts from year to year.

attribute of being controllable – or in other words, ‘dispatchable’. We did not create a separate category for distributed wind generation because of the limited number of small-scale wind systems in Victoria.

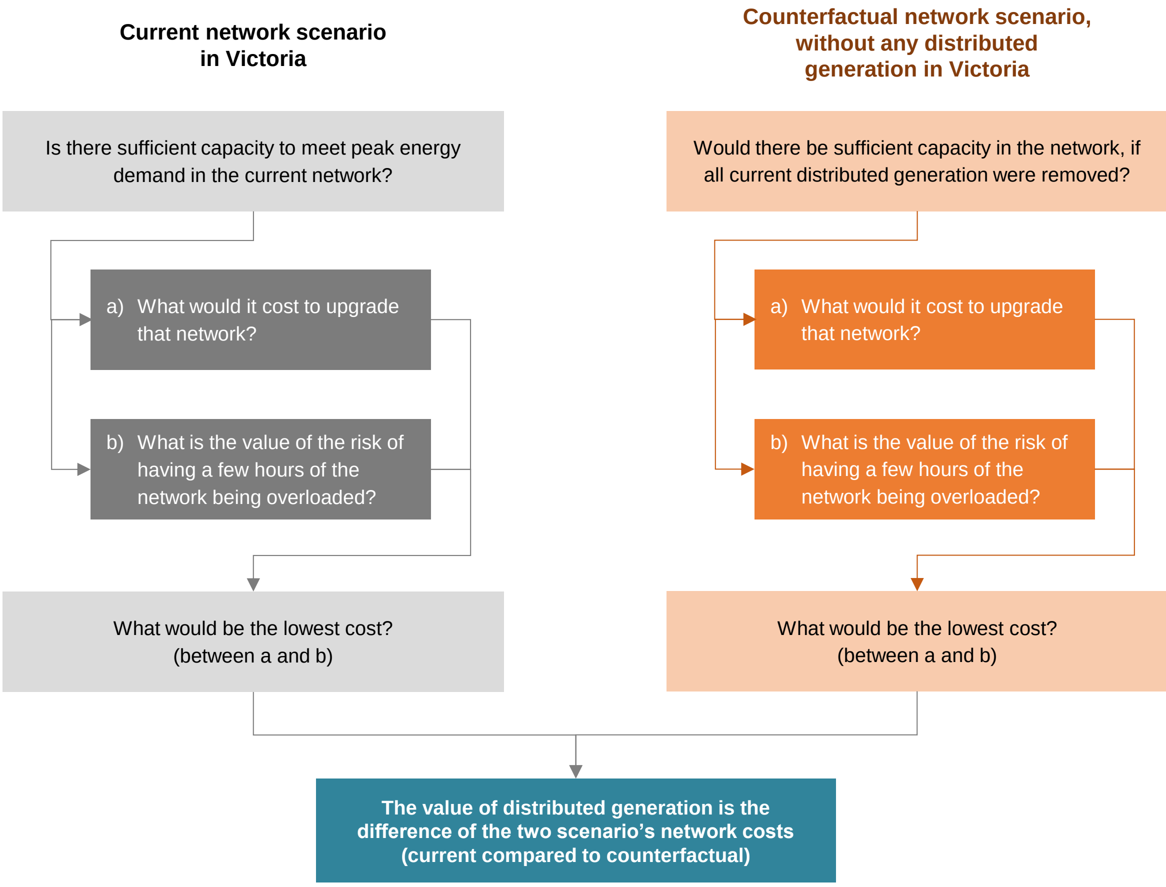
The valuation method is based on performing an analysis of the network, on an asset-by-asset basis, through which a counterfactual scenario is established in which all distributed generation connected to that zone substation is removed from the network. Drawing upon the information published by network businesses in their annual planning statements, the method applies a version of the probabilistic planning method outlined above to identify two results:

- The monetary value of the additional expenditure network businesses would need to maintain their network in the absence of the distributed generation,[26] and
- The expected unserved energy in the absence of the distributed generation, as measured by the value of the ‘energy at risk’ and probability of failure at each network asset in the absence of the distributed generation.

The value, under the counterfactual scenario, in each of these benefit categories is then compared to values under the existing real-world scenario, and combined to produce a total value of reduced congestion. The value of reduced network expenditure is presented as an annualised value of the changed level of capital and operational expenditure, while the value of reduced expected unserved energy is presented as an annual value for that year. The valuation method is summarised in Figure 3.4.

[26] It should be noted that there is no explicit standard for reliability and capacity at the distribution and transmission level network in Victoria. Network capacity and supply reliability are a result of the cost minimisation analysis and planning and the completion of network augmentation projects, on the basis of the 'probabilistic planning approach'. AER 2015, *Issues Paper, Victorian electricity distribution pricing review, 2016 to 2020*, June, p. 14.

FIGURE 3.4 VALUATION METHOD BASED ON THE 'PROBABLISTIC PLANNING APPROACH'



Source: ESC, Jacobs

This method assumes that the network business has identified the least cost option to respond to the network constraint, and incorporated that into its annual planning report.[27] Where the cost of a planned augmentation exceeds $5 million, the national framework requires network businesses to conduct a tender process that is open to non-network solution providers.[28] It is conceivable that in some of these instances, the

[27] Distributed Annual Planning Report (DAPR)

[28] Regulatory Investment Test – Distribution (RIT-D)

network business may identify a lower cost non-network alternative to the network augmentation they identified in their planning report.

To the extent this occurs within a measurement period, the forecasted value identified using our valuation method will exceed the actual value that is ultimately created by the distributed generation in that section of the network in that period.

3.7 ENVIRONMENTAL AND SOCIAL BENEFITS

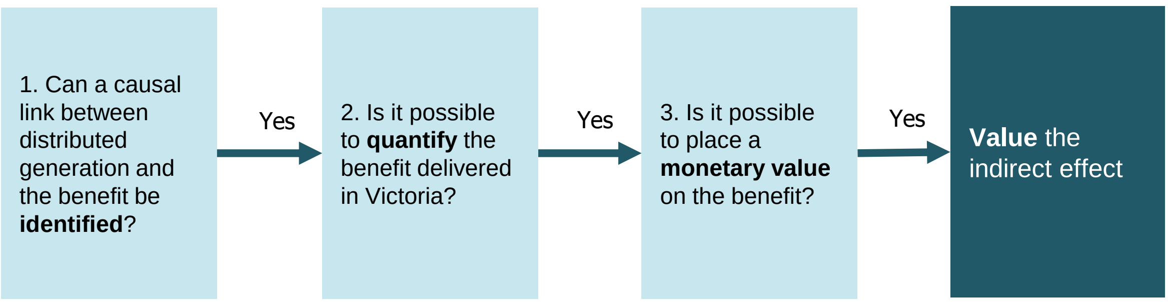
When examining the energy value of distributed generation in stage one of this inquiry, we developed a three-part indirect effects test as a method for considering environmental and social value.

The three-part process applied was:

a. **Identification –** We considered the potential benefits of distributed generation and whether it is possible to establish a causal link between that benefit and its association with the electricity network
b. **Quantification –** We considered whether it is possible to measure the quantum of benefit delivered in Victoria by a unit of distributed generation
c. **Valuation** – We considered whether it is possible to place a monetary value on the benefit.

Only where all three parts of the test can be completed, can a monetary value on that environmental and social benefit be determined.

FIGURE 3.5 INDIRECT BENEFITS TEST



Source: ESC

4 THE NETWORK VALUE OF DISTRIBUTED GENERATION

4.1 INTRODUCTION

This chapter sets out the results of our empirical study into to the network value of distributed generation across the Victorian electricity network.

It also presents our draft findings on the social and environmental value that may arise as an indirect result of distributed generation effects on the operation of the network.

OVERVIEW

Distributed generation can and does provide network value. Distributed generation causes this value when it reduces peak electricity demand within the network in a predictable way. Reductions in peak network demand can allow network businesses to defer network augmentation projects, thereby saving costs. These cost savings are ultimately passed on to end use customers. Distributed generation can also provide value by reducing expected unserved energy. This benefit is experienced by customers generally as a lower incidence of electricity supply disruption when network equipment fails at times of extremely hot or cold weather. Distributed generation can also provide a number of other network benefits but these are not currently material with respect to calculating network value for the purposes of this inquiry. Together, these benefits provided by distributed generation can be described as grid services.[29]

[29] Australian Energy Market Commission 2016, *Contestability of energy services, rule change*, September (http://www.aemc.gov.au/Rule-Changes/Contestability-of-energy-services)

The network value of distributed generation arises as a result of its effect on the entire network, from transmission level assets through to the low-voltage sections of the distribution network. We calculated the value of the benefits that distributed generation provides at the transmission, sub transmission and zone substation levels of the network. That is, our method explored the value of distributed generation at three out of the four levels of Victoria's electricity network. Limitations on the availability of public data meant that it was not possible for us to calculate, on a locational basis, the network value of distributed generation in the fourth level: the low and medium voltage portions of the distribution network.

Distributed generation creates network value in Victoria through reducing and deferring network expenditure and by reducing expected unserved energy. Combining these two sources of value, we estimate that in 2017 the network benefits of solar photovoltaic (PV) systems provide a total of approximately $3 million of network value in Victoria.

This value reflects the specific attributes of Victoria's current fleet of solar PV, not distributed generation more broadly. Forms of distributed generation that are specifically optimised for network value can produce considerably more value than is expressed in our study of solar PV.

The size of network value is affected by:

- **Location** – the value varies based on the distributed generator's location within the network, specifically in terms of its proximity to areas of the network that are congested, or nearing congestion
- **Time** – the value also varies according to the extent to which the electricity generation coincides with the periods of peak demand within the section of the network to which the generator is connected
- **Asset life-cycle** – the value varies based on when in the network operator's cycle of upgrade projects the value is being measured
- **Capacity** – the generation capacity of the distributed generation

- **Optimisation** – 'optimisation' refers to the extent to which the generation is optimised for delivery of grid services. A system that is highly optimised for network benefits is one that reliably produces output at the time it is most needed by the network.

Distributed generation may provide a benefit if it provides a lower cost alternative to network projects undertaken for the purposes of bushfire mitigation. This could occur in circumstances where deploying distributed generation in a remote area, and thereby enabling the linking network to be de-energised during high fire risk days, was a more efficient alternative to other bushfire mitigation steps, such as undergrounding wires. The Commission did not identify any regulatory impediment to this value being realised. We therefore did not assess the merits of greater investment in distributed generation relative to other forms of bushfire mitigation available to network businesses.

4.1.1 STRUCTURE OF THIS CHAPTER

This chapter is divided into five sections:

4.1 Introduction

4.2 Economic value of reduced network congestion

4.3 Economic value of other network benefits

- network support
- managing voltage regulation and power quality
- ancillary services, and
- islanding capability.

4.4 Social and environmental benefits

- bushfire risk mitigation and reduction
- amenity and aesthetic benefit, and
- customer empowerment.

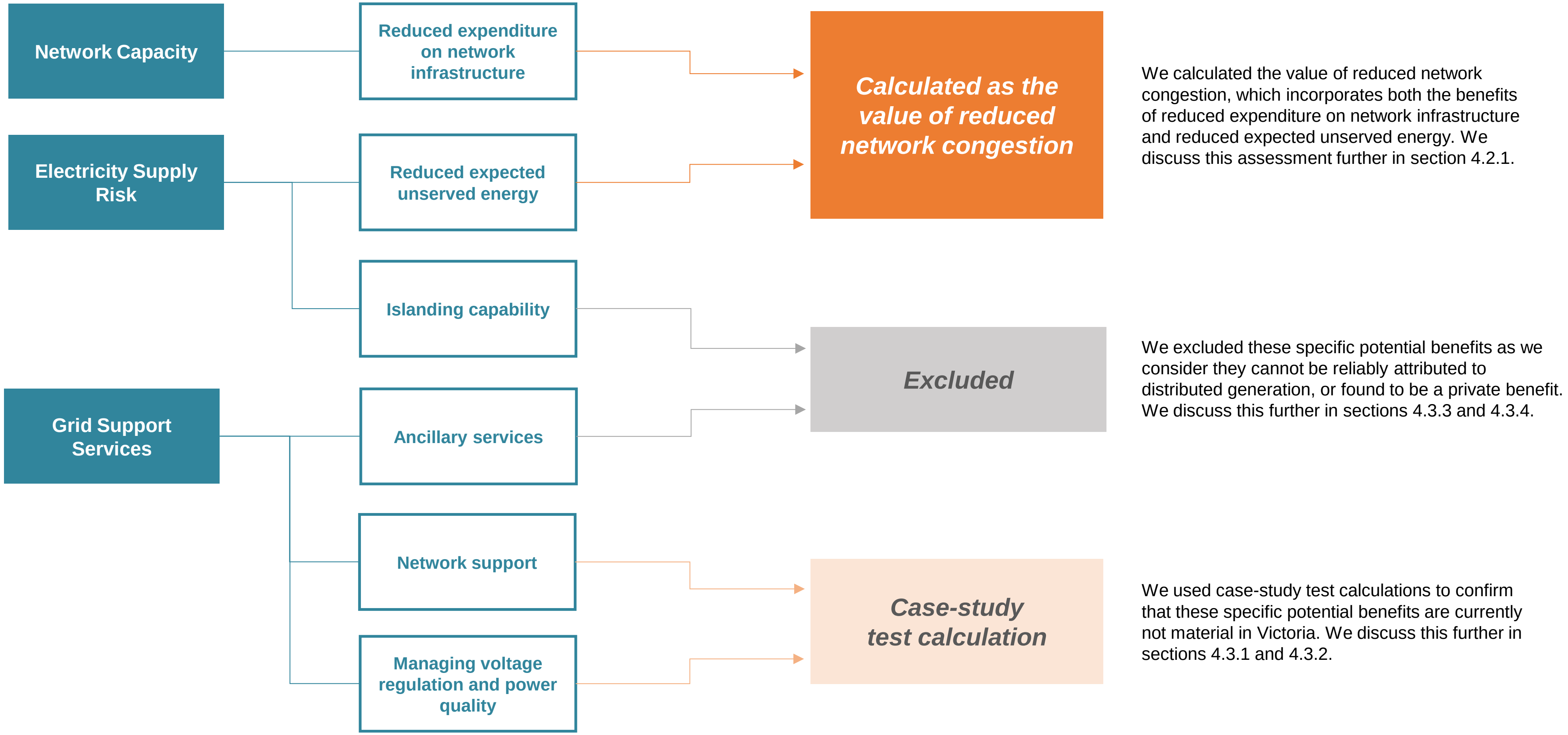
4.5 Conclusion

4.2 ECONOMIC VALUE – REDUCED NETWORK CONGESTION

In chapter 3, we set out our approach to assessing whether distributed generation may lead to economic network benefits, and our approach to calculating that value in Victoria.

As shown in Figure 4.1, we found that two network benefits are material in the context of the examination of network value within this inquiry, and provide value in Victoria: reduced expenditure on network infrastructure and reducing expected unserved energy. Because they both relate to reduced power flows through the network, these two benefits can be described together as 'reduced network congestion'. The remaining potential benefits we assessed as being currently not material in Victoria for the purposes of this inquiry's study of network value, or excluded from further analysis on the basis that they were either a private benefit or were not attributable to distributed generation. In this section, we provide the results of our assessment of reducing network congestion (reduced expenditure on network infrastructure and reduced expected unserved energy).

FIGURE 4.1 SUMMARY OF NETWORK ECONOMIC VALUE ASSESSMENT



Source: ESC

4.2.1 REDUCING NETWORK CONGESTION

The primary means by which distributed generation provides network value is through reducing network congestion. ‘Network congestion’ refers to circumstances in which a part of the network is operating close to the limits of its designed capacity. This typically occurs during periods of network peak demand. To the extent that distributed generation can reliably reduce demands on the network during peak periods, it can reduce network congestion.[30]

Reducing network congestion can lead to two specific network benefits. The first is to defer or reduce expenditure on network infrastructure upgrades (augmentations). As noted by the Energy Networks Association (ENA):

> *…private investment in distributed generation can defer augmentation of Victoria’s electricity network, under certain circumstances. This will be the case if it reduces the use of distribution network at peak times when the network is constrained.*[31]

The second benefit, as noted by AusNet Services, is by reducing the quantum of ‘energy at risk’, which can cause a reduction in expected unserved energy. That is, through a reduction in the likelihood of customers’ energy not being supplied due to an outage.

> *Whilst in many cases on AusNet Services’ distribution network solar contributes minimal reduction in the network peak demand, a more material contribution may be expected over the broader set of hours for which there may be energy at risk.*[32]

In chapter 3, we set out a method for calculating the value of reducing network congestion based on the probabilistic planning approach used by Victorian network businesses. This chapter sets out the results of applying this method to the network in 2017.

[30] In the section on the time varying nature of network value below, we discuss network congestion in terms of periods in which demand for electricity exceeds the N-1 rating of a network asset.

[31] Energy Networks Association 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation – Discussion Paper, Stage 2 – Network Value*, July, p. 1.

[32] AusNet Services 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation – Discussion Paper, Stage 2 – Network Value*, July, p. 8.

DISTRIBUTED GENERATION PROVIDES NETWORK VALUE IN VICTORIA

Distributed generation creates network value in Victoria through reducing and deferring network expenditure and by reducing expected unserved energy. Combining these two sources of value, we estimate that in 2017 the network benefits of solar photovoltaic (PV) systems will provide a total of approximately $3 million of network value in Victoria.[33]

This value reflects the specific attributes of Victoria's current fleet of solar PV, not distributed generation more broadly. As subsequent sections illustrate, forms of distributed generation that are specifically optimised for network value can produce considerably more value than is expressed in our study of solar PV.

Operator controlled, or dispatchable distributed generation such as gas turbines, co-generation, tri-generation or diesel generators, may produce additional value in 2017. However, it is not possible to estimate this value without knowing how these systems will be operated. As a result, our findings are expressed largely in terms of solar PV systems, which are the most common form of distributed generation in Victoria.[34]

In 2017, the majority of the value (89 per cent) is projected to arise through reducing congestion at zone substation and terminal station assets (Figure 4.2). Around 11 per cent of value was caused through reduction of congestion at the sub transmission level. However, our study indicated that the proportion of total value attributed to each level of the network varies between years. The split of value between different levels of network asset in 2017 should therefore not be treated as indicative of a trend. In other years, reduced congestion in the transmission network may be responsible for a far smaller proportion of the total value.

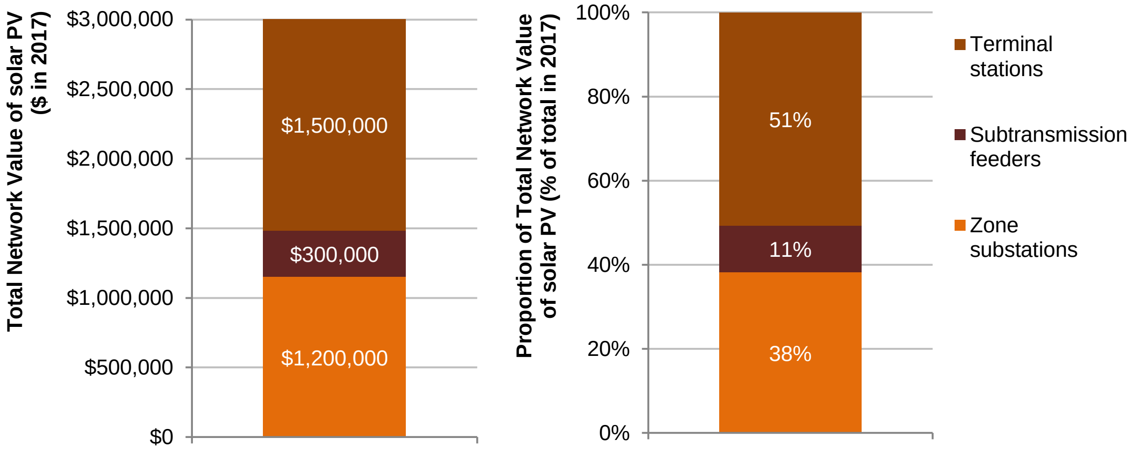
As explained in chapter 3, we did not examine the value of the benefits provided by distributed generation in the lower voltage distribution network, because of the absence

[33] The results and values in this report are presented in real 2016 Australian dollars.

[34] In Victoria, 88% of installed capacity is solar PV, 12% is dispatchable generation, and less than 1% is wind powered. The calculation method was fully applied to known pre-existing dispatchable generation systems installed across Victoria – this includes cogeneration and diesel backup systems. A similar calculation was applied to the areas in Victoria where small amounts of wind-powered distributed generation systems were installed (Ballarat North and Ballarat South ZSSs), so that the potential value from these systems were incorporated.

of publicly available data. Therefore solar PV may provide additional value that is not captured by this exercise.

FIGURE 4.2 NETWORK VALUE OF SOLAR PV, BY ASSET TYPE[a] (2017)



[a] The proportion of value attributable to each asset type is not fixed. It will vary in each measurement period based on the timing of network upgrade projects for each asset type of the network.

Data source: Jacobs

The size of network value is affected by:

- **Location** – The value varies based on the distributed generator's location within the network, specifically its proximity to areas of the network that are congested, or nearing congestion.
- **Time** – The value also varies according to the extent to which the electricity generation coincides with the periods of peak demand within the section of the network to which the generator is connected.
- **Asset life-cycle** – The value varies based on when in the network operator's cycle of upgrade projects the value is being measured. If the measurement is conducted on an annual basis, this means the value varies year-on-year, subject to the timing of network upgrade projects, as well as the supply and demand for energy in the area of the network to which it is connected.
- **Capacity** – The generation capacity of the distributed generation.

- **Optimisation –** ‘Optimisation’ refers to the extent to which the generation is optimised for delivery of grid services, which is largely a function of being both predictable and responsive to the needs of the network. The industry terms applied to these qualities are ‘firm’ and ‘dispatchable’. A system that is highly optimised for network benefits is one that reliably produces output at the time it is most needed by the network.

The following sections outline the effect of each of these factors in more detail.

The analysis quantifies the value of the network benefits of distributed generation, but does not attempt to identify who is receiving that value. Some of the value we identify may already accrue to the investor in the distributed generation if that distributed generator has entered into an agreement to supply grid services to a network business. However, it is our understanding that such agreements are rare for small scale distributed generators, and to the extent any exist, they are limited to a small number of trials.

THE NETWORK VALUE OF DISTRIBUTED GENERATION VARIES BY LOCATION

In Victoria, there are 224 zone sub-stations, 30 terminal stations and hundreds of sub-transmission feeders. Distributed generation may reduce network congestion at any number of these assets. Our analysis calculated the value at each of these levels of the network and its assets, and then expressed that value per zone substation.[35] This equates to using zone substations as the ‘unit of analysis’.

The value is concentrated in a number of specific locations rather than being uniformly spread across the state. Our analysis of the Victorian network showed that the network value was markedly different even between neighbouring zone substations. This pattern exists across the network. There may be considerable value at one network asset and zero value at the next.

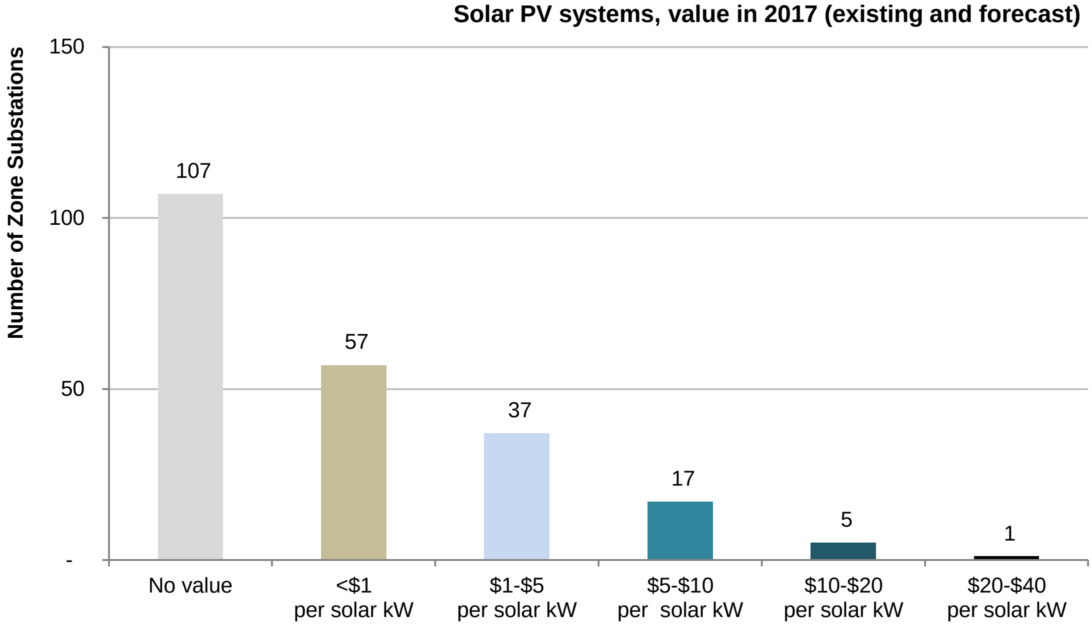
As figure 4.3 shows, in the majority of locations, distributed generators will in 2017 provide no network benefits or will provide less than $1 per kilowatt of installed solar

[35] The locational value of distributed generation in the low voltage portion of the distribution network was not calculated due to the lack of publicly available data.

capacity (solar kW) of value. For solar PV, the value is estimated to exceed $10 per solar kW at only six zone substations. The maximum value provided by solar PV occurs at Barnawatha zone substation, in the north of the state, at a value of around $35 per solar kW.

This means that some but not all solar PV in Victoria provides network value. Network benefits are provided by those systems that are connected to a portion of the network that is congested, or nearing congestion. Figure 4.3 shows the number of zone substations that provide network value across a range of values.

FIGURE 4.3 ZONE SUBSTATIONS BY VALUE RANGE IN 2017
Number of ZSS by network value, solar PV systems ($ per solar kW)

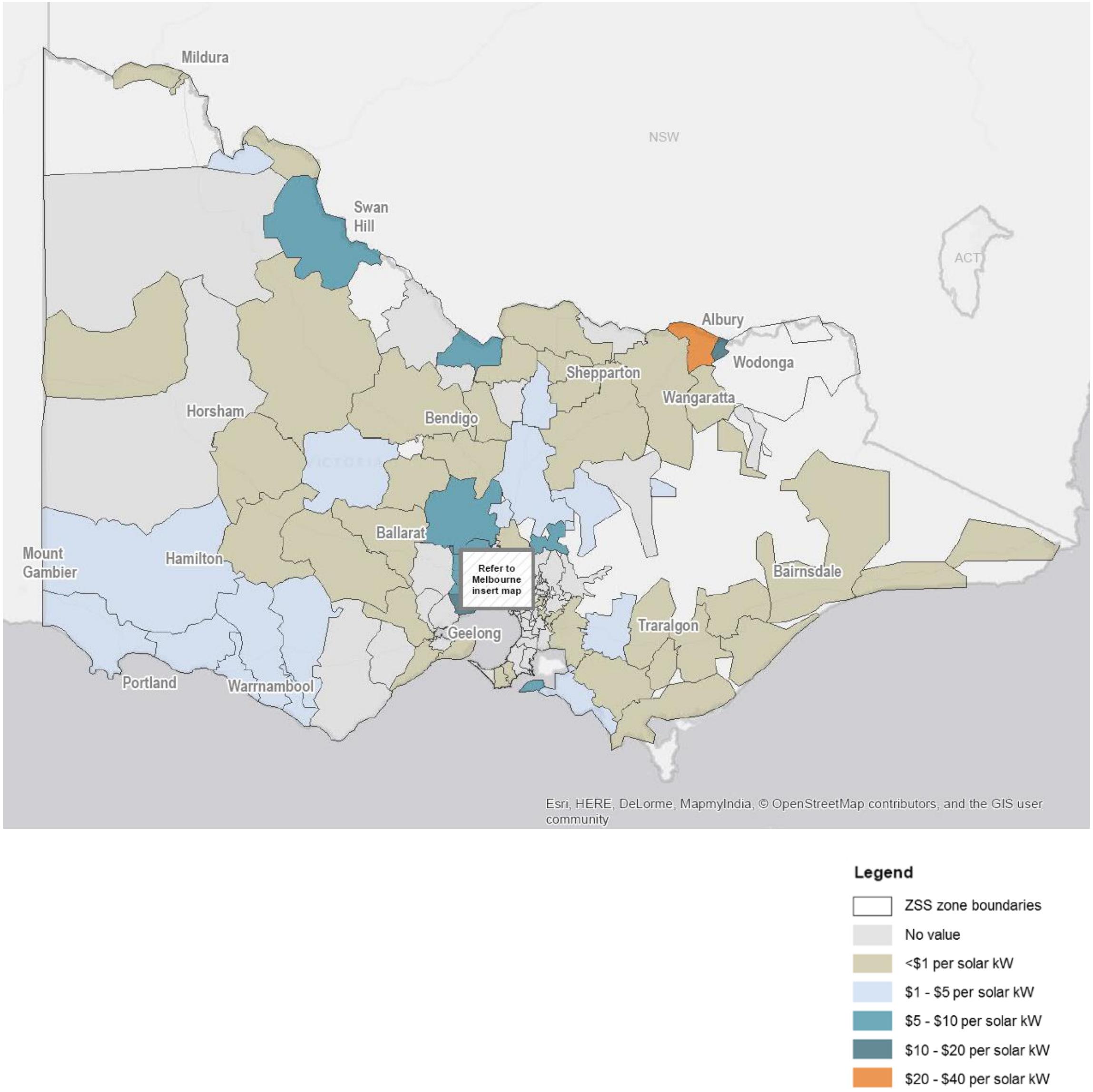


Data source: Jacobs

Higher value areas are located in various regional areas of Victoria (Figure 4.4 and Figure 4.5), and generally in the outer north and west of Melbourne (Figure 4.6 and Figure 4.7). For the majority of the Victorian electricity network, there is very low to no value provided from distributed generation in reducing network congestion.

FIGURE 4.4 NETWORK VALUE BY ZSS AREA IN VICTORIA (SOLAR PV)

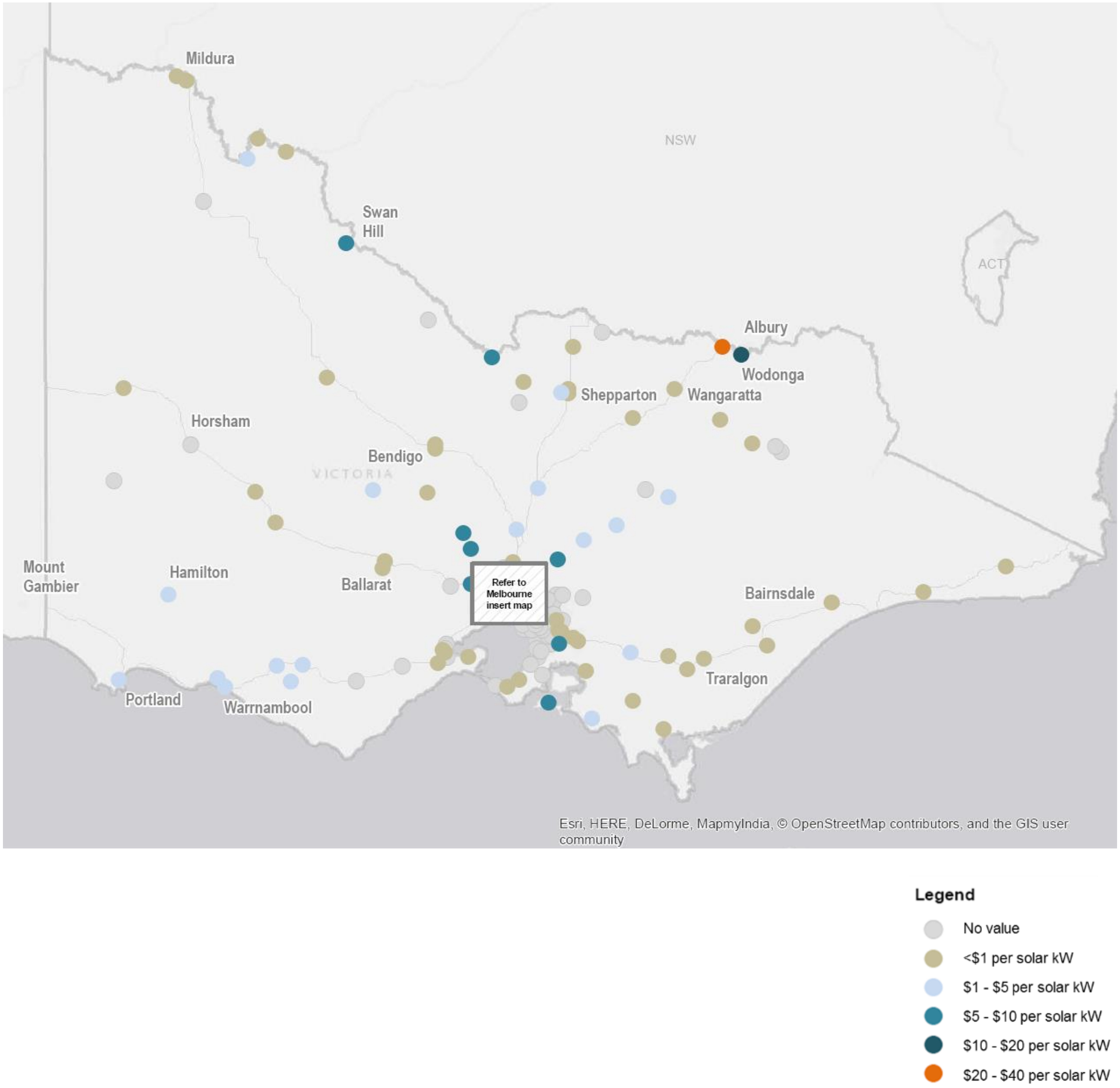
Value by ZSS for existing and forecast solar PV, for value ranges in 2017



Source: Jacobs

FIGURE 4.5 NETWORK VALUE BY ZSS LOCATION IN VICTORIA (SOLAR PV)

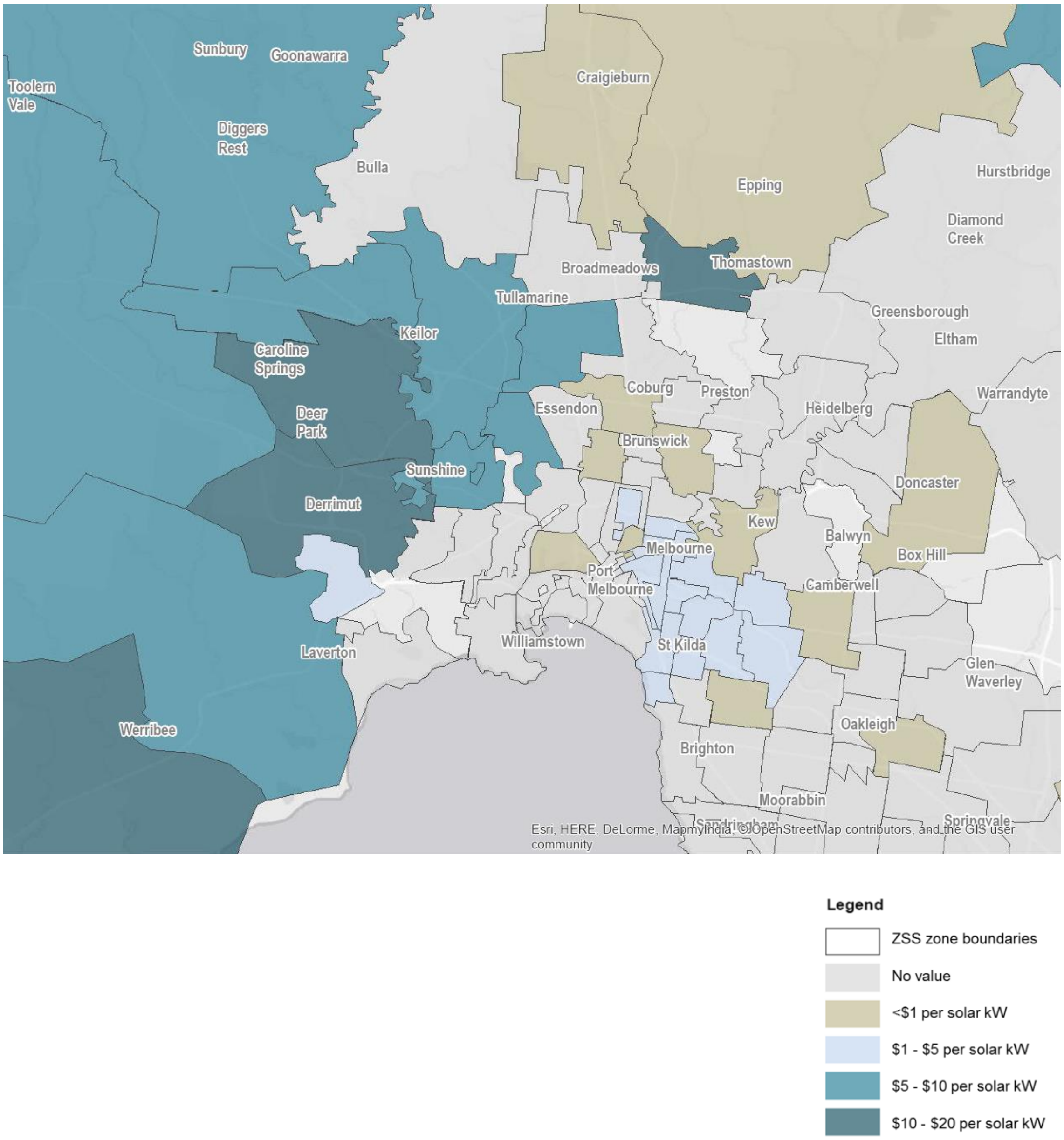
Value by ZSS for existing and forecast solar PV, for value ranges above $1 per solar kW in 2017



Source: Jacobs

FIGURE 4.6 NETWORK VALUE BY ZSS AREA IN MELBOURNE (SOLAR PV)

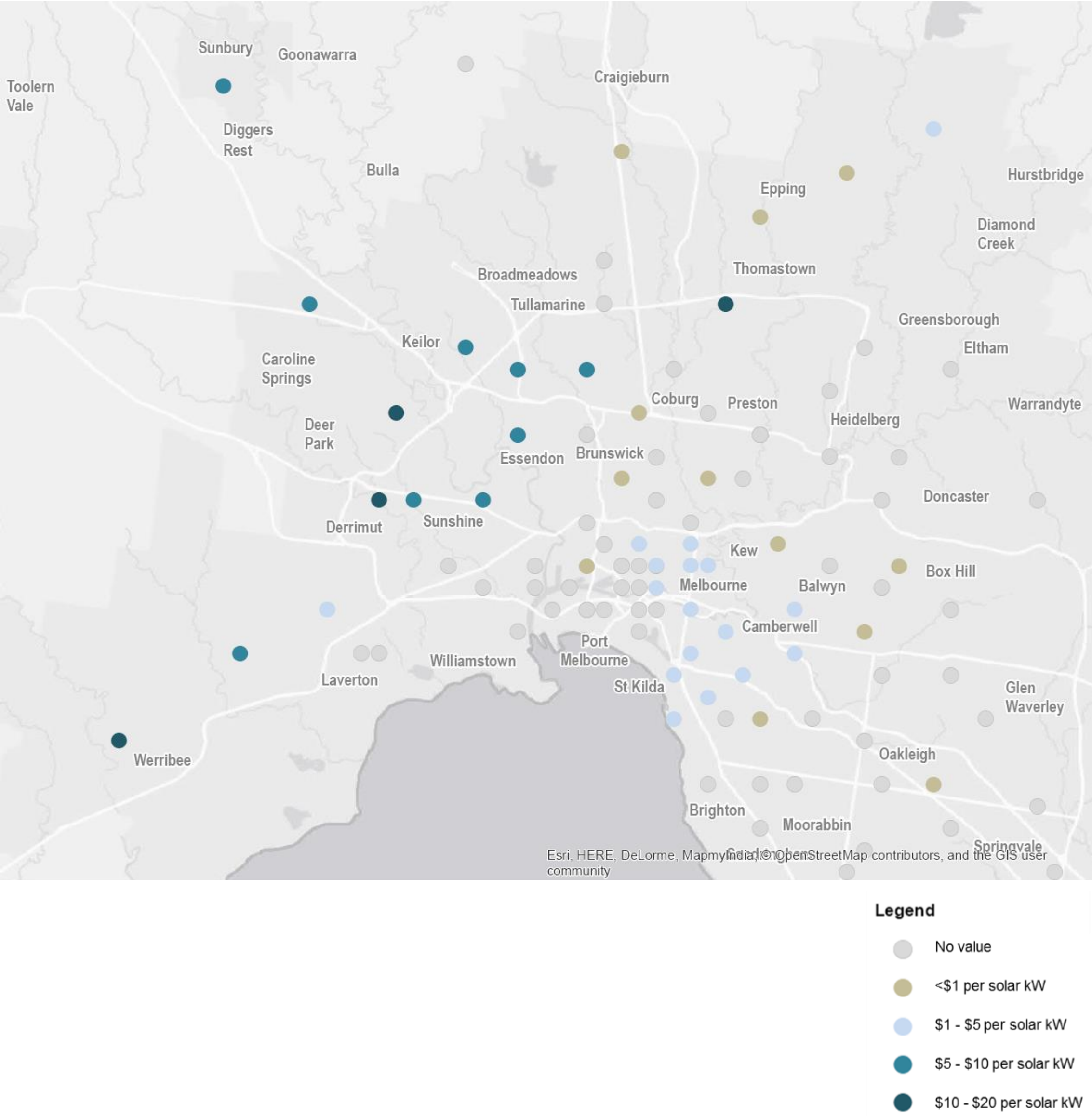
Value by ZSS for existing and forecast solar PV, for value ranges in 2017



Source: Jacobs

FIGURE 4.7 NETWORK VALUE BY ZSS LOCATION IN MELBOURNE (SOLAR PV)

Value by ZSS for existing and forecast solar PV, for value ranges above $1 per solar kW in 2017

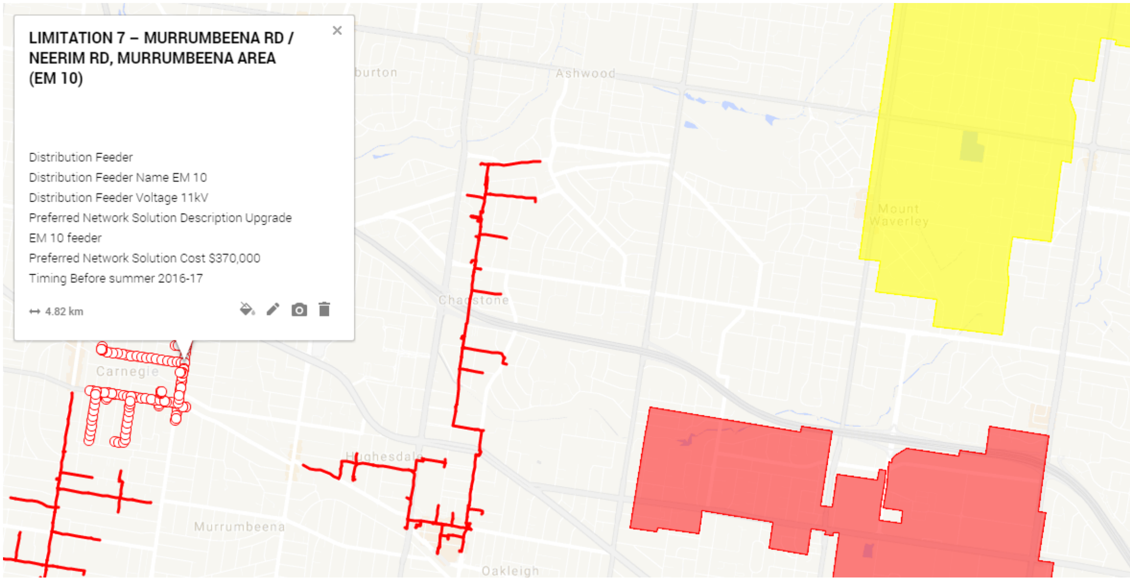


Source: Jacobs

Figures 4.4 to 4.7 only refer to network value at zone substations, sub-transmission feeders and transmission assets. The value in the low voltage portions of the network may be even more localised and granular. In congested sections of the low voltage network, this value may vary by distribution transformer and between sections of low voltage feeder (the type of assets often located at the street level).

Some network businesses have identified distribution level assets that require upgrading, but with limited publicly available data.[36] For example, United Energy developed a Network Limitations Map that identifies the location of required upgrades to distribution level assets. An excerpt of the map is shown in Figure 4.8, showing an 11kV feeder requiring a network upgrade in 2016-2017 at a cost of $370,000. There remains the possibility that distributed generation could provide benefit at very local parts of the low-voltage network if that area is significantly congested.

FIGURE 4.8 EXAMPLE OF DISTRIBUTION LEVEL ASSET UPGRADES
Excerpt from United Energy Network Limitations Map 2015



Source: United Energy 2015, *Network Constraints Map,* accessible at https://www.unitedenergy.com.au/industry/mdocuments-library/

THE NETWORK VALUE OF DISTRIBUTED GENERATION VARIES BY TIME

Our analysis found that the network value of distributed generation in reducing network congestion is highly time dependent. To create value, the output of a distributed generator must coincide with peak network demand in the area of the network to which it is connected. While the network value of distributed generation may be high during

[36] It should be noted that network businesses are required to only provide detailed information (such as the information used for the purposes of this inquiry) at the zone substation level and above.

network peak periods, for the remainder of the day the distributed generator will provide little or no network value.

In more specific terms, network value is time-dependent because the main driver of network value is ‘energy at risk’. The amount of ‘energy at risk’ is a measure of the extent of potential congestion at each network asset, and as such it is what influences the timing of network augmentations and the amount of expected unserved energy.[37]

As we explain in chapter 3, ‘energy at risk’ is the amount of energy that won’t be delivered if one piece of equipment at the zone substation fails (section 3.6.1). The capacity of a zone substation (or any network asset) in a scenario where the largest piece of equipment has failed is referred to as its N-1 capacity. A zone substation is at risk of being congested when the demand for electricity in the sections of the network served by the zone substation exceeds its N-1 capacity.

The amount of ‘energy at risk’ varies each hour, based on the demand at each zone substation. Some zone substations will have no material ‘energy at risk’ because demand at that zone substation never exceeds the N-1 capacity. At other zone substations, the N-1 capacity will be exceeded on a daily basis. However, even in these instances, this will only occur at specific times, possibly only for a single hour.

For distributed generation to reduce the energy at risk, and thereby produce value, its output must coincide with the times at which the N-1 capacity has been exceeded. That is, the generation must occur at the same time there is ‘energy at risk’.[38] This is explained in more detail in box 4.1.

An additional layer of complexity is introduced by the fact the timing of peak demand varies throughout the network. In commercial or industrial areas, the peak may occur around the middle of the day, whereas in residential areas it may occur in the evening.

[37] Expected unserved energy is equal to the ‘energy at risk’ multiplied by the probability of failure of the critical piece of network equipment which places that energy at risk. It may consist of a group of components for each mode of network failure that may cause supply disruption to customers.

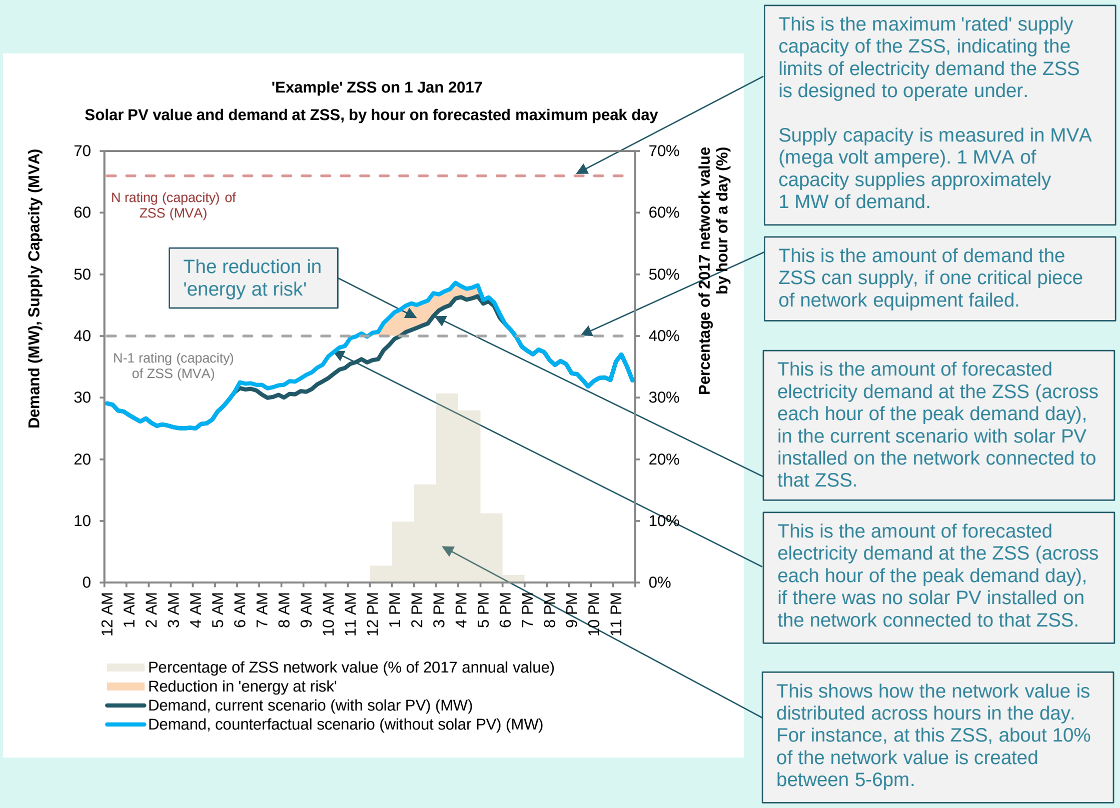
[38] Note that our method may in some cases underestimate the value created by solar PV through the reduction of expected unserved energy. This is because, in practical terms, it is unlikely to be possible to de-energise a portion of the network without disconnecting some solar PV systems. It may also not be able to disconnect the exact amount of load that is needed to meet the available capacity because in practice load is disconnected in controllable blocks based on the distribution feeders supplied from the substation. .

This means there is no uniformity across the network regarding the time of the day at which distributed generation provides network value.

BOX 4.1 READING HOURLY DEMAND AND SOLAR PV VALUE GRAPHS

The following section provides graphs that demonstrate how the network value provided by distributed generation varies by time. These graphs provide examples of how distributed generation, in particular solar PV systems, can provide network value.

The figure below provides explanations of each component of the graph.



Distributed generation will provide value to the network when it reduces the amount of 'energy at risk'.[39] In the example above, distributed generation is providing value between the hours of 12pm and 6pm, because it is reducing the amount of energy that may be 'at risk' if a critical piece of network equipment fails at that ZSS.

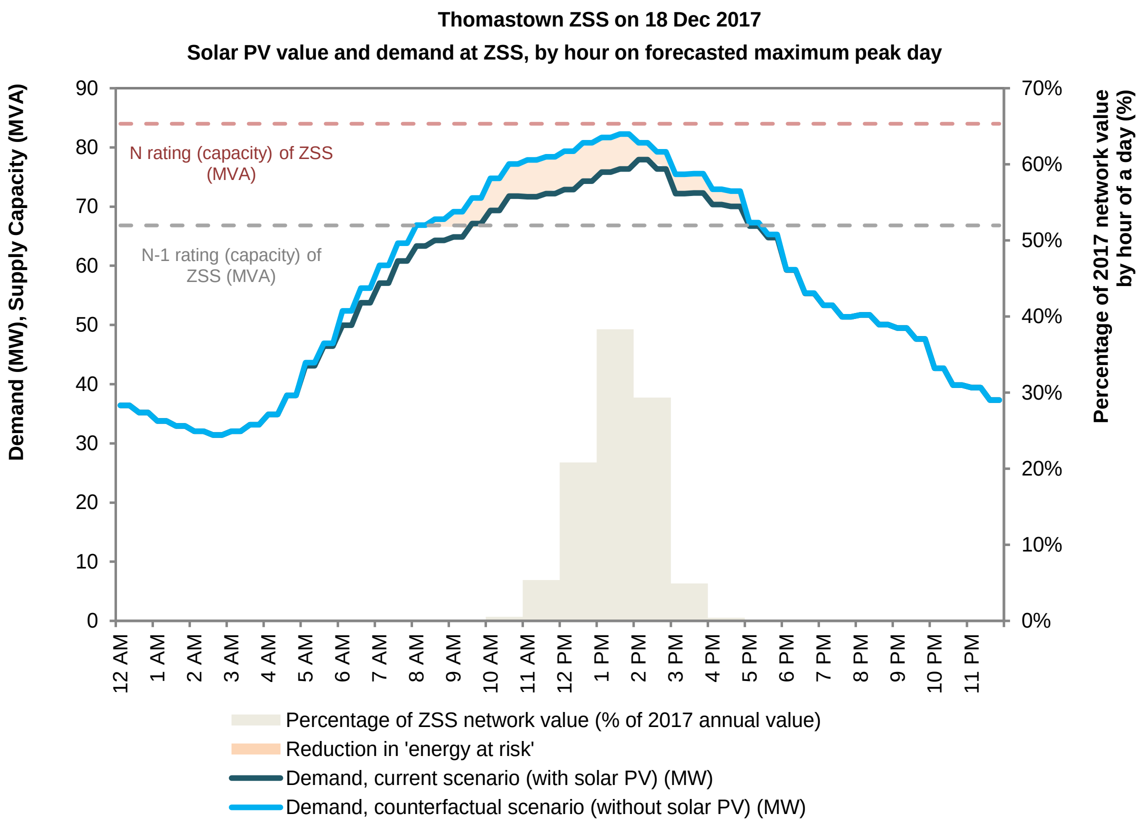
Source: ESC

[39] The 'energy at risk' in this example is the area between the demand for electricity at the ZSS and the N-1 rating of the ZSS.

In the example of Thomastown ZSS, shown in Figure 4.9, the amount of 'energy at risk' is determined by the amount of demand that exceeds the N-1 rating of the zone substation. The 'energy at risk' in a counterfactual scenario occurs between 8am and 5pm during that day. The extent to which distributed generation reduces 'energy at risk' also influences the extent of network value it provides.[40] The highest network value, occurring approximately between 1pm and 2pm, is where distributed generation is mostly reducing 'energy at risk'.

FIGURE 4.9 NETWORK VALUE OF SOLAR PV COMPARED TO ZSS DEMAND AT THOMASTOWN ZSS

For highest peak demand day, forecasted in 2017



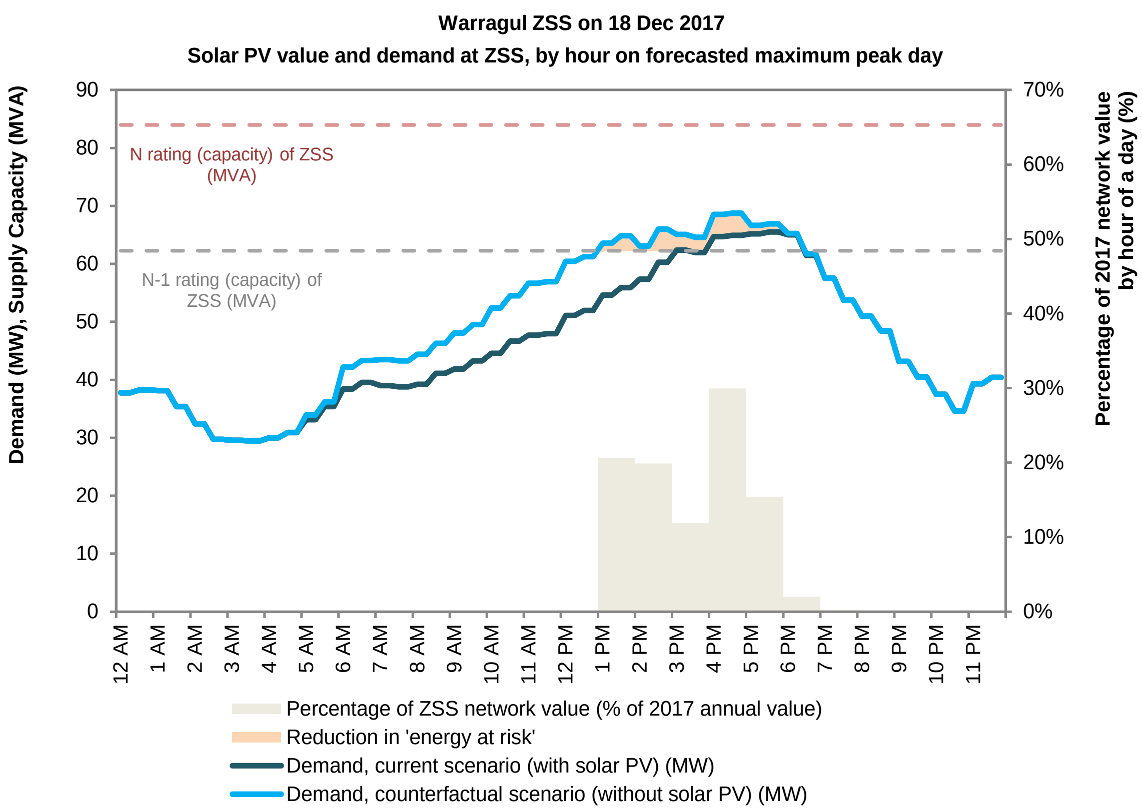
Source: Based on Jacobs modeling

[40] It should also be noted that solar PV systems, in aggregate, could increase cyclic ratings on substation transformers. As shown in Figure 4.9, solar PV systems will reduce the amount of zone substation load earlier in the day, which will lower the operating temperature of transformers prior to facing peak loads later in the day. Initial analysis has shown there may be improvements to cyclic ratings in the order of a 1%, but this would only be relevant to specific locations.

For comparison, Figure 4.10 shows the zone substation at Warragul, where the period during which there is 'energy at risk' is more aligned to residential demand patterns. That is, the period of peak demand occurs later in the day, from 4pm to 6pm. In this example, the N-1 capacity is exceeded at a later period compared to Thomastown, from around 12pm to 6pm.

FIGURE 4.10 NETWORK VALUE OF SOLAR PV COMPARED TO ZSS DEMAND AT WARRAGUL ZSS

For highest peak demand day, forecasted in 2017

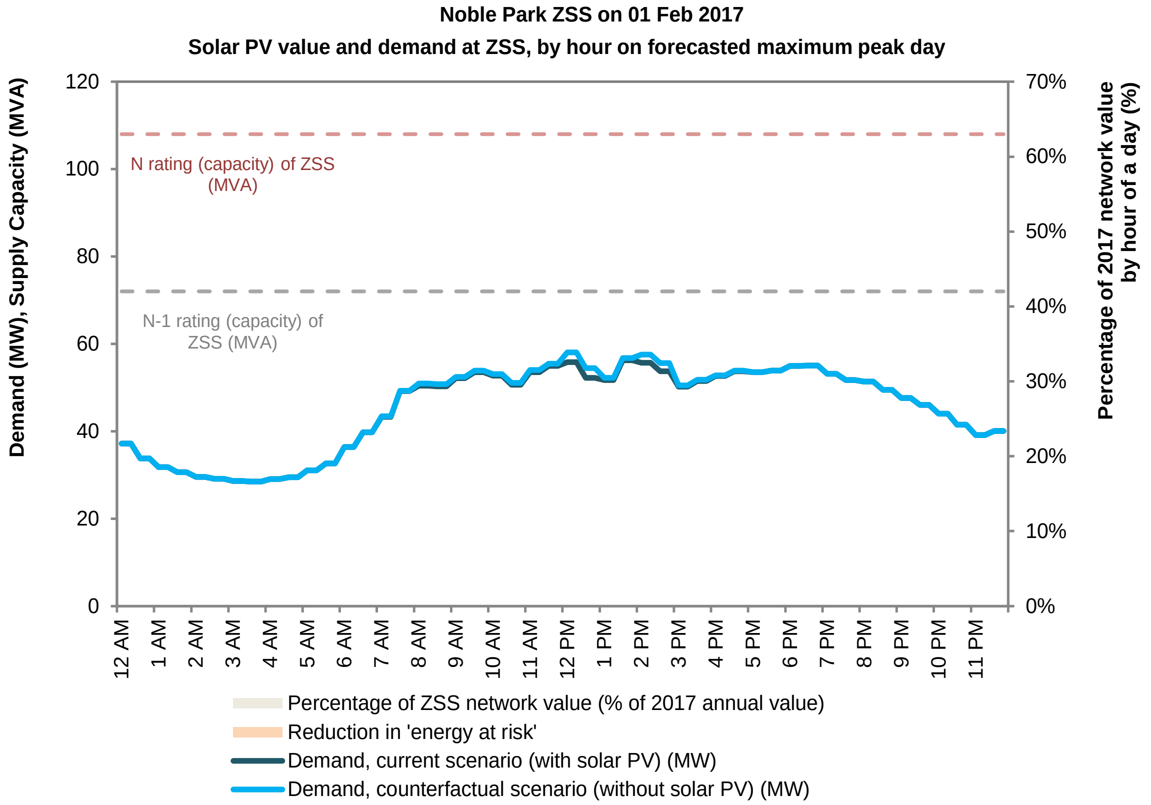


Source: Based on Jacobs modeling

Lastly, Figure 4.11 shows a zone substation (Noble Park) where, on this example day, demand does not exceed the N-1 capacity. This means that there is no material energy at risk in either the current or counterfactual scenario (without solar PV systems installed). As shown there is no assessed network value for the zone substation asset.[41]

FIGURE 4.11 NETWORK VALUE OF SOLAR PV COMPARED TO ZSS DEMAND AT NOBLE PARK ZSS

For highest peak demand day, forecasted in 2017



Source: Based on Jacobs modeling

[41] This example shows only the network value relating to the zone substation asset. There may be value provided by distributed generation for sub-transmission and terminal station assets, which are not solely related to the demand profile of the zone substation.

For the majority of distributed generation systems in Victoria, which are solar PV systems, the higher network values occur when the electricity generation from solar PV coincides with the time of peak demand faced by the zone substation. This means that solar PV systems will not be able to provide material network value if a zone substation area experiences peak demand during the evenings. If the peak of any given zone substation occurs at night, solar PV will provide no value in that area.

NETWORK VALUE VARIES YEAR ON YEAR BASED ON ASSET LIFECYCLE

The network value of distributed generation varies based on when in the network operator's cycle of upgrade projects the value is being measured. The operator's investment profile is determined, at least in part, by the extent to which different parts of the network are nearing congestion. Our analysis indicates that as a part of the network (e.g. a zone sub-station) nears congestion, the network value of distributed generation rises. Once the operator has upgraded that facility, the network value can diminish — possibly to zero.[42]

If the availability of distributed generation (and the network value it delivers) leads to the deferral of planned network upgrade projects, this will prolong the period over which network value is positive. In other words, network value is an endogenous value. It depends on the network operator's upgrade plans which, in turn, depend on the availability of distributed generation at different points in the network which, in turn, depends on the price paid by network operators to the owners of distributed generation. The result of this interplay is that in most locations across the network, the value provided by distributed generation will shift considerably each year.

To examine the extent of this variation, we applied the valuation method for another four years: for 2016 as well as 2018, 2019 and 2020. This enables us to compare the value across the network year-on-year.

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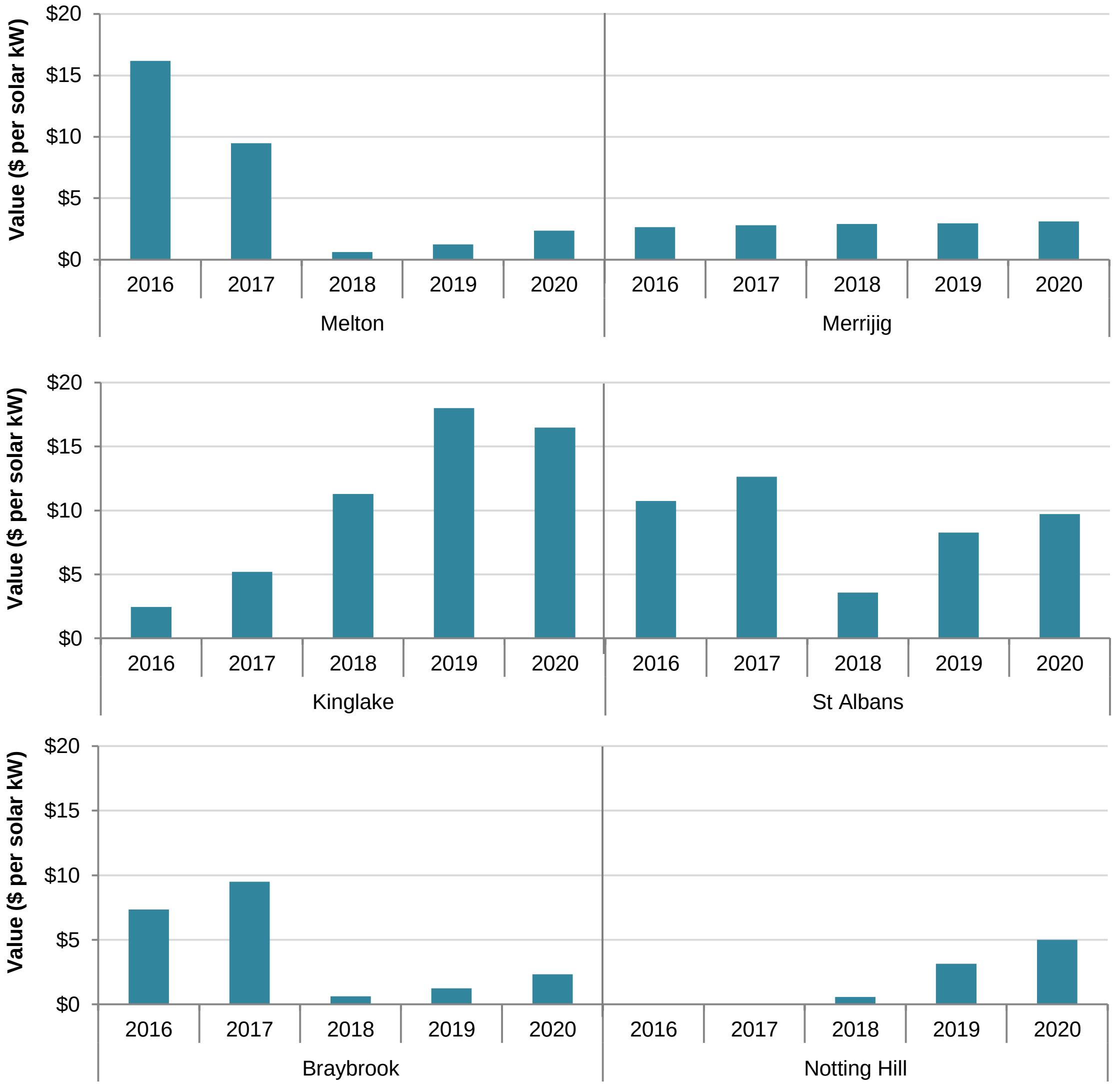
[42] The value will fall to zero only if there is no residual energy at risk without the distributed generation. The relevance of asset lifecycle to value over time was noted in submission by the Energy Networks Association and Ausnet Services. Energy Networks Association 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation - Proposed Approach Paper,* February, p. 3; AusNet Services 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation – Discussion Paper, Stage 2 – Network Value*, July, p. 5.

The results confirmed that, year-on-year, the value provide by distributed generation can increase or decrease sharply, changing by as much as 100 per cent or more between years. It also revealed that, as would be expected, the pattern of the variation is not consistent across the network. Between years, the value at one zone substation may spike, while at the neighbouring zone substation the value may drop or disappear.

The variability of network value each year is demonstrated by Figure 4.12 for six different zone-substations in Victoria. In Melton, the network value calculated in 2016 and 2017 is around $10-15 per kW of solar PV installed. However, this value drops sharply to almost zero in 2018. In contrast, at Merrijig, the value of solar PV remains relatively constant at around $8 per solar kW between 2017 and 2020. The other four example zone substations show how these patterns of yearly value is not consistent across Victoria. The variability of total network value from solar PV across Victoria also changes each year, as shown in Figure 4.13. It is worth noting that the values presented in future years (2018 to 2020) are less certain than the figures quoted for 2016 and 2017. Certainty decreases the further in advance the forecast is made.

FIGURE 4.12 NETWORK VALUE, BY YEAR

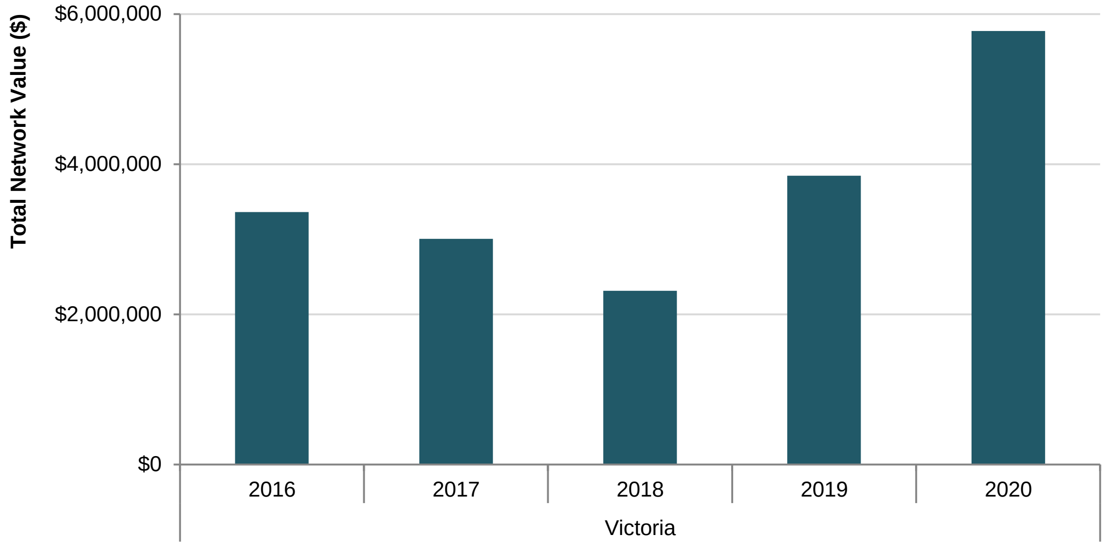
Examples of network value by year ($ per solar kW) at six zone substations in Victoria



Data source: Jacobs

FIGURE 4.13 TOTAL ANNUAL NETWORK VALUE, BY YEAR

Examples of network value by year ($), total in Victoria



Data source: Jacobs

GENERATION CAPACITY INFLUENCES VALUE

Any reduction in network congestion will provide a benefit in the form of reduced expected unserved energy. However, the benefit of deferring network augmentation is only created where the reduction of network congestion reaches a threshold level.

That threshold varies for each network asset, but in keeping with the probabilistic planning method we explained in section 3.6.1, in each case it is defined by the point at which the saving in value of the expected unserved energy is greater than the cost of the planned augmentation project. In other words, to produce a benefit in this category, distributed generation must supply enough electricity at the appropriate times to make the network upgrade unnecessary for the time being.

Because the level of reduced congestion required to defer a network augmentation project is typically large, relative to residential solar PV system, this benefit is normally only produced by larger distributed generation systems, or by substantial numbers of smaller systems operating in unison.

'FIRM' SYSTEMS OPTIMISED FOR NETWORK BENEFITS ARE MORE VALUABLE

'Firmness' of generation is a key concept in the discussion of network value. Firmness is a shorthand means of referring to matters relating to the reliability of generation, which may include intermittency, predictability, and dispatchability.

Importantly, firmness exists along a spectrum. It is not a binary attribute. In other words, generation is not merely 'firm' or 'not firm'. Rather, different electricity generators will have different degrees of firmness. No source of electricity generation is perfectly reliable and can be expected to be fully available at all times. However, sources of thermal and hydropower with availability exceeding 90% of the time and with failure rates less than 2% of the time are usually considered "firm" supplies in a power system context.

One means of influencing the firmness of a generator is through negotiated agreement. This may arise through a contract, for instance, between a network business and a supplier of distributed generation (or their agent, in an aggregation scenario), who is capable of delivering generation on demand. Distributed generation technologies that can be delivered 'on demand'– sometimes referred to as controllable or 'dispatchable' generators – include technologies such as cogeneration plants, diesel engines and certain battery-connected systems. To the extent this contract is honoured, this output can be described as firmer than the output of an equivalent generator with whom no contract for supply has been struck.

Another factor that influences firmness is predictability. This factor applies particularly to solar PV, which is a broadly predictable source of electricity generation by virtue of its output being driven by two factors: system capacity and insolation (available sunshine). Both the effective system capacity and the insolation at the system's location can be predicted based on publicly available weather forecast data.[43] Network

[43] As part of the valuation method used in this inquiry, Jacobs developed a typical generation profile of average solar PV systems in Victoria. Jacobs developed a method using a combination of 2015 hourly weather data from the Bureau of Meteorology for Melbourne and satellite data for areas outside of Melbourne, time-stamped modelled optimal generation data using the PVSys model for 2015, and factored against time-stamped gross outputs from 300 systems in the Ausgrid network area, NSW.

businesses regularly incorporate forecasted output of solar PV in their annual planning processes on the basis of this predictability.

Firmness is relevant to the calculation of network value because that value arises primarily via the impact of distributed generation on the network planning process. Specifically, as explained above, network value is driven by changes in the level of 'energy at risk' at a given asset. When planning the network, the forecasted level of 'energy at risk' is the key driver of network augmentation decisions. Only generation that is sufficiently predictable can be incorporated into these forecasts.

However, as the previous sections illustrate, reliability alone is not sufficient to create network value. Rather, value is created primarily when the output of a distributed generator coincides with a period of network congestion (peak demand). In other words, the more responsive the output of a distributed generator is to the needs of the network – particularly in terms of timing – the greater the potential value it can produce. The systems with the greatest capability of being responsive are those that are fully dispatchable.

Some distributed generation can be relatively predictable, or firm, without being dispatchable. The output of solar PV (without batteries), for instance, is sufficiently predictable to be incorporated into the planning process, notwithstanding natural variations of weather.[44] However, the timing of its output does not always coincide with periods of network congestion. Furthermore, it cannot be controlled in order to alter the timing of its output. It is therefore inherently unresponsive.

On the other hand, a dispatchable distributed generation system, such as a gas turbine, has the capability to be highly responsive. For instance, if network congestion at a given zone substation occurs between 5pm and 7pm, the system can be programmed to run during this period. It may also be large enough to deliver enough generation to defer (or contribute to deferring) a network augmentation. However, without agreements (or potentially incentives) in place, it may not produce any output during this time and therefore may produce no value.

[44] Solar PV output may be affected by cloud cover on peak days, reflecting natural variations in weather, so the impact on peak demand must be considered together with the effect of the relevant weather variables on the underlying demand for electricity. These factors influence the ability of the network planner to rely on the solar PV generation and to include its effect on the assessed energy at risk.

When solar PV systems are supplemented with batteries and control systems (energy management systems), and thereby made dispatchable, the network value that previously accrued as a result of the predictability of standard PV may also change. This is because the output is now determined by the decisions of an operator as opposed to the more predictable interaction of system capacity size and insolation.

If the operator of this system does not align the output of the system in a manner responsive to the network's needs, the value that would otherwise accrue would be lost. This may occur, for instance, if during a period of network congestion the operator uses the electricity from the solar PV system to charge the battery instead of displacing local demand. In an alternative situation, the battery may have already been discharged earlier during a peak day, making it unavailable to support the network later when the peak demand arises. As a result, the system will not reduce the pressure on that section of the network at the time of congestion.

However, the inverse is also possible. A dispatchable solar PV and battery array could be controlled in such a way that it is highly responsive to the network, and thus produce considerably more value that would otherwise have occurred with a predictable but passive, or 'uncontrolled' system.

Distributed generation which bears the attributes of both firmness and dispatchability can be 'optimised' for network benefits.

To examine the additional value that 'optimisation' of distributed generation can deliver, we developed a variation on the counterfactual methodology we set out in chapter 3. Under this variation, we examined the value that would be provided by two identically sized 'additional increments' of distributed generation capacity.[45]

One increment was based on the generation profile of solar PV, while the other was deemed to be 'optimised'. That is, the second increment was assumed to predictably provide generation at the times when it was most needed by the network. We applied this method across the entire Victorian network.

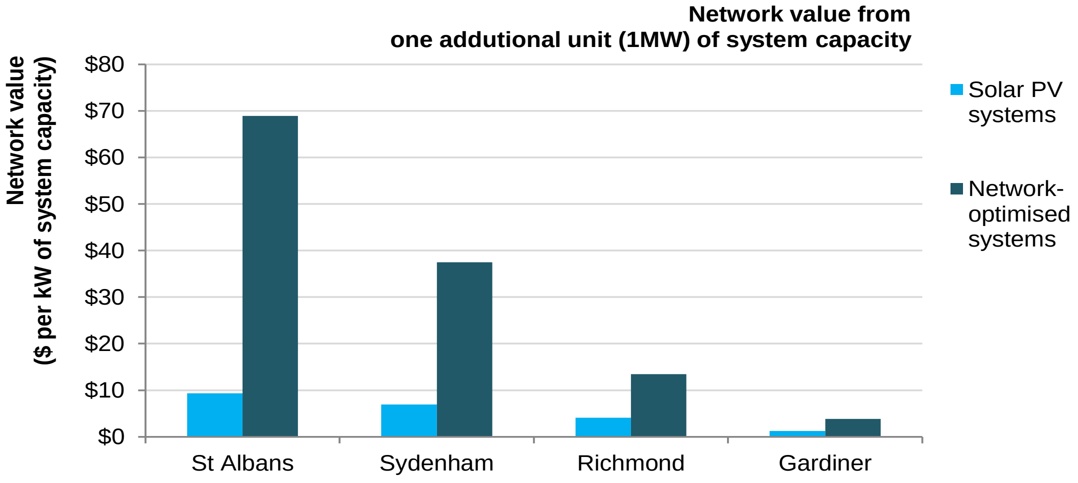
[45] The increment was 1 megawatt (MW).

The results showed that, across the state, 'optimised' distributed generation delivers more value for network operators than solar PV. The difference in value between the two types of generation itself varied based on location. However, as a trend, optimised systems delivered on average around four times more value than solar PV systems. In some instances, the variation was much greater, with optimised systems up to twenty times more valuable.

To illustrate the modelled impact of network optimisation, Figure 4.14 shows the comparison between solar PV and optimised systems at four different zone substations.

FIGURE 4.14 RATIO OF NETWORK VALUE OF NETWORK-OPTIMISED SYSTEMS COMPARED TO SOLAR PV SYSTEMS

Values based on an additional 1MW of capacity, at various ZSS



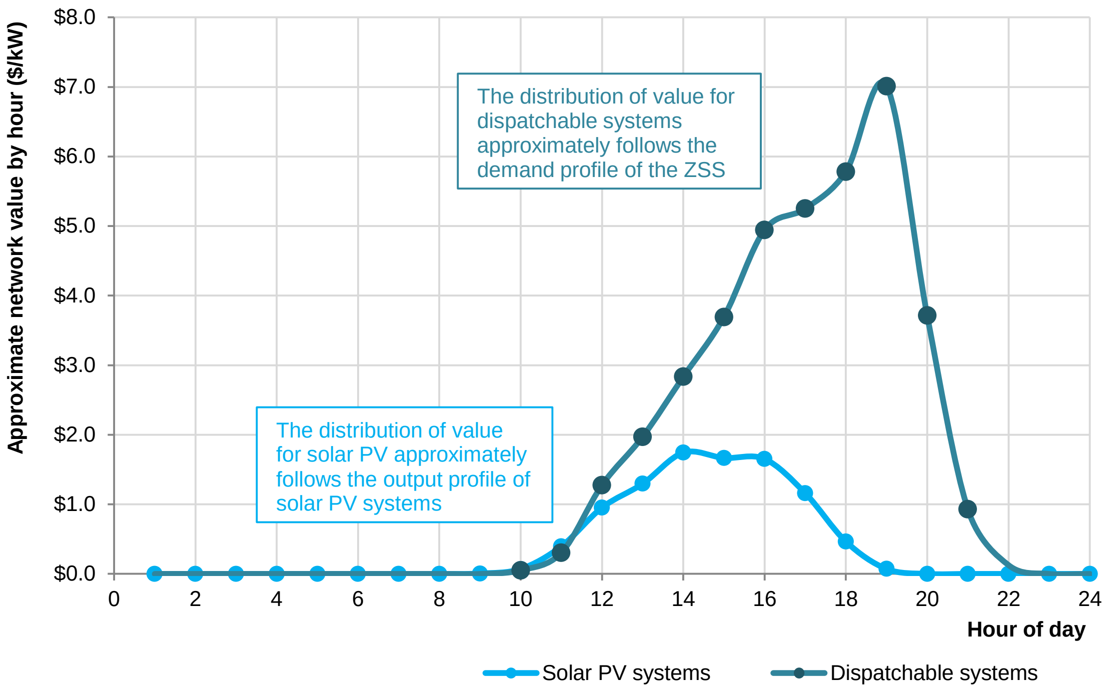
Data source: Jacobs

To further illustrate this variance, Figure 4.15 breaks down the difference in value between solar PV and optimised distributed generation across 24 hours at an individual zone substation (Essendon). In the case of Essendon, the network value of solar PV generation is highest between 2 and 4pm, and zero for the early morning and at night. The pattern of network value from solar PV systems follows the typical pattern of how much electricity it generates throughout a given day.

This is unlike the pattern of hourly network value from optimised systems, which could generate the same amount of electricity at any time of the day. Optimised systems provide value when most needed by the network (often when peak network energy demand is highest). In the example in Figure 4.15, optimised systems can provide much higher network value compared to solar PV in the early evening at 6:30pm. This is primarily because most distributed generation in Victoria is solar photovoltaic (PV), which is not 'controllable' unless it is supplemented with additional technologies such as energy storage and energy management systems.

FIGURE 4.15 NETWORK VALUE, BY HOUR

Approximate total network value by hour in 2017 at Essendon ZSS, comparing solar PV and dispatchable systems



Data source: Based on Jacobs modeling

Our analysis indicated that controllable distributed generation can be significantly more valuable if it is optimised. The most value is likely to arise when the distributed generation system is controlled by a network business, whether directly or through third party arrangements such as contracted aggregation services, because this allows for the most precise optimisation of the system.

If a greater proportion of Victoria’s existing fleet of distributed generation was controllable and responsive to peak network demand – in other words, optimised for network value - its potential to provide value would increase.

4.3 ECONOMIC VALUE – OTHER NETWORK BENEFITS

In this section, we provide the results of our assessment the following potential network benefits of distributed generation:

- network support
- managing voltage regulation and power quality
- ancillary services
- islanding capability.

4.3.1 NETWORK SUPPORT

Network support is a form of grid service that provides an alternative to investment in additional network infrastructure. Under a network support arrangement, distributed generation or other forms of demand-side service can be procured by a network business to address a network issue, such as relieving network congestion in a constrained area of a network. Network support services can be deployed to relieve constraints in either the distribution or the transmission network.[46]

Network support facilities are typically located close to network assets that are nearing capacity, and are generally larger fossil-fuel based generators around 5-10MW in capacity. Network businesses typically procure network support services on the basis that they meet defined technical standards such as availability and guarantee of service. Network support facilities defer the need to upgrade the constrained network asset by injecting electricity into the network downstream from a network constraint.

[46] A specific Network Support Payment mechanism exists within the National Electricity Rules to facilitate payments to distributed generators for network support services rendered to the transmission network.

For example, AusNet Services have a network support agreement with NovaPower to provide up to 10MW of electricity generation during network peak periods in Traralgon. The solution consists of gas-fired generators located close to the Traralgon zone substation.[47] In other cases, network businesses may engage network support agreements for highly specific and localised circumstances, such as responding to very specific demand patterns. The case study in box 4.2 describes a scenario of this nature in Bairnsdale. Based on our analysis and submissions to this inquiry, we have identified a number of other network support agreements currently in place across three of the five distribution areas in Victoria.[48]

One potential benefit of distributed generation is that it can reduce or avoid the need for network support facilities. This presumes that network support payments are in place or may be considered, and that the existence of distributed generation on the network in that area lessens the need, and therefore the cost, of those network support arrangements.

We acknowledge that distributed generation could also defer the need to procure network support services via the same means it can defer the need to upgrade network assets – that is, reducing network congestion. However, the benefit distributed generation provides in this case is already captured in our consideration of reducing network congestion in section 4.2. We were not presented with evidence that distributed generation influenced the scope and cost of network support services beyond that measured in the context of network congestion. As a result, we did not identify a separate benefit that distributed generation provides with regard to network support arrangements.

[47] AusNet Services 2014, *Demand Management Case Study: Embedded Generation,* August.

[48] Citipower submitted that it made payments for network support services of $160,000 between 2011-14. Powercor submitted that it made payments for network support services of $40,000 between 2011-14: CitiPower and Powercor 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation – Proposed Approach Paper,* February, p. 9. AusNet services submitted that it had agreements for network support services in place with two distributed generators: AusNet Services 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation – Proposed Approach Paper,* February, p. 6.

BOX 4.2 NETWORK SUPPORT CASE-STUDY – BAIRNSDALE PROJECT

The Bairnsdale generation project is located in the AusNet distribution area. This network support facility provides generation in the form of two 40MW gas turbines. The plant operates regularly to support the high network demand that occurs each night around midnight, because of a demand pattern that is unique to that area, based on hot water loads being switched-on at off-peak times.

In theory, a large amount of distributed generation at this location could reduce or remove the need to run these turbines, and save the fuel consumption associated with those gas turbines. However, for distributed generation to provide a benefit by reducing the requirement for this network support service its output would need to occur around midnight when output from solar PV is not available.

Source: Jacobs

4.3.2 MANAGING VOLTAGE REGULATION AND POWER QUALITY

Network businesses must also operate the network to meet certain power quality requirements. These include managing the voltage within their network to ensure it does not damage electrical equipment (referred to as voltage regulation) or cause annoyance to customers' electrical lighting (voltage flicker).

Fluctuations in voltage depend on customer loads (regardless of whether they have distributed generation systems) and the characteristics of the transformers and feeders conveying the electricity. These issues often occur in network areas under high load conditions, or where the load at that location exceeds the design specifications of supporting network equipment.

To minimise these effects, network businesses are required to operate the network at acceptable voltage levels – this requirement is known as voltage regulation.[49] Network businesses use a number of methods to maintain required voltage levels, such as

[49] In technical terms, voltage regulation is the change in load voltage when the load is removed.

adjusting transformer taps[50] or installing equipment such as capacitor banks[51] at substations.

Some stakeholders have noted that under certain conditions, distributed generation could potentially assist with voltage regulation, but only with the aid of advanced 'smart' inverters (see box 4.2), or if they are made highly responsive to the needs of network business. Citipower and Powercor stated:

> *...there may be network benefits in managing these voltage variations, but only if all solar PV inverters in a local area were controlled to adjust the power factor of each solar PV installation (so as to keep within a required voltage range).*[52]

The Energy Network Associated (ENA) provided another example where specific technologies, such as solar PV combined with battery storage, could reduce the need to manage voltage variations:

> *…reduced intermittency and day-time output potentially means less need for measures to manage voltage deviations and reverse control issues and therefore lower network management costs.*[53]

BOX 4.3 'SMART' INVERTERS AND A NEW AUSTRALIAN STANDARD

In Australia, distributed generation systems (particularly solar PV systems) are typically installed with inverters that allow connection with the grid. These inverters are required to meet certain Australian standards. Since 9 October 2016, accredited inverter systems must now meet an updated standard, *AS/NZS 4777.2:2015 Grid connection of energy systems via inverters - Inverter requirements*.[54]

[50] Transformers are comprised of a number of coils (or windings) that dictate the supply voltage of the transformer. A transformer tap is a component of the transformer that can change the number of 'turns' in the coils of a transformer, which changes the supply voltage.

[51] Capacitor banks are used to store electrical energy temporarily, and are used to regulate voltage or high loads for customers.

[52] Citipower and Powercor 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation – Discussion Paper, Stage 2 – Network Value*, July, p. 5.

[53] Energy Networks Association 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation – Discussion Paper, Stage 2 – Network Value*, July, p. 4.

[54] Standards Australia 2015, *Grid connection of energy systems via inverters - Inverter requirements*, AS/NZS 4777.2:2015, October.

The main updates to inverter standards allow distributed generation system to have the capability to provide services to the network. This includes further new voltage and frequency set-points and limits to be compatible with requirements of network businesses.

The updated standards also require inverters to have Demand Response Mode (DRM) capabilities. DRM capabilities allow a remote operator to alter the inverter system to operate in a certain way, such as disconnecting from the grid, preventing generation of power, or increasing power generation. These functionalities for new inverters make it distinct from older generation inverters, and have been referred to as 'smart' inverters.

The updated standard requires inverters to have the capability for eight different modes of operation (referred to as DRM0 to DRM8). However, only one of the modes (DRM0) is required to be functional at the time of the installation. DRM0 allows a remote operator to disconnect the inverter form the grid. Disconnection from the grid may occur when the network is disrupted, when frequency and voltage levels are outside the set limits and when the DRM0 mode is activated (potentially by a network business).

Source: ESC, *AS/NZS 4777.2:2015 Grid connection of energy systems via inverters - Inverter requirements*

Beyond using solar PV-based systems, network businesses may also procure voltage control services from other types of distributed generation, known as synchronous generators. Synchronous generators, such as cogeneration plants, can be operated to provide or consume reactive power, which can assist network businesses by raising or lowering voltage levels in the network. [55]

[55] The transfer of electricity in the network occurs through the production of magnetic fields – these fields are produced by reactive power. Reactive power is power where the current is completely out of phase with the voltage, which delivers no net energy to the customer. Reactive power effects voltage levels in a system, which can be useful for managing voltage regulation.

In evaluating the extent to which distributed generation in Victoria provides this benefit, we note that voltage regulation can only be provided by very specific forms of distributed generation. Those systems must also be able to respond to the requirements of network businesses at certain times and locations. In box 4.4, we set out further information about voltage regulation requirements in Victoria, and the voltage control projects we have identified.

On the basis of the information presented, we formed the view that there was not sufficient evidence to support the claim that small scale distributed generation is providing voltage regulation and power quality benefits in Victoria. However, we acknowledge that this may change as 'smart' inverters become more widespread and to the extent that distributed generation customers program those inverters to provide voltage regulation services. Indeed, the value of voltage regulation in distribution systems will increase as solar PV penetration rises, so there will be an increasing incentive for distributed generation to provide voltage control if only to secure its delivery to the grid.[56]

BOX 4.4 CASE-STUDY FINDINGS – BENEFITS OF MANAGING VOLTAGE REGULATION AND POWER QUALITY

A very small number of zone substations in Victoria have voltage regulation issues at any time, demonstrated by the few voltage control projects identified as follows:

- 8 MVAr capacitor banks at four zone substations in the Jemena network area, costing approximately $2.2 million.
- Voltage regulators on two feeders in the Jemena network area, typically costing around $250k.
- Two 6 MVA capacitor banks at two zone substations in the AusNet Services network area.

[56] Conversely, increasing penetration rates of distributed generation may also lead to higher grid management costs associated with bidirectional flows of electricity. EY 2015, *Evaluation Methodology of the Value of Small Scale Embedded Generation and Storage to Networks*, Clean Energy Council, July

A typical 1MW cogeneration plant with a 0.8 power factor could only provide 0.75 MVAr – this only provides a portion of the needs of the voltage control projects listed earlier. Jacobs estimated that the annualised cost of deferring or avoiding capital infrastructure for such voltage control projects would amount to less than $500,000 per year across the network in Victoria.

Appropriate technologies of distributed generation plants existing in Victoria, would only defer a small portion of this amount. These distributed generation plants will also be required in very specific locations and must be able to respond at certain times.

Source: Jacobs

4.3.3 ANCILLARY SERVICES

Ancillary services are services to maintain power safety, security and reliability of the grid.

AEMO procures such ancillary services to support the operation of the grid through a number of markets. These include markets for Frequency Control Ancillary Services (FCAS), Network Support Control Ancillary Services (NSCAS), and System Restart Ancillary Services (SRAS) markets.

Service providers can receive payments from AEMO for the availability and delivery of such ancillary services. However, these service providers must be capable of reliably dispatching these ancillary services, and capable of offering and bidding in specific markets – they must also register with AEMO in order to bid into any of these ancillary services markets. Payments to service providers can vary and change significantly, depending on the needs of the network.

Some stakeholders, such as the Clean Energy Council, suggested that we consider how distributed generation may be able to provide ancillary services:

> *Consideration should be given to the capability of small scale distributed generation and storage to provide high speed ancillary services like frequency management.*[57]

In this section, we discuss whether distributed generation provides, or can provide, benefits in form of ancillary services to AEMO.

FREQUENCY CONTROL ANCILLARY SERVICES (FCAS)

The NEM must be operated within a set frequency range of around 50 Hertz (Hz) in order to safely and reliably deliver power from larger generators to consumers.[58] However, frequency levels in the network can change quickly, depending on the balance of supply and demand – if electricity supply exceeds demand at any given time, frequency in the system increases (and vice versa).

AEMO manages frequency levels in the system by procuring specific services. For example, service providers could be procured to generate electricity or shed (reduce) loads very quickly (within 6 or 60 seconds) or after a delay (5 minutes).

AEMO operates eight separate ancillary services markets to procure these frequency control responses (referred to as FCAS) from service providers. In these markets, only specific types of service providers can deliver these services, such as those with fast-responding dispatchable electricity generators, load-shedding[59] devices, or generator governors.[60] AEMO procures these services in increments of at least 1MW.

SYSTEM RESTART ANCILLARY SERVICES (SRAS)

AEMO requires system restart ancillary services to enable parts of the network to be restarted following a partial or complete blackout.

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[57] Clean Energy Council 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation – Discussion Paper, Stage 2 – Network Value*, July, p. 6.

[58] Australian Energy Market Operator 2016, *Fact Sheet: Frequency Control*, August.

[59] These are devices that may be attached to a customer's load or equipment to quickly disconnect that load from the network. These types of devices tend to be installed in industrial plant and machinery.

[60] A generator governor is a specific device on generation engines that limit the speed or amount of fuel required by the engine.

In order to provide SRAS, service providers must be able to supply and energise a part of the network within one and half hours of a major disruption. Service providers must also provide capacity to meet 40 per cent of peak demand in that part of the network – often requiring large generators, such as power stations.

NETWORK SUPPORT AND CONTROL ANCILLARY SERVICES (NSCAS)

There are a range of other ancillary services that support the operation of the network (referred to as Network Support and Control Ancillary Services). AEMO procures specific services in three types of markets related to NSCAS:

- Network Loading Ancillary Service (NLAS), which are used by AEMO to control the flow of electricity between regions of the NEM (particularly across interconnectors) over short periods of time.[61] These services can be provided by either increasing generation levels or shedding load in targeted areas. NLAS markets generally require larger dispatchable generators, as compared to small-scale distributed generators.
- Transient and Oscillatory Stability Ancillary Service (TOSAS), which are used in the event of spikes in power flows, potentially due to short circuits and malfunctioning equipment. The services procured in this market require technologies that can quickly regulate network voltage or change power output, such as synchronous condensers, generators with power system stabilisers (PSS), and static VAR compensators[62].
- Voltage Control Ancillary Service (VCAS), which procure services to maintain voltage levels across the network within specific ranges. In these VCAS markets, services are provided by specific technologies like synchronous condensers and static reactive plant, which can provide and absorb reactive power, which impacts voltage levels.[63]

[61] NLAS is procured by AEMO at a national level, and is different to the local network support services procured by distribution businesses as discussed in section 4.3.1.

[62] Static VAR compensators are a specific combination of electrical devices that provide reactive power quickly, and are usually used on transmission level network assets.

[63] VCAS is procured specifically by AEMO at a national level. A further discussion on voltage regulation and procurement of these services by Victorian network businesses is discussed in section 4.3.2.

These services tend to be highly locational specific (depending on the need) and are often required outside of Victoria. For example, in 2014-15, AEMO only procured approximately $10 million in VCAS. At Murray Switching Station, Yass Substation, and transmission lines south of Sydney, 800MVAr of reactive power absorption capability was procured from shunt reactors[64]. At Tumut and Murray Power Stations, reactive power generation and absorption were provided by 28 synchronous generators which operates in a special mode, specifically, at no load as synchronous condensers.

CONCLUSION

To provide any of the ancillary services described in this section requires a generator to have specific, often highly responsive, capabilities. These services are also typically required at a larger scale than could be provided by individual solar distributed generators. Whilst we acknowledge the possibility for technology to improve the capability of small scale distributed generators to provide these types of services, advice provided to us by Jacobs Consulting indicates that Victoria's existing fleet of distributed generators is unlikely to be capable of participating in the ancillary services markets. As a result, we have not included ancillary services in our valuation of the network benefits of distributed generation.

4.3.4 ISLANDING CAPABILITY

'Islanding' refers the capability of premises, or section of the network, to remain powered when the rest of the network experiences a blackout. Distributed generation systems are typically deployed with 'anti-islanding' equipment to ensure that they de-energise during a blackout. This is primarily for safety reasons, so that crews sent to restore power can work without encountering live wires.

As a result, the majority of solar PV systems currently installed in Victoria can only generate electricity for a customer when there is a live connection with the grid. If there

[64] Shunt reactors are specific devices used on high-voltage transmission lines, to absorb reactive power.

is a power outage during the day, these types of solar PV systems will be unable to generate electricity for that customer.[65]

However, some distributed generation systems can be fitted with equipment that allows the system to generate electricity for that particular customer, in the event of a blackout – equipment that allows 'islanding'. This can also occur at scale. A group of distributed generators and customers can also be 'islanded', which is typically referred to as a local micro-grid.

Facilities with islanding capability provide benefit to these customers, as they have access to power during grid outages. Stakeholders, such as the Clean Energy Council, stated that there may also be network reliability benefits as a result of islanding:

> *In an independent micro-grid or a system with islanding capability…, the electricity generated provides reliability and safety. There are both private and public benefits in reliability and safety.*[66]

In our assessment, the possibility of islanding is analogous to the use of back-up generation with islanding capability by large commercial or industrial customers. The quantity of back-up generation currently installed in Victoria system is not accurately known, but it is estimated that around 100MW of back-up generators are located in state hospitals.[67] These types of systems provide benefits to those who invest in them, but as they are private benefits they are outside the scope of this inquiry.

To the extent that the potential islanding benefits of distributed generation may lead to further environmental and social benefits, we examine this within the context of reducing bushfire risk in section 4.4.1, and customer empowerment in section 4.4.3.

[65] Most solar PV systems currently installed in Victoria are installed with inverters that require a live connection to the grid in order to generate electricity. These inverters have anti-islanding capabilities for safety reasons, preventing solar PV systems from exporting electricity to surrounding unpowered lines, which can be dangerous for workers who may need to maintain or work on these lines.

[66] Clean Energy Council 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation – Discussion Paper, Stage 2 – Network Value*, July, p. 3.

[67] There are currently no reporting requirements associated with back-up generation systems in Victoria.

4.3.5 CONCLUSION – ECONOMIC VALUE

The Commission reviewed a range of potential direct benefits for the management and operation of the network that may arise from distributed generation.

We found that distributed generation can create value by reducing network congestion. Our analysis to determine the extent of such network value in Victoria indicates that it varies by location, time of generation and peak demand, and by the 'firmness' of the generated electricity. It could also change significantly over time as distribution businesses invest in network upgrades.

We considered network value associated with reducing network congestion as being sufficiently material to justify investigation of whether the current regulatory framework adequately compensates distributed generation proponents (chapter 5), and whether regulatory reform is needed (chapter 6).

Distributed generation can also provide other benefits to the network, under specific circumstances. The quantity of these identified benefits is estimated to be immaterial for the purposes of this inquiry.

4.4 ENVIRONMENTAL AND SOCIAL VALUE

In section 3.7, we set out our three-part test to assess whether distributed generation may provide environmental and social benefit and value in Victoria.

Where distributed generation leads to changes in the way the network is managed, this may cause flow-on, or indirect**,** social and environmental benefits. A number of submissions highlighted specific social and environmental benefits from distributed generation that they believe warranted further investigation. These specific benefits are:

- bushfire risk mitigation and reduction
- amenity and aesthetic benefits, and
- customer empowerment.

In this section, we present our assessment of these benefits.

4.4.1 BUSHFIRE RISK MITIGATION

Stakeholders suggested that distributed generation may facilitate a reduction in the risk of bushfire ignition, by limiting or avoiding the use of electricity assets on high fire risk days and at high fire risk locations. The reduction in bushfire risk potentially leads to safety benefits and reduced insurance premiums for network businesses.

In 2009, the Victorian Bushfires Royal Commission found that faults in live powerlines could ignite bushfires in high fire risk areas.[68]

Stakeholders such as the Clean Energy Council (CEC) stated that distributed generation could avoid the need for powerlines and reduce bushfire risk:

> *Electricity grids are a bushfire safety risk. There are significant safety benefits when distributed generation avoids or reduces the need for additional overhead poles and wires.* [69]

AusNet Services also agreed that distributed generation could assist the reduction in bushfire risk, stating:

> *It can be anticipated that communities could rely on standalone power systems on the critical fire risk days, with the local network de-energised, for example. Alternatively, permanent separation from grid supply may be optimal.*[70]

Stakeholders also referred to the Victorian Bushfires Royal Commission as a source of information regarding the role of distributed generation in bushfire mitigation. In 2011, the Powerline Bushfire Safety Taskforce (the Taskforce) reviewed options to reduce bushfire risk, particularly related to the electricity network in Victoria.[71] As part of its review, the Taskforce considered two mitigation options that incorporate certain technologies of distributed generation, which are:

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[68] The review found that powerline faults could ignite bushfires either by; by an electric arc caused by electrical assets or clashing powerlines coming in contact with combustible material, or the flow of electric current through vegetation, an animal or other material comes into contact with a live electricity network asset. Bushfires can also be ignited through natural causes such as lightning, and human activity (indirectly or arson).

[69] Clean Energy Council 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation – Proposed Approach Paper,* February, p. 2.

[70] AusNet Services 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation – Proposed Approach Paper,* February, p. 10.

[71] Powerline Bushfire Safety Taskforce 2011, *Powerline Bushfire Safety Taskforce: Final Report,* September, pp. 74-78.

- powerlines are temporarily turned off during high fire risk times, with distributed generation providing back-up power to customers, and
- customers are provided standalone power supplies, with the powerlines turned off permanently.

The Taskforce concluded that it would be more costly to use distributed generation technologies, compared to other options, in reducing bushfire risk, stating:

> *…there are more cost-effective options to reduce the bushfire risk associated with powerlines than to provide back-up generators to electricity customers in rural areas and to deliberately turn off powerlines temporarily on high fire risk days.*[72]

On the basis of the assessment of the Taskforce, we recognise that distributed generation may, in a theoretical sense, provide a means of reducing bushfire risk, albeit at potentially higher cost than alternative measures.

However, we were not provided with evidence indicating that the current fleet of distributed generators in Victoria has caused powerlines to be decommissioned, thereby leading to lower bushfire risk. Nor were we supplied with evidence the current fleet of distributed generators enables powerlines to be de-energised for the purposes of bushfire risk mitigation. We therefore were not able to conclusively state that Victoria's current fleet of distributed generators are providing this benefit.

Nonetheless, we recognise that distributed generation may be an increasingly viable means of undertaking bushfire mitigation, particularly as technology improves and costs reduce. The installation of bi-modal inverters, for instance, may more easily allow distributed generators to operate in circumstances where the grid itself has been de-energised. Particularly when installed with energy storage, this could allow distributed generation to be deployed in a remote area, thereby enabling the linking network to be de-energised during high fire risk days. This could provide a societal benefit if it was more efficient than other bushfire mitigation options, such as undergrounding wires.

The Commission did not identify any regulatory impediment to this value being realised. We therefore did not view the possibility of this benefit as warranting a

[72] Powerline Bushfire Safety Taskforce 2011, *Powerline Bushfire Safety Taskforce: Final Report,* September, pp. 76-77.

regulatory intervention. Nor did we assess the merits of greater investment in distributed generation relative to other forms of bushfire risk mitigation available to distribution businesses.

4.4.2 AMENITY AND AESTHETICS BENEFIT

Some stakeholders, including the CEC, suggested that distributed generation could provide amenity and aesthetic benefit by reducing the need to build poles and wires.

For existing poles and wires, these benefits would only be realised if such network infrastructure were removed completely, which could potentially occur if there were sufficient distributed generation installations to enable a local area to disconnect from the grid. The Commission has not been provided any evidence to suggest that rural or urban powerlines have been specifically decommissioned as a result of distributed generation.

New developments require new electricity connections, which could be supported by new electrical infrastructure such as poles and wires. Where a new development opts to be sourced by electricity from distributed generation sources, removing the need for poles and wires, the benefits of increased amenity and aesthetics accrue largely to the investor without the need for government intervention. As such, it is outside the scope of this inquiry.

4.4.3 CUSTOMER EMPOWEMENT

The Institute of Sustainable Futures considers that the 'islanding' capability of certain distributed generation technologies increases customer empowerment.[73]
Environmental Justice Australia stated:

> *Victorians see benefit in using distributed energy to reduce their reliance on the grid, or go off-grid all together…*[74]

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[73] Institute for Sustainable Futures 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation – Proposed Approach Paper,* February, p. 2.

[74] Environmental Justice Australia 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation – Proposed Approach Paper,* February, p. 7

Distributed generation may be causally linked to increased empowerment for the investor. However, this benefit accrues directly to the owner/investor in distributed generation. That is, it is a private benefit and accrues to the investor without regulatory intervention and is outside the scope of this inquiry.

4.4.4 CONCLUSION – ENVIRONMENTAL AND SOCIAL BENEFITS

Distributed generation may provide a benefit if it provides a lower cost alternative to network projects that could be undertaken for the purposes of bushfire mitigation. This could occur in circumstances where deploying distributed generation in a remote area, and thereby enabling the linking network to be de-energised during high fire risk days, was a more efficient alternative to other bushfire mitigation steps, such as undergrounding wires. The Commission did not identify any regulatory impediment to this value being realised. We therefore did not assess the merits of greater investment in distributed generation relative to other forms of bushfire risk mitigation available to distribution businesses.

The Commission did not identify any data that demonstrated the network effects of the distributed generation installed Victoria is giving rise to additional social or environmental benefits.

4.5 CONCLUSION

This chapter examined whether distributed generation provides benefits to the network, considering a range of potential economic, environmental and social benefits. A summary of our findings is described in Table 4.1.

We found that distributed generation can reduce network congestion, and these benefits are highly variable but can be quantified and valued in Victoria.

We also considered a range of indirect environmental and social benefits of distributed generation. We recognise that distributed generation may be an increasingly viable means of undertaking bushfire mitigation, particularly as technology improves and costs reduce. The Commission did not identify any regulatory impediment to this value being realised. We therefore did not view the possibility of this benefit as warranting a regulatory intervention.

4.5.1 DRAFT FINDINGS

Draft Finding 1: Network value of distributed generation

Distributed generation can and does provide network value. The value is primarily derived from reductions in network congestion, which can lead to the deferral of network augmentation expenditure and reduce the quantity of expected unserved energy. Distributed generation can also provide other network benefits but these are not currently material with respect to calculating network value for the purposes of this inquiry.

Draft Finding 2: Network value is highly variable

The size of the network value of distributed generation is affected by:

- **Location** - The value varies based on the distributed generator's location, specifically in terms of its proximity to areas of the network that are congested, or nearing congestion.
- **Time** - The value also varies according to the extent to which the electricity generation coincides with the periods of peak demand within the section of the network to which the generator is connected.
- **Asset life-cycle** - The value varies based on when in the network operator's cycle of upgrade projects the value is being measured. If the measurement is conducted annually, this means the value varies year-on-year, subject to the timing of network upgrade projects, as well as the supply and demand for energy in the area of the network to which it is connected.
- **Capacity** - The generation capacity of the distributed generation.
- **Optimisation** - 'Optimisation' refers to the extent to which the generation is optimised for delivery of grid services, which is largely a function of being both predictable and responsive to the needs of the network. A system that is highly optimised for network benefits is one that reliably produces output at the time it is most needed by the network.

Draft Finding 3: 'Firm' distributed generation has significantly more network value than 'intermittent' generation

Distributed generation can provide significantly more network value when it is 'firm'. The greatest value is created when distributed generation can provide firm output in capacity increments that match the extent of the network congestion.

Draft Finding 4: Technology can transform intermittent generation into firm generation

When intermittent distributed generation systems are supplemented with additional technologies – such as energy storage (batteries) and energy management technologies – they may be capable of operating as firm generators, which would increase their potential value. Technology also exists to coordinate, or 'orchestrate', multiple small-scale distributed generators in order to produce larger increments of firm generation and thereby maximise their network value.

Draft Finding 5: Social and environmental benefits of network effects

Distributed generation may provide a benefit if it provides a lower cost alternative to network projects undertaken for the purposes of bushfire mitigation. This could occur in circumstances where deploying distributed generation in a remote area, and thereby enabling the linking network to be de-energised during high fire risk days, was a more efficient alternative to other bushfire mitigation steps, such as undergrounding wires. The Commission did not identify any regulatory impediment to this value being realised.

TABLE 4.1 SUMMARY OF NETWORK BENEFITS

Benefit category	Potential network benefit	Assessment summary	
Network Capacity	Reduced expenditure on network infrastructure	Quantifiable network value	Distributed generation can defer the need for network businesses to invest in new or upgraded infrastructure. This benefit is captured as part of the calculation of value in *reducing network congestion*. This network value varies by location, time of generation, asset lifecycle, generation capacity, and the extent to which the generation is optimised for network benefits.
Electricity Supply Risk	Reduced expected unserved energy	Quantifiable network value	Distributed generation can reduce the expected unserved energy in parts of the network, in the case where a critical piece of network equipment fails. This benefit is captured as part of the calculation of value in *reducing network congestion*. This network value varies by location, time of generation, asset lifecycle, generation capacity, and the extent to which the generation is optimised for network benefits.
	Islanding capability	Excluded	Distributed generation with islanding capabilities does provide benefits, in the event of a network outage. These benefits are private to the investor.
Grid Support Services	Network support	Non-material benefit with respect to calculating network value in this inquiry	Distributed generation can provide alternatives to current network support services, but this is highly localised to a very small number of ZSS areas.
	Managing voltage regulation and power quality	Non-material benefit with respect to calculating network value within this inquiry	Given there are very few voltage control projects required in Victoria, distributed generation is unlikely to provide significant network benefits. Also, the current distributed generation fleet is not designed to contribute any significant voltage control capacity.
		Future DG could provide benefit	Future distributed generation systems with 'smart' inverters could contribute to distribution system voltage control, which will increase in value as solar PV penetration rises.
	Ancillary services	Excluded	AEMO contracts specific resources to address network needs (ancillary services) that cannot be addressed by the current fleet of distributed generation.
Environmental and Social	Bushfire risk mitigation	Cannot be attributed to existing DG	We were not presented with evidence that the current fleet has caused a bushfire mitigation benefit, for instance through the decommissioning of powerlines.

Benefit category	Potential network benefit	Assessment summary	
		Future DG could provide benefit	Future distributed generation systems may be capable of contributing to bushfire risk mitigation, if lower in cost than alternative measures.
	Amenity and aesthetic benefit	Excluded	Distributed generation could provide increased amenity and aesthetics in new developments, which could avoid the need for above ground poles and wires. These benefits are private to the investors.
	Customer empowerment	Excluded	Distributed generation could give greater empowerment to investors, where the user has the ability to go off-grid. These benefits are private to the investor.

Source: ESC, Jacobs

5 REGULATORY FRAMEWORK

5.1 INTRODUCTION

This chapter sets out our analysis of the existing regulatory framework, as it relates to the network value of distributed generation of less than 5 megawatts (MW) in capacity.

It outlines the various regulations and mechanisms that exist at both the National and Victorian level that govern the interaction of distributed generation with distribution and transmission networks.

OVERVIEW

The primary purchasers of grid services are large, monopoly network businesses, which have access to more information than individual small-scale distributed generation proponents, who may often be residential households. In these circumstances, network businesses are likely to have considerable bargaining power. Conversely, procuring grid services from multiple small-scale providers may be challenging for network businesses, particularly from the perspective of risk allocation and transaction costs.

Some of these factors are acknowledged by the national regulatory framework that applies to monopoly network businesses and which contains:

- incentives for network businesses to appropriately apportion their expenditure between traditional network upgrade projects, such as upgrading the 'poles and wires', and non-network solutions, such as using grid services to defer upgrades of the existing network infrastructure
- requirements that network businesses provide a level of information about opportunities for the provision of grid services, and

- processes network businesses must follow when deciding how to respond to network constraints, including undergoing a tender process before undertaking major upgrades of the network.

The regulator and the rule maker[75] for the National framework have identified ways in which the framework could be changed to improve how the market for grid services functions. Processes are underway at the national level to:

a. Develop and implement improved 'demand-side' incentive and allowance schemes, to take effect from 2021.[76] The new schemes are intended to better assist network businesses in identifying and selecting non-network solutions, including using distributed generation to defer network upgrades, where they are an efficient alternative to traditional network expenditure.
b. Potentially expand the information available to suppliers of grid services, including distributed generators, about the dollar value of reducing peak demand in specific locations around the network. If implemented, this information would be available on an annual basis from 2018 onwards.[77]
c. Potentially consider expanding the opportunities for suppliers of grid services to offer their services, as an alternative to traditional network expenditure, by requiring network businesses to conduct public tender processes when replacing some types of network asset.[78]

The framework is not orientated towards ensuring small-scale providers of grid services are able to efficiently participate in the market for grid services. As such, it does not contain any mechanisms designed to ensure network businesses calculate the network value of small-scale distributed generators on an individual basis, nor to ensure they make payments on the basis of that value.

[75] The Australian Energy Regulator (AER) and the Australian Energy Market Commission (AEMC)

[76] Demand Management Incentive Scheme (DMIS) and Demand Management Incentive Allowance (DMIA)

[77] The AEMC's preferred rule within the draft determination in the Local Generation Network Credit (LGNC) rule change proceeding, which is described as a 'system limitations report. '

[78] Australian Energy Market Commission 2016, *Replacement expenditure planning arrangements*, (http://www.aemc.gov.au/Rule Changes/Replacement-Expenditure-Planning-Arrangements.aspx#)

5.1.2 STRUCTURE OF THIS CHAPTER

This chapter is divided into six sections

5.1 Introduction

5.2 An examination of the Victorian State regulatory framework relating to the remuneration of distributed generation

- feed-in tariffs
- Electricity Industry Guidelines 14 and 15, and
- the Electricity Distribution Code.

5.3 An examination of the elements of the National regulatory framework that have a bearing on the remuneration of distributed generation

- National electricity rules (NER) Chapter 2: Small generation aggregation framework (SGAF)
- NER Chapter 5: Demand-side engagement strategy (DSES), distribution annual planning report (DAPR), Regulatory Test for Distribution (RIT-D)
- NER Chapter 5A: Connection regime, and
- NER Chapter 6: Network price reform, capital expenditure sharing scheme (CESS) and efficiency benefit sharing scheme (EBSS), service target performance incentive scheme (STPIS), avoided transmission use of system costs (TUOS), network support payments.

5.4 Planned and potential changes to the National regulatory framework

- Demand Management Incentive Scheme (DMIS) and Demand Management Incentive Allowance (DMIA)
- local generation network credit (LGNC) rule change (and 'system limitations report')
- replacement expenditure (REPEX) planning arrangements rule change, and
- demand response mechanism (DRM) and ancillary services unbundling rule change.

5.5 The Commission's findings with regard to the regulatory framework

5.2 VICTORIAN FRAMEWORK

The relevant elements of the Victorian regulatory framework are:

- feed-in tariffs (FiT)
- Electricity Industry Guidelines 14 and 15, and
- the Electricity Distribution Code.

5.2.1 FEED-IN TARIFFS

Since 2004, there have been four separate FiTs in Victoria and their policy objectives have evolved over time. Only one of these schemes, the minimum FiT, is open to new entrants.[79] The design of this FiT as it relates to the energy value of distributed generation was addressed through an earlier set of papers within this inquiry.[80] None of the Victorian FiTs reflect the network value of distributed generation in payments.

The minimum FiT was established as an outcome of the *Power from the People* review, completed by the then Victorian Competition and Efficiency Commission (VCEC) in 2012. In its final report, VCEC observed that:

> *recovering the network value and paying it to the proponents of distributed generation is important to ensure there are incentives for the efficient incorporation of distributed generation into Victoria's electricity system.*[81]

However, VCEC also noted both the practical difficulties of identifying such a localised value, and the regulatory design challenges of reflecting such a granular value in a broad-based feed-in tariff. Consequently, when establishing the principles upon which

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[79] For a discussion of the other FiT schemes, see Essential Services Commission 2016, *The Energy Value of Distributed Generation - Distributed Generation Inquiry Stage 1 Final Report*, August, p. 15.

[80] Essential Services Commission 2016, *The Energy Value of Distributed Generation – Distributed Generation Inquiry Stage 1 Final Report*, August; Essential Services Commission 2016, *The Energy Value of Distributed Generation – Distributed Generation Inquiry Stage 1 Draft Report*, April; Essential Services Commission 2015, *The Energy Value of Distributed Generation – Distributed Generation Inquiry – Our Proposed Approach,* December.

[81] Victorian Competition and Efficiency Commission 2012, *Power from the People: Inquiry into Distributed Generation,* July, p. 85.

the FiT would be set, VCEC recommended that the FiT be based exclusively on the wholesale value of the electricity produced by distributed generators.[82] As a result, the FiT does not include any provision for remunerating distributed generators on the basis of network value.

5.2.2 ELECTRICITY INDUSTRY GUIDELINES 14 AND 15

Until recently, the connection process for distributed generators in Victoria was governed primarily by two Victorian instruments: Electricity Industry Guidelines 14 and 15.[83] These Guidelines were developed by the Commission in 2004, and contained provisions relating to connecting and, in the case of Guideline 15, remunerating distributed generation for network value.

Guideline 15 contained three provisions that explicitly addressed the question of monetary transactions between network businesses and distributed generators for network value. These included provisions:

- Requiring that distributors must pass through a share of avoided distribution system costs to embedded generators. The guideline outlines how this should be calculated.
- Requiring that distributors must pass through the value of any Transmission Use of System (TUOS) charges they avoid due to the use of distributed generation. The guideline requires that the amount of avoided TUOS be calculated according to clause 5.5 of the NER.
- Allowing distributors to be compensated by a distributed generator for failing to provide network support services as and when required.

[82] VCEC recommended that the wholesale value be calculated in such a way that reflected the impact of line losses – that is, the electricity that is lost when it is transported through the system.

[83] Essential Services Commission 2004, *Electricity Industry Guideline No.14 provision of services by electricity distributors*, Issue 1 (*www.esc.vic.gov.au/getattachment/b57f7430-0352-4eba-ae98-0995c99511cd/Electricity-Industry-Guideline-No-14.pdf)*

However, the application of these Guidelines changed in July 2016 following the implementation of Chapter 5A of the National Energy Rules (NER) in Victoria, which governs the connection of distributed generation[84] less than 5MW in capacity.

The introduction of Chapter 5A meant that a number of the requirements of the Victorian regulatory framework contained within these Guidelines are now duplicated by the national regime. The Guidelines are scheduled for formal review following the conclusion of this inquiry.

An overview of Chapter 5A and its relevance to distributed generation is provided in Section 5.3.3 below.

5.2.3 THE VICTORIAN ELECTRICITY DISTRIBUTION CODE

The *Victorian Electricity Distribution Code*[85] *(the Code),* with which all Victorian licensed distribution businesses are required to comply, places conditions on how the Victorian distribution business should engage with a distributed generator that requests a connection. The key facets of the Code as they relate to distributed generation include:

- distributors are required to ensure they are able to receive supply from a connected embedded generator in accordance with a connection agreement, and
- distributors and embedded generators are required to negotiate in good faith to reach a connection agreement.

The Code also outlines the technical and safety standards that embedded generators connecting to the distribution system in Victoria must satisfy. The Code does not address the question of remuneration of distributed generation for network value.

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[84] Referred to in Chapter 5A as embedded generation.

[85] Essential Services Commission 2012*, Electricity Distribution Code*, Version 7 (*www.esc.vic.gov.au/getattachment/c2697e4e-d485-4b6d-a5a5-11149fa3b3df/Electricity-Distribution-Code-May-2012.pdf)*

5.3 NATIONAL FRAMEWORK

In addition to the mechanisms that apply exclusively within Victoria, distributed generators in this state are also affected by a separate, National regulatory framework known as the National Energy Rules (NER).

As regulated monopolies, the revenue that network businesses earn through building and operating the grid is determined by the Australian Energy Regulator (AER) through an approval process that occurs every five years.

This approval process occurs under Chapter 6 of the NER, which requires all network businesses operating in the NEM to submit proposals to the AER outlining the revenue and expenditure they believe is necessary to operate their networks during the upcoming five year regulatory period. The AER assesses these proposals against a range of criteria outlined in Chapter 6 and makes a decision (determination) as to how much revenue the distribution business can collect during the regulatory period.

This approval process also determines how much network businesses will charge customers for using the network, as well as how they will apportion their approved capital between the different forms of expenditure required to manage the network. This can include upgrading the network's capacity ('augmenting' the network), replacing existing network equipment that is deteriorating, or it can include operating expenses such as paying the wages of staff and contractors. The framework that governs this process exists within the NER.

A central objective of the NER is ensuring that network businesses manage the grid in the most efficient way possible. To serve this objective, the NER contains an array of incentives, programs and regulatory process requirements aimed at ensuring that network businesses preparing to spend money on the grid always find and choose the most efficient option. The 'most efficient option' means the lowest cost means of achieving the levels of service, safety and reliability that network businesses are required to meet.

Sometimes, the most efficient option is to spend money on building new network infrastructure, such as adding a new transformer to a substation. In other circumstances, the most efficient option is not to change the network, but to change the way the network is used. Instead of expanding the capacity of the physical network to cope with greater demand for energy, this option entails reducing or 'reshaping' the demand. This option is referred to as 'demand-side management' or 'demand-side response', and can include things like paying energy users to reduce their demand during peak periods. It can also include offsetting demand using distributed generation.

In combination, the rules and mechanisms within the NER are designed to ensure that the right (efficient) amount of capital is allocated to demand response options. They also aim to furnish potential suppliers of grid services, including distributed generation, with a level of information about opportunities available for grid services. As well, they stipulate various processes network businesses must follow when deciding how to respond to network constraints, including a requirement to undergo a tender process before undertaking major upgrades of the network.

This section outlines the relevant sections of the NER that have a bearing on the remuneration of distributed generation for network value.

5.3.1 CHAPTER 2 OF THE NATIONAL ELECTRICITY RULES

SMALL GENERATION AGGREGATION FRAMEWORK (SGAF)

This framework establishes a Small Generation Aggregator as a new category participant within the NEM. This reduces the barriers for a third party aggregator in offering grid services to network businesses, which are associated with operating or investing in the grid. A 'third party aggregator' is an entity that aggregates the supply from a number of distributed generators and transacts through the wholesale market on their behalf. This mechanism provides a framework for small-scale generators to participate in aggregation schemes and potentially obtain financial benefit.

5.3.2 CHAPTER 5 OF THE NATIONAL ELECTRICITY RULES

DEMAND-SIDE ENGAGEMENT STRATEGY

Under Chapter 5 of the NER DNSP's must develop and publish a demand-side engagement strategy that details a DNSP's processes and procedures for assessing non-network options as alternatives to network expenditure and for interacting with non-network providers. This provides greater transparency about how DNSPs assess and consider non-network options (including distributed generation), and is intended to make it easier to engage with DNSPs at an appropriate stage in the planning process.

DISTRIBUTION ANNUAL PLANNING REPORT (DAPR)

This places obligations on DNSPs to annually plan and report on assets and activities that are expected to have a material impact on their network. This provides transparency on the DNSPs' planning activities and decision-making, and better enables non-network providers to put forward options (including distributed generation) as credible alternatives to network investment.

REGULATORY INVESTMENT TEST FOR DISTRIBUTION (RIT-D)

The RIT-D is a framework that requires electricity distribution businesses to consider a range of options where an investment in network augmentation is required above $5 million. Its purpose is to '…identify the credible option that maximises the present value of the net economic benefit to all those who produce, consume and transport electricity in the NEM'.[86] The framework requires DNSPs to consider both credible network and non-network options, which might include demand-side management or specific distributed generation projects.

The RIT-D process is triggered when a DNSP identifies the need to augment its network, and the capital cost of the most expensive credible option to address the need is over $5m. Once the RIT-D is triggered the DNSP must follow a detailed process, laid down in guidelines produced by the AER[87], to determine how to proceed with the investment. As part of this process the DNSP has to prepare a non-network options report. This report must include:

- a description of the identified need
- the relevant deferred augmentation charge associated with the identified need, and
- the technical characteristics of the identified need that a non-network option would be required to deliver:

[86] National Electricity Rules, clause 5.17.1b, version 85

[87] Australian Energy Regulator 2013, *Regulatory investment test for distribution (RIT-D) and application guidelines*, August (https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/regulatory-investment-test-for-distribution-rit-d-and-application-guidelines)

- the size of the load reduction or additional capacity
  - location, and
  - the operation profile.
- a summary of the potential credible options to address the identified need, including both network and non-network options.

Once published, stakeholders must have no less than three months to respond to the non-network report and submit alternative options.

Having assessed all the options identified and presented, the DNSP must publish a Draft Project Assessment Report that outlines and justifies the preferred option.

5.3.3 CHAPTER 5A OF THE NATIONAL ELECTRICITY RULES

Chapter 5A governs the connection of distributed generation systems[88] less than 5MW (which is the threshold below which a generator is exempt from registering as a participant with AEMO). It provides for three different connection options:

- basic connection service – provided to a typical retail customer and to a micro-embedded generator[89] via a model standing offer
- standard connection service – for connections larger than for a micro-embedded generator, but for which there is a model standing offer, and
- negotiated connection service – for connections not covered by either the basic or standard connection service.

Chapter 5A outlines the process and timelines that should be followed under each connection type.

Chapter 5A also provides the framework for determining the charges that network businesses can recover from a connecting customer. They allow, in certain

[88] Referred to in Chapter 5A as embedded generation.

[89] A micro-embedded generator is defined as that which is connected via AS4777 inverter standards

circumstances, for a DNSP to recover extension and augmentation costs required to connect a distributed generator[90] to the network.

The connection costs that will be recovered from micro-embedded generators will be detailed in the relevant DNSP's model standing offer that will reflect the DNSP's connection policy. The DNSP's connection policy, which is approved by the AER, must comply with the AER's connection charge guidelines and with the connection charge principles outlined in Chapter 5A. These outline that micro-embedded generators:

- can be required to make a contribution to the capital cost of an extension, which could arise when the distribution network is extended beyond the current boundary of the network, and
- can be required to make a contribution to the capital cost of augmentation, but only if the service in question is not a basic connection service and a relevant DNSP threshold has been exceeded.

Distributed generators that are not classified as micro-embedded generators (but below the 5MW AEMO registration threshold), can be charged for both the extension and augmentation costs related to their connection.

5.3.4 CHAPTER 6 OF THE NATIONAL ELECTRICITY RULES

Under Chapter 6 of the NER, all DNSPs operating in the NEM must submit proposals to the AER outlining the revenue and expenditure they believe is necessary to operate their networks during the upcoming five-year regulatory period. The AER assesses these proposals against a range of criteria outlined in Chapter 6 and makes a decision (determination) as to how much revenue the distribution business can collect during the regulatory period. Chapter 6 also contains a range of mechanisms to encourage DNSPs to consider non-network (demand-side) options in their revenue proposals. These are outlined below.

[90] Or a new customer who does not have generation, but which because of the additional demand (load), requires the DNSP to invest in network augmentation to service the customer.

DISTRIBUTION NETWORK PRICING

Distribution businesses recover costs for their own distribution services through a charge for the use of the distribution system. These charges are known as Distribution Use of System (DUOS) charges. These charges are passed through to consumers by retail businesses. If a customer installs distributed generation this may lead to a reduction of these charges for that customer, but these contribute to the private benefit of distributed generation. They are not considered part of the external benefit of distributed generation.[91]

Under recent changes to Chapter 6, DNSPs are now required to develop network prices that reflect the efficient cost of providing network services to individual customers. Each network tariff must be based on the long run marginal cost (LRMC) of providing the service.

Cost reflective network tariffs based on LRMC are intended to signal the cost incurred by DNSPs in investing in their network to meet future demand. As these tariffs reflect the costs of increasing capacity at different locations across the network, they should more accurately reflect the network value caused by distributed generation reducing the need to build additional capacity.[92]

The main impact of this change is that network tariffs for all customers will now include a demand charge. This is calculated based on a customer's highest 30 minute demand during the peak charging window, which has been set for all Victorian DNSPs at 3pm-9pm on weekdays. The charge applied to this demand is higher in the summer months (December – March) than in the non-summer months, reflecting the times when network demand is higher. The introduction of a demand charge will be matched by a reduction in the fixed component of a customer's bill.

[91] Part of or all of value may be received where the distributed generator uses a portion of the generation energy to meet their own use of electricity. Network charges are thereby reduced according to the reduced purchase of electricity from the external network.

[92] However, the introduction of LRMC based cost reflective tariffs would nonetheless not account for all the value of the network benefits of distributed generation. The LRMC based cost reflective tariffs are intended to reflect the costs associated with meeting future demand (augmentation), and do not reflect the value of reducing expected unserved energy. As a consumption tariff, a cost reflective tariff of the structure would not reward the network benefits of electricity that is exported into the grid.

In Victoria the transition to full LRMC network tariffs is being phased-in over the next few years. There are two elements to the transition:

- Demand charges will be introduced over time. In the first year of the new tariffs (2017), a percentage of the demand charge will be applied. This will increase over time. Citipower for example will apply 20% of the full demand charge in 2017, rising to 100% by 2021.

- Demand charges are being introduced for customers using less than 40 MWh a year, on an opt-in basis. That is, consumers cannot be automatically assigned to the new tariffs; they must actively make the choice to be assigned to the new LRMC based tariffs.

CAPITAL EXPENDITURE SHARING SCHEME (CESS) AND THE EFFICIENCY BENEFIT SHARING SCHEME (EBSS)

These schemes provide incentives for network businesses to further invest and operate networks more efficiently. If a network business identifies a non-network solution, such as distributed generation, as more cost effective than a previously planned (and approved) investment in typical network infrastructure, the schemes allow the network business to keep part of the cost savings. The intention of these mechanisms is to remove the distortions to incentives that would otherwise emerge as a result of the five yearly pricing determination process.

SERVICE TARGET PERFORMANCE INCENTIVE SCHEME (STPIS)

This mechanism provides distribution businesses with a financial incentive to maintain and improve service performance where customers are willing to pay for these improvements. It could encourage a DNSP to recognise any reliability and service quality benefits from distributed generation, and pay for them.

AVOIDED TRANSMISSION USE OF SYSTEM COSTS

DNSPs are required to pass through any TUOS costs that have been avoided as a result of distributed generation, i.e. where the energy supplied by distributed generation avoids energy supplied to the distribution network via the transmission network. This mechanism only applies to distributed generation with a capacity above 5MW, meaning that it would not apply to the scale of distributed generation that is the subject of this inquiry.

NETWORK SUPPORT PAYMENTS

Distributed generation with a capacity above 5MW can negotiate payments from DNSPs and transmission network service providers (TNSPs) for providing specific network support services. These payments may be made by DNSPs and TNSPs for services where distributed generation defers a specific shared transmission network asset, or for a service that contributes to reliability and security of a transmission network. This mechanism only applies to distributed generation with a capacity above 5MW, meaning that it would not apply to the scale of distributed generation that is the subject of this inquiry.

5.4 CURRENT CHANGE PROCESSES

The AEMC and/or the AER are currently considering a number changes to the national regulatory framework that is relevant to the interaction of distributed generation with electricity networks. These are outlined below.

5.4.1 DEMAND MANAGEMENT INCENTIVE SCHEME (DMIS) AND INNOVATION ALLOWANCE (DMIA)

The AER is required to develop and publish the incentive scheme and set an innovation allowance to fund innovative projects that have the potential to deliver ongoing reductions in demand or peak demand. The innovation allowance will provide DNSPs with funding for research and development in projects that have the potential to reduce long-term network costs. Projects may incorporate distributed generation solutions as part of this scheme. The AER is in the process of developing the detail of the DMIS and DMIA. They are scheduled to be applied in the next regulatory period that begins in 2021.

5.4.2 LOCAL GENERATION NETWORK CREDIT (LGNC) RULE CHANGE[93]

The AEMC has recently published its draft decision on the LGNC rule change proposal. Their preliminary decision is not to proceed with the LGNC. The AEMC have proposed an alternative rule change aimed at improving the information that is provided by DNSPs in relation to network constraints.

If implemented, the LGNC rule change, as originally proposed, would have required DNSPs to calculate the network value of distributed generation, including that below 5MW, connected to its network, and make a payment (credit) to the distributed generator to reflect the calculated value.

5.4.3 REPLACEMENT EXPENDITURE PLANNING ARRANGEMENTS RULE CHANGE PROPOSAL[94]

This is a rule change, proposed by the AER, to improve the reporting and planning requirements in relation to replacement capital expenditure. The rule change applies the current requirements in relation to augmentation expenditure (APR, RIT-D and RIT-T) to replacement expenditure. If implemented this would mean that distribution and transmission businesses would need to consider non-network options when proposing to replace existing network infrastructure, as well as augmentations.[95]

5.4.4 DEMAND RESPONSE MECHANISM AND ANCILLARY SERVICES UNBUNDLING RULE CHANGE[96]

The AEMC has made a draft decision in relation to the rule change proposed by the COAG Energy Council. If implemented as proposed, the rule change would have created a demand response mechanism (DRM) within the context of the electricity

[93] Australian Energy Market Commission 2016, *Local Generation Network Credits*, (http://www.aemc.gov.au/Rule-Changes/Local-Generation-Network-Credits)

[94] Australian Energy Market Commission 2016, *Replacement expenditure planning arrangements*, (http://www.aemc.gov.au/Rule Changes/Replacement-Expenditure-Planning-Arrangements.aspx#)

[95] Strbac, G et. al. 2016, *Delivering future-proof energy infrastructure*, National Infrastructure Commission UK 2016, February.

[96] Australian Energy Market Commission 2016, *Demand Response Mechanism and Ancillary Services Unbundling Rule Change*, (http://www.aemc.gov.au/Rule-Changes/Demand-Response-Mechanism)

wholesale market and unbundle the provision of ancillary services from the sale of electricity.

In its draft decision the AEMC determined not to implement the proposed DRM. The AEMC observed that demand response for wholesale energy market purposes is already happening in the NEM and that there are no barriers to the continued proliferation of demand response of this kind. (This is distinct to demand response that is delivered for network purposes). They concluded that the costs of implementing the DRM would outweigh the benefits.

The AEMC have decided to continue with the proposal to unbundle the provision of ancillary benefits from the sale of electricity. They have proposed a draft rule to provide for a new type of market participant – a market ancillary service provider – to offer a customer’s demand response, or aggregation of customers’ demand responses, into frequency control ancillary services (FCAS) markets. Under the proposed rule a market ancillary service provider does not have to be a customer’s retailer.

5.5 CONCLUSION

The national framework is fundamentally geared towards ensuring that network businesses pursue the most efficient outcome when planning investments in their network. This extends to ensuring they have the right incentives to consider non-network options, including distributed generation.

It also contains mechanisms that are designed to provide a level of information to potential suppliers about grid service opportunities. Another mechanism is designed to ensure network businesses undergo a tender process before undertaking major upgrades of the network.

The framework is not orientated towards ensuring small-scale providers of grid services are able to efficiently participate in the market for grid services. As such, it does not contain any mechanisms designed to ensure network businesses calculate the network value of small-scale distributed generators on an individual basis, nor to ensure they make payments on the basis of that value.

To the extent that small-scale distributed generation has the potential to provide material value in the market for grid services – which could be realised to the benefit of all customers, through lower network charges, if it led to a more efficient operation of the network – there may therefore be potential to explore regulatory reform options that serve an enabling role for the participation of small-scale grid services providers, including distributed generation, in that market.

Chapter 6 examines the extent to which this potential exists, and explores the question of how it may be realised.

6 REGULATORY REFORM

6.1 INTRODUCTION

This chapter sets out our proposed reform direction and invites stakeholder feedback.

OVERVIEW

Distributed generation is one of a number of means through which network value can be delivered. Other demand-side measures, such as demand response, may also give rise to network value. The potential network benefits provided by all these forms of demand-side measures can be collectively described as ‘grid services’.

Because of the focus of this inquiry, we have centred our analysis on the value of the grid services provided by distributed generation. But some measures implemented for the purposes of remunerating distributed generation for the provision of grid services could be designed in such a way that did not preclude the remuneration of other means of delivering grid services.

Technology now exists that can effectively transform intermittent distributed generation, such as solar photovoltaics (PV), into firm generation and thereby make it considerably more valuable to networks. Such technology includes energy storage (batteries), ‘smart’ inverters, and energy management systems.

Technology is also emerging that enables the coordination of large numbers of small-scale distributed generators. These technologies enable multiple systems to be bundled, or ‘orchestrated’, in order to deliver grid services at the times and in the locations that they have the greatest value.

A regulatory framework exists at the national level to incentivise monopoly network businesses to appropriately apportion their expenditure between traditional network upgrade projects and non-network solutions. That framework is not geared towards providing opportunities for small-scale grid service providers, such as distributed generators, to participate in the market for grid services.

Unlike other jurisdictions in the National Energy Market (NEM), Victoria has advanced metering infrastructure (AMI), or 'smart meters'. Smart meters allow grid services to be deployed more easily and at lower cost than is possible under traditional metering.

The penetration of smart metering within Victoria raises the possibility that opportunities exist in Victoria for the further development of a well-functioning market for grid services that may not presently exist within the other jurisdictions of the national energy market.

So that small-scale providers of grid services in Victoria, including distributed generation, have adequate opportunities to participate in the market for grid services, we believe it important to identify the principles and measures for enabling a well-functioning market in Victoria.

Because of the characteristics of network value, a broad-based feed-in tariff (FiT) is unlikely to be an appropriate tool to achieve this purpose. The value of the grid services that distributed generation can provide is too variable – between locations, across times, and between years – to be well suited for remuneration via a broad-based FiT.

The Commission is seeking input from stakeholders to identify the principles and measures by which a market space can be developed that provides adequate opportunities for small-scale grid service providers, such as distributed generators, to be remunerated for the grid services they are capable of providing.

In providing feedback, we encourage stakeholders to take account of measures in place or under consideration throughout Australia and in international jurisdictions. The principles and measures should have regard to matters including but not limited to:

- market access opportunities for small-scale grid services providers, including efficient transaction and settlement
- the availability of information for small-scale grid services providers, in particular the granularity and 'dynamism' of pricing for grid services
- the allocation of risk between network businesses, grid service providers, and third parties
- risks associated with an increasingly dynamic market for grid services
- the costs and benefits associated with any potential regulatory intervention to enable markets for grid services, and
- regulatory oversight.

6.1.1 STRUCTURE OF THIS CHAPTER

This chapter is divided into four sections

6.1 Introduction

6.2 Distributed generation as a 'grid service'
- discussion of what constitutes a high value grid service, and
- examination of circumstances in which distributed generation constitutes a high value grid service.

6.3 The market for grid services
- the market for grid services in Victoria, and
- a network value feed-in tariff?

6.4 Questions for stakeholders

6.2 DISTRIBUTED GENERATION AS A 'GRID SERVICE'

Our analysis of the Victorian electricity network demonstrates that distributed generation can and does provide network value. Distributed generation can create this value primarily through reducing network congestion. This may defer network augmentations and reduce the amount of expected unserved energy.

However, distributed generation is one of a number of means by which network congestion can be reduced. Other demand-side measures, such as demand response, may also give rise to network value.

The potential network benefits provided by all these forms of demand-side measures can be collectively described as 'grid services'. 'Grid services' is the term used to describe the full suite of services that electricity networks require in order to run safely, reliably and efficiently. All current and potential network benefits of distributed generation are associated with various types of grid service, from deferring network augmentation projects by reducing congestion through to assisting with ancillary services such as frequency control. When we discuss the market for grid services, we are referring to the arena in which network businesses transact with providers of grid services.

Because of the focus of this inquiry, we have centred our analysis on the value of the grid services provided by distributed generation. But measures implemented for the purposes of remunerating distributed generation for the provision of grid services could be designed in such a way that did not preclude the remuneration of other means of delivering grid services.

6.2.1 INTERNATIONAL EXAMPLES

The potential of increasingly dynamic markets for grid services is receiving increasing attention, particularly in light of pioneering reforms being implemented under the auspices of New York State's Reforming the Energy Vision (REV) reform package.

The REV is a far-reaching set of reforms aimed at reshaping the traditional utility model for the purposes of ensuring cost-effective and reliable electricity supply in an increasingly decarbonised future. A central element of the REV is the conversion of network operators into 'distributed system operators', charged with managing the grid as a platform over which multiple agents transact and procure energy related services, including the types of grid services that we have discussed in this report.

The question of how the various benefits of distributed energy resources, including distributed generation, might be valued is a key focus of a current proceeding within the wider REV programme. In a report issued in October 2016, the New York State Department of Public Service identified the challenge inherent in obtaining the level of granular pricing information necessary to send appropriately targeted signals to distributed energy resources. As the report notes, '[t]he effort to better identify, quantify, and monetize more granular costs and values at the distributed level has really just begun'.[97]

The types of energy service markets envisaged by the REV reforms are broader in scope than the grid services market discussed in the context of our inquiry.[98] The New York State Department of Public Service has identified principles that it believes should inform the development of methodologies for the valuation of distributed energy resources (including distributed generation) within the context of the various tariff and market based mechanisms that will be developed (box 6.1).

BOX 6.1 REFORMING THE ENERGY VISION – MARKET & VALUATION

New York State Department of Public Service principles to guide the development of valuation methods that will underpin various tariff and market based mechanisms.

- increased precision and alignment of valuation of benefits and costs from distributed energy resources (DER)
- clarity and simplicity to ensure customers and developers can use and respond to the methodology
- certainty, predictability, and stability to allow market and financing efficiency
- gradualism to avoid sudden disruption of DER markets

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[97] New York Department of Public Service 2016, *Staff Report and Recommendations in the Value of Distributed Energy Resources Proceeding,* October, p9

[98] The REV process is also in part focused on the issue of transitioning existing distributed generators off high tariffs or credits for generated electricity, referred to in the United States context as 'net energy metering' arrangements.

- technology neutrality that accounts for the unique characteristics and performance of different technologies
- support for public policy to acknowledge the goals of multiple jurisdictions
- breadth to include a greater number of value components than are present under net energy metering[99]
- transparency of valuation methods
- flexibility to allow valuation methods to evolve over time
- equity and fair access for all customers to the full range of DER technologies, and
- customer affordability, balancing between support for DER market growth and impacts to ratepayers.

Source: New York State Department of Public Utilities[100]

The potential emergence of a 'distributed system operator' (DSO) model, and associated markets, to replace elements of the existing utility model is also being examined in the United Kingdom (UK). In a report issued in March 2016, the UK National Infrastructure Commission (NIC) took the view that the establishment of distributed system operators 'should be treated as a priority'.[101] Energy UK, the trade association for the UK energy industry, has indicated the likely need to make such a transition.[102]

In explaining its position, the NIC identified the potential that this model held for unlocking additional value from resources such as distributed generation. In citing the benefits that may emerge, the report states:

> *A DSO with a clear idea of what the local network needs at each moment in time will be able to purchase or procure these services to manage its system, creating revenue streams and market signals to suppliers. It is currently difficult*

[99] A mechanism broadly equivalent to the feed-in tariff.

[100] New York Department of Public Service 2016, *Staff Report and Recommendations in the Value of Distributed Energy Resources Proceeding,* October, p16-17

[101] National Infrastructure Commission UK 2016, *Smart Power*, March, p. 70.

[102] Energy UK 2016, *Pathways for the GB Electricity Sector to 2030*, February, p. 15.

to put together a commercial business case for local level storage and demand flexibility measures, as their benefits are diffused across different parts of the system. This change will also incentivise the development of new and innovative business models, and save money for consumers by reducing or deferring the need for costly physical enhancements to the grid.[103]

Given the significant differences between electricity markets in New York State, the UK and Australia, it is not the Commission's intention to advocate for the adoption of a distributed system operator model in the Victorian context or more broadly in the NEM. Such a proposal would need to be part of a much larger discussion about the future of electricity networks, and touches on key debates currently underway about ownership models, contestability[104] and ring-fencing,[105] which are not within the primary focus of this inquiry.

However, these examples illustrate the types and scope of reforms that are being considered in other jurisdictions, elements of which may have implications for the remuneration of small scale distributed generators as providers of grid services.

Indeed, discussions of the applicability of these concepts are already advancing in the Australian context, such as is occurring under the auspices of the Electricity Network Transformation Roadmap project, a partnership between the Energy Networks Association (ENA) and CSIRO. In its Interim Program Report last year, the project considered a number of future scenarios, including one in which network providers operate as 'enabling platforms', facilitating transactions through which distributed generations would be remunerated for providing energy and grid services.[106]

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[103] National Infrastructure Commission UK 2016, *Smart Power*, March, p. 68.

[104] In early September this year, the AEMC received a rule change request from the Council of Australian Governments (COAG) Energy Council to clarify energy service classifications for the purposes enabling contestable provision of services from emerging technologies. The AEMC has not yet initiated the rule change: Australian Energy Market Commission 2016, *Contestability of energy services, rule change*, September (http://www.aemc.gov.au/Rule-Changes/Contestability-of-energy-services). This follows a rule change approved by AEMC last November which initiated processes to expand contestability in metering services: AEMC 2015, *National Electricity Amendment (Expanding competition in metering and related services) Rule 2015 No. 12*, November.

[105] Ring-fencing refers to the practice of 'separating business activities, costs, revenues and decision making within an integrated entity associated with a regulated monopoly service, from those that are associated with providing services in a competitive market.' The AER has been developing an electricity distribution ring-fencing guideline, which is expected to be released in November 2016. Australian Energy Regulator 2016, Electricity ring-fencing guideline 2016, January, (https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/electricity-ring-fencing-guideline-2016).

[106] Energy Networks Association and CSIRO 2015, *Electricity Network Transformation Roadmap – Interim Program Report*, December, p. 12.

More recent work from the Roadmap project, released in October 2016, emphasised the benefits associated with facilitating grid services transactions between network businesses and small-scale operators, including residential customers. The report, prepared by Energeia, noted:

> *With the increase of new technologies in the energy system, early opportunities for buying and selling grid services are best served through agreements between customers and service providers to allow for dynamic and locational network orchestration of distributed energy resources where they can provide a lower cost solution to a traditional distribution service expenditure, to either augment or replace the existing grid.*[107]

These examples illustrate the emerging thinking about how grid service providers, including distributed generators, might be remunerated in the context of improving technological capabilities, more precise pricing arrangements, and potential shifts in the orientation of the commercial models of network businesses.

6.2.2 HIGH VALUE GRID SERVICES

Our analysis in chapter 4 demonstrated that distributed generation provides significantly more value when it is ‘firm’ and responsive. In most instances, firm generation that was optimised for the purposes of network benefits was several orders of magnitude more valuable than ‘intermittent’ solar PV. In the year we examined (2017), the value of firm distributed generation at some substations was more than twenty times greater than the value of standard solar PV.

Historically, firm grid services were exclusively provided by larger, fossil-fuel based generators such as diesel generators or gas turbines. These systems could be controlled to dispatch generation when required by the network, subject to ‘ramp up’ times. They could also provide dispatch in sufficiently large capacity increments. (If 7MW of additional capacity is required to defer a network upgrade, providing only 6.5MW can mean the deferral value does not materialise because the deferral threshold is not reached and the upgrade project proceeds as scheduled.[108])

[107] Energy Networks Association and CSIRO 2016, *Unlocking Value for Customers: Enabling New Services, Better Incentives, Fairer Rewards*, October, p. 3.

[108] However, in this scenario there may still be value through reductions in the expected amount of unserved energy.

By contrast, intermittent distributed generators such as wind and solar PV systems rely upon the presence of sun and wind, respectively, in order to generate electricity. They cannot provide certainty of dispatch, which limits their ability to provide grid services to networks. Furthermore, because Victoria's fleet of solar PV is comprised largely of small-scale systems – the average system size is currently 3kW[109] – these systems are individually unlikely to be capable of providing grid services on a scale that makes them capable of creating material network value.

These factors have led to some stakeholders forming the conclusion that small-scale intermittent distributed generation such as solar PV is an inherently unviable source of utility-scale grid services.

6.2.3 TRANSFORMING SOLAR PV INTO FIRM GENERATION

However, this status quo appears to be shifting, as new technology expands opportunities for intermittent solar PV systems – currently the dominant form of distributed generation in Victoria – to become controllable, and therefore capable of providing firm generation that is responsive to network needs.

Such technologies include energy storage (batteries), 'smart' inverters and energy management systems. Some of these technologies are not new – various forms of energy storage have been in use for decades,[110] but they are becoming increasingly economic for small-scale distributed generation owners to purchase and install.[111]

ENERGY STORAGE

There are many varying estimates of the timing and scale of energy storage (battery) uptake in Australia. Estimates of the pace and extent of this expansion vary

[109] This average encompasses all existing solar PV. Estimates by Jacobs Consulting for AEMO, published in June this year, indicate that the average size of systems being installed today across the NEM is 4.5 kW. Jacobs Consulting 2016, *Projections of uptake of small-scale systems*, Australian Energy Market Operator, June p.10.

[110] Australian Energy Market Commission 2015, *Integration of Energy Storage: Regulatory Implications*, December.

[111] The scope of technology change and integration with the network is a broader scope than is covered in this inquiry. Currently, a number of studies nationally and internationally are exploring these technology changes and the operation of the future grid (for example, Strbac, G et. al. 2016, Delivering future-proof energy infrastructure, National Infrastructure Commission UK 2016, February, pp. 20-24; Energy Networks Association and CSIRO 2015, *Electricity Network Transformation Roadmap – Interim Program Report*, December; and New York Department of Public Service 2016, *Staff Report and Recommendations in the Value of Distributed Energy Resources Proceeding,* October).

considerably. Jacobs Consultancy projects that the installed battery storage capacity within the National Electricity Market (NEM) will grow from negligible levels today to around 1,000 megawatts (MW) by 2020, of which around 300 MW will be located in Victoria.[112]

Other estimates are significantly higher. Morgan Stanley estimated in June 2016 that by 2020 installed battery capacity (residential) in the NEM will be 'about four times' higher than that forecast by Jacobs.[113]

Issues surrounding battery storage remain to be addressed, including those relating to safety, installation and operating standards, as well as standardised communications protocols and regulatory implications.[114] Nonetheless, it is reasonable to assume that this technology will become more widely available.[115]

ENERGY MANAGEMENT SYSTEMS

Energy management systems are used to monitor, control and optimise the energy output and consumption of customers' generation and appliances. Such systems often rely on cloud-based software that enables customers to remotely manage or monitor their energy generation, consumption and transactions.

When deployed in combination, energy storage and energy management systems can equip solar PV owners with the ability to store their excess solar energy and then dispatch it into the grid at the time of their choosing. If this dispatch is actively responsive to the needs of the network, it may have considerable network value. In other words, the combination of these technologies can effectively transform intermittent solar PV into firm, dispatchable generation.

[112] Jacobs Consulting 2016, *Projections of uptake of small-scale systems*, Australian Energy Market Operator, June, p 29.

[113] Morgan Stanley 2016, *Australia Utilities – Asia Insights: Solar & Batteries*, June, p.6. Note that Morgan Stanley reports an uptake of batteries of approximately 6GWh in the NEM by 2020, compared to Jacobs reported uptake of round 6.9GWh in the NEM by 2037.

[114] For a discussion of regulatory implications in the context of contestability of energy services rules within the national framework, see Australian Energy Market Commission 2015, *Integration of Energy Storage: Regulatory Implications*, December.

[115] Australia has been earmarked as an early adopting market globally for energy storage due to the high penetration of solar and the prevalence of wholesale value based feed in tariffs that are typically significantly lower than the retail price for energy.

For instance, a residential customer who owns a solar PV array and battery might use an energy management system to automatically purchase energy from the grid when prices are low, and during that time store the energy produced by their solar panels. When the price of energy increases, the energy management system might automatically switch to using the energy stored in the customer's battery, or if the 'export tariffs' were sufficiently high the system may begin exporting energy from the battery directly into the grid. The system may also be programmed to supply energy to the grid when it is most needed by the network; that is, to provide grid services.

Energy management systems can also be used to control appliances within the home, such as air conditioners and refrigerators, in response to changes in the price and availability of energy, or conditions within the grid.

SMART INVERTERS

As of early October 2016, an updated Australian Standard applies to newly installed solar inverters. Inverters are devices that convert the DC output of solar PV units into AC electricity that can be used by customers and/or exported into the grid, along with an increasing range of other functions such as power factor correction and voltage regulation. Inverters installed in Australia after 9 October 2016 must be capable of additional functionality, including functions related to demand response.[116] Further information is provided in box 4.2.

COORDINATION OF DISTRIBUTED GENERATION

Our analysis of network value within the Victorian grid demonstrated that the greatest value occurs when the quantity of generation is matched to the needs of the network. To reduce congestion in a way that produces the greatest value may require larger quantities of generation capacity than small-scale distributed generators can provide individually. However, this value can be unlocked by multiple smaller systems acting in unison.

[116] Standards Australia 2015, *Grid connection of energy systems via inverters - Inverter requirements,* AS/NZS 4777.2:2015, October.

Technology is emerging that enables multiple distributed generation systems to be coordinated, or 'orchestrated', in order to collectively deliver output in the locations, and at the times, where it has the greatest value.[117] By pooling their output, multiple small units may collectively reach the capacity thresholds required by the network to deliver augmentation project deferrals.

Conceivably, pooled distributed generation may be capable of being more responsive to network needs than conventional fossil-fuel based distributed generation. When compared with traditional sources of grid services, orchestrated distributed generation may be able to deliver ramp up rates of seconds rather than minutes or hours. Additionally, it may be capable of producing near to real time provision of ancillary services such as frequency control.[118]

DEMONSTRATION PROJECTS

All additional technologies come at a cost, and there remains uncertainty as to how quickly these new technologies will become mainstream. The pace of deployment will depend on factors such as the cost of the new technologies and the structure of electricity consumption tariffs.[119]

However, a small but growing number of companies in Australia have developed market-ready energy management systems for use within households and businesses.[120] The maturity and capabilities of these technologies is currently being

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[117] Large scale coordination of distributed energy resources, including distributed generation, is sometimes referred to as a Virtual Power Plant (VPP). The NER contains a mechanism – the Small Generation Aggregation Framework – that is specifically designed to enable aggregation. The mechanism creates a new market participant who is entitled to participate in the wholesale market on behalf of a fleet of aggregated distributed generators. This mechanism is sometimes incorrectly cited as explicitly enabling the provision of aggregated grid services. However, this result is incidental. Unlike participation in the energy wholesale market, the provision of grid services does not require a particular legal standing or the attainment of a minimum capacity threshold defined by regulation. To the extent the Small Generation Aggregator Framework has a bearing on the provision of aggregated grid services, it is through its potential to incentivise the aggregation of distributed generators for energy trading purposes, which creates a 'ready-made' unit of distributed generation whose capabilities might also be deployed as grid services.

[118] There have been various trials nationally and internationally on co-ordinating distributed energy resources for the needs of the network. See UK Power Networks 2015, *Flexible Plug and Play, Closedown Report.*

[119] In general, the more cost reflective customer consumption tariffs, the greater the likely uptake of energy storage and associated technologies. If customers are exposed to the higher prices during peak periods, they have a greater incentive to invest in technologies, such as batteries, that will enable them to avoid drawing energy from the grid during those periods.

[120] A recent survey completed on behalf of the Australian Energy Market Commission identified 21 such companies presently active across the NEM. Oakley Greenwood 2016, *Current Status of Demand Response in the NEM:*

illustrated in Victoria through demonstration projects that are proceeding with the assistance of grants and allowances.

Network provider United Energy has partnered with new energy technology company Greensync to defer capital investment on the Mornington Peninsula using a mix of demand-side measures, including coordinated distributed generation.[121] The capital investment by United Energy would otherwise be required to upgrade the network to meet infrequent high demand that occurs during the summer holiday period. The Community Grids Mornington Peninsula project will proceed with a pilot over the summer of 2016/17, the results of which will inform the project itself, commencing in late 2018.

United Energy has used funds available via an allowance scheme[122] to trial a number of distributed energy resource projects[123] for the purposes of deferring augmentation at seven constrained substations.[124] Separately, network provider Citipower has used funding made available via the same scheme to conduct a residential storage trial in targeted areas within their network. In a similar vein, AusNet Services has used the mechanism to trial battery storage in residential settings, which it used as the basis of a pilot 'mini grid' encompassing 16 houses at Mooroolbark, a suburb in Melbourne.[125]

The examples listed above are instances in which investment has been led by network businesses. However, future investment in these technologies is likely to be driven, in part, by the decisions of energy customers rather than those of traditional energy businesses such as network providers.[126] We therefore consider it appropriate, in the context of the technology changes occurring in the industry, to examine whether small-

interviews with Electricity Retailers and Demand Response Specialist Service Providers, Australian Energy Market Commission, June.

[121] Community Grids Mornington Peninsula project received $554,886 in grant funding from the Victorian Government as part of the Government's New Energy Jobs Fund.

[122] The Demand Management Incentive Allowance (DMIA) scheme.

[123] Such as the Virtual Power Plant (VPP) Project, as described in, United Energy 2016, *Demand Management Incentive Scheme Report – 2015*, July, p. 2.

[124] United Energy 2016, *Submission to the Australian Energy Markets Commissioner on the Local Generation Network Credits Rule Change*, February, p. 3.

[125] Residential battery trial funded via the DMIA.

[126] Energy Networks Association and CSIRO 2015, *Electricity Network Transformation Roadmap – Interim Program Report*, December.

scale distributed generators will have adequate opportunities to monetise the grid services they are capable of providing, now and into the future.

6.3 THE MARKET FOR GRID SERVICES

The primary purchasers of grid services are large monopoly network businesses. By virtue of this status, network businesses have access to more information than individual small-scale distributed generation proponents, who may often be residential households. In these circumstances, it would also be expected that network businesses will have greater bargaining power. Conversely, procuring grid services from multiple small-scale providers may be challenging for network businesses, particularly from the perspective of risk allocation and transaction costs.

Some of these factors are acknowledged in the national regulatory framework, which incentivises monopoly network businesses to appropriately apportion their expenditure between traditional network upgrade projects, such as upgrading the ‘poles and wires’, and non-network solutions, such as using grid services to defer upgrades of the existing network infrastructure. The objective of these incentives is to ensure the grid is built and managed in the most efficient way.

The national framework is orientated towards efficient capital expenditure, and providing at least some opportunities for grid service providers to engage with network businesses. For instance, when undertaking large network upgrades (greater than $5 million), network businesses must run a tender process into which grid service providers may bid.[127]

Chapter 5 showed that the national framework is not geared towards providing opportunities for small-scale grid service providers, such as distributed generators, to participate in the market for grid services.

[127] See discussion of the Regulatory Investment Test – Distribution (RIT-D) in Chapter 5.

6.3.1 THE MARKET FOR GRID SERVICES IN VICTORIA

Although the Australian energy market shares a common national framework, each jurisdiction has unique features that reflect the varying pace of reform, different ownership arrangements, and various models of supply chain integration.

Unlike other jurisdictions in the National Energy Market (NEM), Victoria has almost full penetration of advanced metering infrastructure (AMI), or ‘smart meters’. Smart meters allow grid services to be deployed more easily and at lower cost than is possible under traditional analogue metering. This is because smart metering enables near to real-time remote monitoring of electricity flows to and from customers. Providers in Victoria can therefore provide accurate and timely grid services without the need to install additional metering infrastructure.

The penetration of smart metering within Victoria raises the possibility that opportunities exist in Victoria for the further development of a well-functioning market for grid services that may not presently exist within the other jurisdictions of the national energy market.

So that small-scale providers of grid services in Victoria, including distributed generation, have adequate opportunities to participate in the market for grid services, we believe it important to identify the principles and measures for enabling a well-functioning market in Victoria.

6.3.2 A NETWORK VALUE FEED-IN TARIFF?

The feed-in tariff (FiT) is an instrument that already exists to make payments to small-scale generators on the basis of the value of the energy they produce. We have considered whether this instrument could be used to enable small-scale distributed generation to participate in the market for grid services. However, we found the value of the grid services that distributed generation can provide is too variable – between locations, across times, and between years – to be well suited for remuneration via a broad-based FiT.

A key characteristic of network value is its variability across locations, across the hours of the day, and between years. It varies by location because it manifests in specific, localised sections of the grid rather than across the grid as a whole, or even across geographic regions. Chapter 4 showed that the network value was markedly different even between neighbouring zone substations in Victoria.

This pattern exists across the Victorian network. There may be considerable value at one network asset and zero value at the next. The value in the low voltage portions of the network – which we did not examine because of the absence of publicly available data – may be even more localised and granular.

Network value is also highly dependent on the time of generation. As we showed through our reports during the first stage of this inquiry, the *energy* produced by distributed generation always has a wholesale market value, even if it fluctuates between higher and lower values over the course of the day (in keeping with movements in the electricity wholesale market).

By contrast, to provide *network* value, the output of a distributed generator must coincide with peak network demand in the area of the network to which it is connected. While the network value of distributed generation may be high during network peak periods, for the remainder of the day the distributed generator will provide little or no network value.

An additional layer of complexity is introduced by the fact that the timing of peak demand varies throughout the network. In commercial or industrial areas, the peak may occur in the middle of the day, whereas in residential areas it may occur in the evening. This means there is no uniformity across the network regarding the time of the day at which distributed generation provides network value.

This variation across time and location makes it difficult to express network value through a broad-based FiT. In order to ensure payments to distributed generators accurately reflect the network value they are providing, it would be necessary to construct a tariff structure that reflected the variable nature of that value across time and locations.

This would require a tariff with many location zones, each with a unique time of use structure. Conceivably, the resulting tariff structure could produce different time of use structures for each zone substation in Victoria (of which there are over 220). Establishing such a structure would be costly and complex, and would produce an outcome that was expensive and difficult to administer for network businesses and regulators alike. The exercise would also need to be repeated each year.

Alternatively, the variability of value could be dealt with by 'averaging' the values to reduce the number of location zones and time blocks to a manageable number, so they could reasonably be reflected in a broad-based FiT. However, averaging across time and locations would result in payments being made to distributed generators who were providing no network value.

Equally, those distributed generators that could potentially provide very high levels of network value would receive payments that were significantly lower than the level of benefit they cause.

In short, if a broad-based network value FiT was calculated with sufficient granularity to reflect the underlying network value, it would be disproportionately complex and costly to implement. If it were made simple enough to implement, it would be inadequately reflective of value and could lead to payments to distributed generators who were not providing benefits while, at the same time, not sufficiently rewarding those who were.

This conclusion aligns with the view of the then Victorian Competition and Efficiency Commission (VCEC), in its 2012 inquiry into feed-in tariff arrangements in Victoria, that network value was fundamentally different in character to energy value.[128] The conclusion also aligns with the position taken by the Australian Energy Market Commission (AEMC) in its recent draft determination on a rule change proposal to introduce Local Generation Network Credits (LGNC), another tariff-based instrument.[129]

Even if the issue of time and location variability could be resolved, there remains the issue of year-on-year variability. Victoria's current 'energy value' FiT varies each year based on changes in the wholesale value of electricity. These annual variations are

[128] Victorian Competition and Efficiency Commission 2012, *Power from the People: Inquiry into Distributed Generation,* July, p. XXXVIII.

[129] Australian Energy Market Commission 2016, *Draft Rule Determination – National Electricity Amendment (Local Generation Network Credits) Rule 2016*, September.

relatively minor when compared to the annual variability of network value, which can spike by orders of magnitude, or be reduced to zero, from one year to the next.[130]

The impact on investment of introducing such ‘peaky’ incentives into a FiT, and whether there might be unintended effects, is not clear. For example, incorporating high network values in specific high-value locations into a FiT may cause a surge of investment in distributed generation at that location, only to have the value collapse in the following one to two years due to either the constraint being deferred by the surge in investment or because the network augmentation project eventually becomes necessary and proceeds.

This may prove difficult for individual investors in distributed generators to comprehend or accept, particularly if they have made an investment decision of the basis of the FiT payment that was available in ‘year one’.

Finally, a FiT is by design a limited means by which to remunerate network value because it is paid on the basis of exported electricity – that is, excess energy that is exported by the distributed generator back into the grid – whereas the network value of distributed generation is driven by the entire capacity of the system. Rewarding distributed generators for only the portion of their generation that is exported means some portion of the value they provide would not be remunerated.

For these reasons, the Commission has formed the view that a broad-based FiT is unlikely to be an appropriate means by which to remunerate network value for distributed generation. It is nonetheless desirable that distributed generators are remunerated for the network value they create. We have therefore taken a broader view to this question and sought to explore other means of ensuring appropriate remuneration for network value occurs.

[130] The extent of this annual variability can be influenced by the method used to calculate the value. Some methods apply smoothing functions which mitigate the sharpness of variation. However, even calculation methods that include smoothing functions necessarily produce values that reflect the underlying driver of value, which is the timing of network augmentation projects. This means values retain a high degree of annual variation under any method.

6.4 QUESTIONS FOR STAKEHOLDERS

Examining the potential for distributed generation to be remunerated via a market for grid services is particularly germane at this point in the evolution of the energy sector, due to the emergence of technologies capable of transforming the dominant form of distributed generation, solar PV, from a low-network value to a high-network value distributed energy resource, including at scale.

The emergence of these technologies make it necessary to question whether distributed generators in Victoria will have adequate opportunities to monetise their potential to provide network value as these technologies mature and become mainstream in the years ahead.

6.4.1 SMALL-SCALE PARTICIPATION IN THE GRID SERVICES MARKET

The Commission is seeking to identify the principles by which a market space can be developed that provides adequate opportunities for small-scale grid service providers, including distributed generators, to be remunerated for the grid services they are capable of providing.

The Commission seeks stakeholders' views about the most appropriate *principles* for designing a market space that delivers this outcome in Victoria, given the unique characteristics of this jurisdiction, such as the advanced roll out of smart metering infrastructure.

The Commission also seeks stakeholder input on practical *measures* that might plausibly be implemented in Victoria to support the participation of small-scale grid service providers, including distributed generators, in a well-functioning market for grid services, including through reference to measures that may be in place in international jurisdictions.

Stakeholder suggestions regarding both principles and measures should take into account the nature and pace of technology and market developments. The principles and measures should have regard to matters including but not limited to:

- market access opportunities for small-scale grid services providers, including efficient transaction and settlement

- the availability of information for small-scale grid services providers, in particular the granularity and 'dynamism' of pricing for grid services
- the allocation of risk between network businesses, grid service providers, and third parties
- risks associated with an increasingly dynamic market for grid services
- the costs and benefits associated with any potential regulatory intervention to enable markets for grid services, and
- regulatory oversight.

The Commission will hold public consultation and targeted meetings with stakeholders to explore these questions.

The input from stakeholders will inform the Commission's final recommendations to Government in February 2017 about the most appropriate means by which to facilitate adequate remuneration of distributed generation for network value.

6.4.2 DRAFT FINDINGS

Draft Finding 6: Sources of grid services

Reducing network congestion is a form of 'grid service'. Network congestion can be reduced by a number of means, of which distributed generation is only one. Measures implemented for the purposes of remunerating distributed generation for the provision of grid services could be designed in a way that does not preclude the remuneration of other means of delivering grid services, such as demand response.

Draft Finding 7: A well-functioning market for grid services

Distributed generation in Victoria could be remunerated for its network value through a well-functioning market for grid services, assuming the market for grid services provided adequate opportunities for the participation of small-scale grid service providers, including distributed generation.

Draft Finding 8: A broad-based feed-in tariff is unlikely to be an appropriate mechanism to remunerate network value

A broad-based feed-in tariff is unlikely to be an appropriate mechanism to support the participation of small-scale distributed generation in a market for grid services. If a network value FiT was calculated with sufficient granularity to reflect the underlying network value it would be disproportionately complex and costly to implement. If it were made simple enough to implement, it would be inadequately reflective of value and could lead to payments to distributed generators who were not providing benefits while, at the same time, not sufficiently rewarding those who were.

Draft Finding 9: Opportunities for the grid services market in Victoria

For reasons including but not limited to the roll out of advanced metering infrastructure, there may be opportunities in Victoria for the development of a well-functioning market for grid services that are not currently available in other jurisdictions. This inquiry presents an opportunity to identify the principles and measures by which a market space can be developed in Victoria that provides adequate opportunities for small-scale grid service providers, including distributed generators, to be remunerated for the grid services they are capable of providing.

7 NEXT STEPS

7.1 CONSULTATION

We will now begin an extensive round of consultation across the state. Consultation will take the form of public forums, stakeholder meetings and written submissions.

7.2 PUBLIC FORUMS

We will hold a series of public forums. All members of the public are welcome to attend these forums. These public forums present an opportunity for the public to express their views on the Commission's findings and on the questions posed in this report. Times and locations for the public forums will be made available on our website.

7.3 SUBMISSIONS

We welcome submissions on any topic relevant to this inquiry. In particular, we are seeking submissions to help us answer the questions listed in box 7.1.

BOX 7.1 QUESTIONS FOR RESPONSE

Market for grid services

1. What are the appropriate means to measure the effectiveness of the market for grid services in Victoria?
2. What are the appropriate principles to guide the ongoing development of the market for grid services in Victoria, including any regulatory interventions that might be considered?
3. What opportunities or circumstances exist in Victoria to support the emergence of a well-functioning market for grid services?
4. What are the practical measures that might be considered to enable small-scale grid service providers to participate in the market for grid services, to the extent they are capable of delivering value in that market?

Environmental and social value of distributed generation electricity.

5. Is there additional data and analyses that the Commission should consider in assessing the environmental and social benefits of distributed generation in respect of electricity networks, specifically in terms of identifying, quantifying and valuing those benefits of distributed generation?

Readers are invited to make a submission to this draft report. Submissions do not have to address every question listed in box 7.1.

Submissions should be made by **5pm, Monday 12 December 2016**.

Submissions, preferably in electronic format, and marked Submission to True Value of Distributed Generation Inquiry should be sent:

By email to: DGInquiry@esc.vic.gov.au

By mail to: Distributed Generation Inquiry
Essential Services Commission
Level 37, 2 Lonsdale Street
Melbourne, Victoria 3000

Submissions will be made available on the Commission's website, except for any information that is commercially sensitive or confidential. Submissions should clearly identify which information is sensitive or confidential.

7.4 FINAL REPORT

Our final report into the network value of distributed generation will be completed in February 2017.

APPENDIX A – TABLE OF RESULTS

This appendix presents an extract of the results from the valuation method applied in this inquiry. It inventories the value of the forecast benefit of reduced network congestion caused by distributed generation in Victoria in 2017, presented by zone substation.

The quoted figures incorporate the value of the forecast benefits caused by distributed generation at transmission, sub-transmission and zone substation assets. It does not include the value of the effect of distributed generation on the low voltage distribution network, as this was not possible to calculate on the basis of publicly available data.

Table A.1 should be read as follows:

- The first column of results is the value provided by existing and forecasted solar PV systems in 2017. The value is a $ per kW of solar PV capacity.
- The second column of results is the potential value provided by an additional megawatt (MW) of solar PV system capacity installed on the network in 2017. The value is a $ per kW of solar PV capacity. Note that it is not possible to deduce the value of a single, say 3kW, system of solar PV from this figure. The value provided is a function of the size of the increment that was used for the calculation (i.e. +1MW of capacity). Adding differently sized increments would produce a different average per kW value.
- The third column of results is the potential value provided by an additional megawatt of network-optimised system[131] capacity installed on the network in 2017. The value is a $ per kW of system capacity. Note that it is not possible to deduce the value of a single 'network optimised' distributed generation system from this

[131] A 'network optimised' system is one that provides firm output during periods of network congestion.

figure. The value provided is a function of the size of the increment. Adding differently sized increments would produce a different average per kW value.

- The final column of results is the ratio of value from an additional megawatt capacity network-optimised system compared to a solar PV system.

TABLE A. 1 NETWORK VALUE IN 2017, BY ZONE SUBSTATION ($/kW of capacity of distributed generation system)

Zone Substation Name	Existing and forecast solar PV systems ($/solar kW)	+1MW capacity of solar PV systems ($/solar kW)	+1MW capacity of network-optimised systems ($/kW capacity)	Ratio of network-optimised to solar PV value (#)
Airport West	$9.48	$6.90	$37.41	5.4
Albert Park	-	-	-	-
Altona	-	-	-	-
Altona Chemicals	-	-	-	-
Ararat	$0.01	$0.00	$0.04	10.5
Armadale	$1.64	$1.23	$3.90	3.2
Bacchus Marsh	-	-	-	-
Bairnsdale	$0.91	$0.49	$2.33	4.8
Balaclava	$1.64	$1.23	$3.84	3.1
Ballarat North	$0.01	$0.00	$0.04	10.5
Ballarat South	$0.38	$0.02	$0.75	30.9
Barnawatha	$35.45	$25.82	$178.19	6.9
Bayswater	-	-	-	-
Beaumaris	-	-	-	-
Belgrave	-	-	-	-
Benalla	$0.93	$0.42	$3.13	7.4
Bendigo	$0.42	$0.11	$0.82	7.6
Bentleigh	-	-	-	-
Berwick North	$0.34	$0.17	$0.92	5.4
Boronia	-	-	-	-
Boundary Bend	$0.60	$0.30	$1.11	3.7
Bouverie Queensberry	$1.64	$1.23	$3.84	3.1
Bouverie St/ Queensberry	$1.64	$1.23	$3.84	3.1
Box Hill	-	-	-	-
Braybrook	$9.48	$6.90	$37.41	5.4
Bright	$0.00	-	$0.04	-
Broadmeadows	-	-	-	-

Zone Substation Name	Existing and forecast solar PV systems ($/solar kW)	+1MW capacity of solar PV systems ($/solar kW)	+1MW capacity of network-optimised systems ($/kW capacity)	Ratio of network-optimised to solar PV value (#)
Broadmeadows South	-	-	-	-
Brunswick	-	-	-	-
Brunswick	-	-	-	-
Bulleen	-	-	-	-
Burwood	-	-	-	-
Camberwell	$1.64	$1.23	$3.84	3.1
Camperdown	$1.05	$0.78	$53.50	69.0
Cann River	$0.95	$0.46	$2.08	4.6
Carrum	-	-	-	-
Castlemaine	$0.32	$0.06	$0.93	15.6
Caulfield	$0.30	$0.24	$2.43	9.9
Celestial Avenue	$0.05	$0.05	$0.11	2.3
Charam	-	-	-	-
Charlton	$0.28	$0.06	$0.63	10.8
Cheltenham	-	-	-	-
Chirnside Park	-	-	-	-
Clarinda	-	-	-	-
Clover Flat	-	-	-	-
Clyde North	$9.40	$5.10	$32.29	6.3
Cobden	$1.05	$0.78	$53.50	69.0
Cobram East	-	-	-	-
Coburg North	-	-	-	-
Coburg South	$0.03	$0.02	$0.15	6.3
Cohuna	-	-	-	-
Colac	-	-	-	-
Collingwood	$1.64	$1.23	$3.84	3.1
Collingwood	$1.64	$1.23	$3.84	3.1
Coolaroo	-	-	-	-
Corio	-	-	-	-
Cranbourne	-	-	-	-
Croydon	-	-	-	-
Dandenong	-	-	-	-
Dandenong South	-	-	-	-
Dandenong Valley	-	-	-	-
Deepdene	-	-	-	-
Dock Area	$0.00	$0.00	$0.16	50.1
Docklands	-	-	-	-

Zone Substation Name	Existing and forecast solar PV systems	+1MW capacity of solar PV systems	+1MW capacity of network-optimised systems	Ratio of network-optimised to solar PV value
	($/solar kW)	($/solar kW)	($/kW capacity)	(#)
Doncaster	$0.01	$0.01	$0.09	13.5
Doreen	$1.34	$1.24	$20.11	16.2
Dromana	$0.04	$0.04	$0.53	15.3
Drysdale	$0.66	$0.36	$1.88	5.2
Eaglehawk	$0.47	$0.09	$0.95	10.4
East Burwood	-	-	-	-
East Malvern	-	-	-	-
East Preston (66/22 kV)	-	-	-	-
East Preston Switch House A	-	-	-	-
East Preston Switch House B	-	-	-	-
Echuca	$6.61	$13.48	$43.77	3.2
Elsternwick	-	-	-	-
Eltham	-	-	-	-
Elwood	$1.64	$1.23	$3.84	3.1
Epping	$0.23	$0.13	$0.91	6.9
Essendon	$9.48	$6.90	$37.41	5.4
Fairfield	-	-	-	-
Ferntree Gully	-	-	-	-
Fishermans Bend	-	-	-	-
Fishermans Bend (2)	-	-	-	-
Fitzroy	-	-	-	-
Flemington	-	-	-	-
Flinders/Ramsden	$1.94	$1.50	$4.77	3.2
Footscray East	-	-	-	-
Footscray West	-	-	-	-
Ford North Shore	-	-	-	-
Foster	$0.86	$0.45	$1.99	4.4
Frankston	-	-	-	-
Frankston South	-	-	-	-
Gardiner	$1.64	$1.23	$3.85	3.1
Geelong	$0.11	$0.03	$0.20	7.8
Geelong B	-	-	-	-
Geelong City	$0.10	$0.05	$0.17	3.6
Geelong East	-	-	-	-
Gisborne	$9.48	$6.90	$37.41	5.4
Glen Waverley	-	-	-	-
Hamilton	$1.05	$0.78	$53.50	69.0

Zone Substation Name	Existing and forecast solar PV systems ($/solar kW)	+1MW capacity of solar PV systems ($/solar kW)	+1MW capacity of network-optimised systems ($/kW capacity)	Ratio of network-optimised to solar PV value (#)
Hampton Park	-	-	-	-
Hastings	-	-	-	-
Heatherton	-	-	-	-
Heidelberg	-	-	-	-
Horsham	-	-	-	-
Kalkallo	$0.23	$0.13	$109.83	839.2
Kew	$0.10	$0.09	$0.43	4.6
Keysborough	-	-	-	-
Kilmore South	$4.81	$0.29	$2.22	7.7
Kinglake	$5.19	$0.29	$2.22	7.7
Koroit	$1.05	$0.78	$53.50	69.0
Kyabram	$0.00	-	-	-
Lang Lang	$0.34	$0.17	$0.92	5.4
Langwarrin	-	-	-	-
Laurens Street	-	-	-	-
Laverton	$6.37	$14.44	$118.13	8.2
Laverton North 11	$1.69	$0.78	$4.67	6.0
Laverton North 22	$1.69	$0.78	$4.67	6.0
Leongatha	$0.86	$0.45	$1.99	4.4
Lilydale	-	-	-	-
Little Bourke Street	-	-	-	-
Little Queen	-	-	-	-
Lyndale	-	-	-	-
Lysterfield	$0.34	$0.18	$1.00	5.5
Maffra	$0.91	$0.49	$2.33	4.8
Mansfield	-	-	-	-
Maryborough	$1.30	$0.47	$6.34	13.5
McIllwraith Place	$1.64	$1.23	$3.84	3.1
Melton	$9.48	$6.90	$37.41	5.4
Mentone	-	-	-	-
Merbein	$0.60	$0.30	$1.11	3.7
Merrijig	$2.81	$1.78	$32.91	18.4
Mildura	$0.78	$0.36	$1.30	3.6
Moe	$0.86	$0.45	$1.99	4.4
Montague	-	-	-	-
Moorabbin	-	-	-	-
Mooroopna	$1.27	$0.76	$3.78	5.0

Zone Substation Name	Existing and forecast solar PV systems ($/solar kW)	+1MW capacity of solar PV systems ($/solar kW)	+1MW capacity of network-optimised systems ($/kW capacity)	Ratio of network-optimised to solar PV value (#)
Mordialloc	-	-	-	-
Mornington	-	-	-	-
Morwell	$0.86	$0.45	$1.99	4.4
Mt Beauty	-	-	$10.55	-
Mulgrave	-	-	-	-
Murrindindi	$4.81	$0.29	$2.22	7.7
Myrtleford	$0.00	-	$0.04	-
Narre Warren	$0.34	$0.17	$0.92	5.4
Newmerella	$0.86	$0.45	$1.99	4.4
Newport	-	-	-	-
Nhill	$0.02	$0.01	$0.19	17.6
Noble Park	-	-	-	-
North Brighton	-	-	-	-
North Essendon	-	-	-	-
North Heidelberg	-	-	-	-
Northcote	$0.07	$0.04	$2.68	61.6
Notting Hill	$0.01	$0.01	$0.04	3.6
Nth Richmond	$1.64	$1.23	$3.84	3.1
Numurkah	$0.05	$0.01	$0.31	55.4
Nunawading	-	-	-	-
Oakleigh	-	-	-	-
Oakleigh East	-	-	-	-
Officer	$0.34	$0.17	$0.92	5.4
Ormond	-	-	-	-
Ouyen	-	-	-	-
Pakenham	$0.34	$0.17	$0.92	5.4
Pascoe Vale	$9.48	$6.90	$37.41	5.4
Phillip Island	$5.54	$2.30	$47.85	20.8
Port Melbourne	-	-	-	-
Portland	$1.05	$0.78	$53.50	69.0
Prahran	$1.64	$1.23	$3.84	3.1
Preston	-	-	-	-
Richmond	$4.61	$4.07	$13.43	3.3
Ringwood North	-	-	-	-
Riversdale	$0.06	$0.06	$0.38	6.6
Robinvale	$0.60	$0.30	$1.11	3.7
Rosebud	$0.08	$0.05	$0.57	11.2

Zone Substation Name	Existing and forecast solar PV systems ($/solar kW)	+1MW capacity of solar PV systems ($/solar kW)	+1MW capacity of network-optimised systems ($/kW capacity)	Ratio of network-optimised to solar PV value (#)
Rubicon 'A'	$4.81	$0.29	$2.22	7.7
Russell Place	$1.64	$1.23	$3.84	3.1
Sale	$0.91	$0.49	$2.33	4.8
Sandringham	-	-	-	-
Seymour	$4.81	$0.29	$2.22	7.7
Shepparton	$0.00	$0.00	$0.01	4.1
Shepparton North	$0.76	$0.36	$1.15	3.2
Somerton	$0.23	$0.13	$0.91	6.9
Sorrento	-	-	-	-
South Melbourne	-	-	-	-
South Morang	$0.23	$0.13	$0.91	6.9
Southbank	-	-	-	-
Spencer Street	-	-	-	-
Springvale South	-	-	-	-
Springvale/Springvale West	-	-	-	-
St Albans	$12.63	$9.33	$68.95	7.4
St Kilda	$1.66	$1.24	$3.92	3.2
Stanhope	-	-	-	-
Stawell	$0.06	$0.04	$0.24	6.7
Sunbury	$9.48	$6.90	$37.41	5.4
Sunshine	$13.24	$8.45	$49.87	5.9
Sunshine East	$9.64	$6.96	$37.59	5.4
Surrey Hills	-	-	-	-
Swan Hill	$5.06	$0.18	$0.99	5.4
Sydenham	$9.49	$6.91	$37.48	5.4
Tavistock Place	-	-	-	-
Terang	$1.05	$0.78	$53.50	69.0
Thomastown	$18.11	$2.36	$8.03	3.4
Toorak	$1.64	$1.23	$3.84	3.1
Tottenham	-	-	-	-
Traralgon	$0.91	$0.49	$2.33	4.8
Tullamarine	$9.48	$6.90	$37.41	5.4
Victoria Market	-	-	-	-
Wangaratta	$0.03	$0.03	$0.16	5.9
Warragul	$1.12	$0.56	$2.85	5.1
Warrnambool	$1.05	$0.78	$53.50	69.0
Watsonia	-	-	-	-

Zone Substation Name	Existing and forecast solar PV systems ($/solar kW)	+1MW capacity of solar PV systems ($/solar kW)	+1MW capacity of network-optimised systems ($/kW capacity)	Ratio of network-optimised to solar PV value (#)
Waurn Ponds	$0.45	$0.16	$0.63	3.9
Wemen	$4.19	$4.11	$22.80	5.5
Werribee	$12.47	$1.65	$23.83	14.5
West Brunswick	$0.11	$0.09	$0.32	3.5
West Doncaster	-	-	-	-
Westgate	-	-	-	-
Winchelsea	-	-	-	-
Wodonga	$13.93	$8.39	$28.92	3.4
Wonthaggi	$1.77	$0.92	$10.20	11.1
Woodend	$9.48	$6.90	$37.41	5.4
Woori Yallock	-	-	-	-
Yarraville	-	-	-	-

APPENDIX B – TERMS OF REFERENCE

TERMS OF REFERENCE – INQUIRY INTO THE TRUE VALUE OF DISTRIBUTED GENERATION TO VICTORIAN CONSUMERS

The Andrews Labor Government recognises the importance of renewable energy for Victoria. We acknowledge sustainable sources of energy can deliver economic, environmental and social benefits to the State, including jobs for regional Victoria.

The Labor Government is acting to support the growth of renewable energy in Victoria through a suite of policy measures. These include:

- Establishing a renewable energy target of no less than 20 per cent by 2020.
- Using the government's electricity purchasing power to support the creation of hundreds of renewable energy jobs.
- Ending unfair discrimination for solar customers.
- Helping communities to transition to a clean energy future.
- Improving access to the grid for solar customers.
- Developing a Renewable Energy Action Plan.

Supporting clean energy jobs through the $20 million New Energy Jobs Fund.

An important source of renewable energy for Victoria is distributed generation, such as household solar systems. In Victoria, there are over 245,000 solar systems installed across the State, with a total generation capacity of over 700 megawatts.

The Labor Government believes Victorians with small-scale renewable energy generation should be fairly compensated for the value their generation provides. In Opposition, we committed to undertake an inquiry into the true value of distributed generation. In Government, we are getting on with it, and asking the Essential Services Commission to commence this inquiry.

The inquiry will seek to ascertain the true value of distributed generation, including determining what value distributed generation provides to the electricity market and the network. The Essential Services Commission will also be asked to consider the environmental and social value of distributed generation.

The findings of the inquiry will help inform the design of the feed-in-tariff arrangements in Victoria and assess current frameworks for the compensation of network value of distributed generation by relevant Victorian Electricity Industry Guidelines and the National Electricity Rules.

SCOPE OF THE INQUIRY

The inquiry will:

1. Examine the value of distributed generation including: the value of distributed generation for the wholesale electricity market; the value of distributed generation for the planning, investment and operation of the electricity network; and the environmental and social value of distributed generation.
2. Assess the adequacy of the current policy and regulatory frameworks governing the remuneration of distributed generation for the identified value it provides.
3. Make recommendations for any policy and or regulatory reform required to ensure effective compensation of the value of distributed generation in Victoria. These recommendations should have regard to the most appropriate policy and regulatory mechanisms for compensating different benefits of distributed generation, including considering their practicality and costs.

The inquiry will not consider the policy and regulatory frameworks governing the costs of connecting distributed generation to the network. The inquiry will also not consider whether the feed-in-tariff should be deregulated.

The inquiry should have regard to reviews and reports completed in Victoria and other jurisdictions which may be relevant to the objectives of this inquiry.

The inquiry will involve extensive consultation with industry, environmental organisations and consumer advocacy groups.

STRUCTURE OF THE INQUIRY

PART 1. THE TRUE ENERGY VALUE OF DISTRIBUTED GENERATION

This part of the inquiry will examine the social, environmental, locational and temporal value of energy produced by distributed generation. The analysis will be completed in time to inform the next FiT decision in August 2016 (for effect in calendar year 2017).

The outputs of this part of the inquiry are:

- Output 1: Approach Paper

This Paper should be presented to Government by the end of 2015.

- Output 2: Draft Part 1 Report into the true energy value of distributed generation

This Report should be presented to Government by April 2016.

- Output 3: Final Part 1 Report

This Report should be presented to Government by August 2016.

PART 2. THE TRUE NETWORK VALUE OF DISTRIBUTED GENERATION

This part of the inquiry will seek to account for the impact on the network of investment in distributed generation.

The outputs of this part of the inquiry are:

- Output 4: Discussion Paper on network value of distributed generation

This Paper should be presented to Government in the first half of 2016.

- Output 5: Draft Part 2 Report (methodology) on network value of distributed generation

This Report should be presented to Government by October 2016.

- Output 6: Final Part 2 Report (methodology) and on network value of distributed generation

This Report should be presented to Government by February 2017.

APPENDIX C – LIST OF REFERENCES

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