ESSENTIAL SERVICES COMMISSION

THE ENERGY VALUE OF DISTRIBUTED GENERATION

Distributed Generation Inquiry Stage 1 Draft Report

April 2016

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CHAIRPERSON'S INTRODUCTION

For the last few years, Victoria has operated a single, flat Feed in Tariff (FiT) at all times of day and in all places across the state. The payment made to distributed generators for the electricity they export has been the same irrespective of whether that electricity is being delivered at a time of high demand or at a time when supply is in abundance. Similarly, the payment to a distributed generator in a region where a considerable amount of electricity is lost as it is transported across the State, is no more than in areas where electricity can be delivered with significantly fewer losses. As such, the current FiT arrangements do not provide a signal that distinguishes between investment in distributed generation in areas where it is potentially most valuable or at times when the electricity produced (and exported) can provide the greatest benefit.

In this report, we explore different opportunities through which a redesigned FiT can signal to investors, and potential investors, the 'true value' of the electricity they may have available for export into the electricity system. There are almost endless options available each with its own relative merits. We have sought to lay out as openly as possible the matters we considered when reaching our draft recommendations regarding the opportunity to redesign Victoria's feed in tariff arrangements.

We have also been requested to consider how investors in distributed generation can be renumerated for the environmental and social benefits arising by virtue of that investment. This task has been proven particularly challenging due to incomplete data about the scale of those benefits or how they might be attributed to distributed generation. One area in which we felt we could complete the task with confidence was in regard to the value of the emission avoided when distributed generation of low emissions intensity displaces centrally dispatched electricity. Because these benefits are proportional to the total output of a distributed generation unit, and because we do not meter this output directly, we have proposed a methodology for deeming output and the value of the emissions avoided as a result.

Under our proposal, investors in distributed generation would therefore receive two payment streams: a feed in tariff (FiT) reflecting the market value of the electricity they export and a deemed output tariff (DOT) reflecting the value of the emissions avoided as a result of their investment.

Importantly, the scope of the benefits we investigate in this draft report does not extend to the benefits distributed generation may produce for the more efficient operation of the distribution network. That work will commence with the release of a discussion paper in June.

In the meantime, we will be consulting widely on the proposals outlined in this draft report and we welcome written submissions from interested parties. As already mentioned, there remain some significant gaps in the data we been able to source. We would be particularly grateful for any guidance respondents can provide about the numerous questions listed at the end of this report.

Dr Ron Ben-David
Chairperson

GLOSSARY

Distributed generation	Refer to section 3.2.1
Emissions intensity	A measure of the greenhouse gas emitted per unit of energy produced
Emissions intensity factor	The number of kilograms of CO_2-e emissions per kWh of electricity generated
Gross output	The total electricity generated by a distributed generation system
Line losses	Electricity that is lost while being transported through the grid
Marginal generator	The last (and most expensive) generator selling electricity at any point in time until demand is met
Net output	The electricity generated by a distributed generation system and exported into the grid
Output profile	The pattern of electricity produced across time by a distributed generation technology

ACRONYMS

AEMO	Australian Energy Market Operator
ATSE	Australian Academy of Technological Sciences and Engineering
CER	Clean Energy Regulator
COAG	Council of Australian Governments
CPRS	Carbon Pollution Reduction Scheme
DG	Distributed generation
DGT	Distributed Generation Tariff
EJA	Environmental Justice Australia
EPA Victoria	The Environment Protection Authority of Victoria
ERF	The Commonwealth Emissions Reduction Fund
EU ETS	The European Union Emission Trading Scheme
FiT	Feed-in tariff
GHG	Greenhouse gas
ICT	Information and communication technology

IPART	Independent Pricing and Regulatory Tribunal
kVA	Kilovolt-amp
kW	Kilowatt
kWh	Kilowatt hour
MSGA	Market Small Generation Aggregator
MEI	Melbourne Energy Institute
MW	Megawatt
NEM	National Electricity Market
NO_x	Nitrogen oxide
NPI	National Pollution Inventory
NSW EPA	NSW Environment Protection Authority
PFIT	Premium Feed-in Tariff
PM	Particulate matter
$PM_{2.5}$	Fine particulate matter, with a diameter of less than 2.5 micrometres
PV	Photovoltaic
RET	Renewable Energy Target
RRN	Regional Reference Node
SC-CO_2	Social cost of carbon
SGAF	Small Generation Aggregation Framework
SFIT	Standard Feed-in Tariff

SO_2	Sulphur dioxide
SRES	Small-scale Renewable Energy Scheme
TFIT	Transitional Feed-in Tariff
VCEC	Victorian Competition and Efficiency Commission
VNM	Virtual Net Metering

CONTENTS

SUMMARY

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 true *energy value* and true *network value* of distributed generation. We also proposed extending the timelines. The Government accepted the proposed changes and issued revised terms of reference in December 2015.

Within this new inquiry structure, this Draft Report addresses the energy value of distributed generation. The network value of distributed generation will be addressed through a separate series of reports in the second half of 2016.

Scope of the inquiry

The terms of reference set out the Government's expectation that payments made via Victoria's existing minimum feed-in tariff (FiT), or similar instrument, would reflect the 'true value' of distributed generation, understood as the direct value of distributed generation in the wholesale electricity market as well as the value of its indirect contributions to environmental and social outcomes.

The Commission's task in this inquiry is to identify the various direct and indirect benefits as a result of distributed generation electricity 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 an appropriately designed payment mechanism.

We have interpreted the terms of reference of this inquiry to reflect the Government's ongoing commitment to provide regulated payments to owners of distributed generation for the value it delivers. We have not assessed alternative policy options for promoting investment in distributed generation or assessed alternative policy options for achieving the indirect effects that were identified as having been derived from investment in distributed generation.

We have limited the analysis to the true value of direct and indirect benefits associated with distributed generation. This means we do not countenance an expansion of the FiT to cover other actions customers may take to reduce their demand; other strategies that may be implemented to reduce the emissions intensity of electricity supply; or other steps that may be taken to reduce demands on the network.

Purpose of this report

Through this Draft Report, the Commission seeks to respond to the following questions arising out of the terms of reference:

- What is the value in the wholesale electricity market of the electricity produced by distributed generation?
- What is the value of the environmental and social effects caused by the electricity produced by distributed generation?
- To what extent does the current policy and regulatory framework lead to appropriate remuneration to owners of distributed generation systems for the value distributed generation electricity provides in the wholesale market, and for the value of its social and environmental benefits?
- What reform is needed to the framework to ensure the effective compensation of the energy value of distributed generation?

THE COMMISSION'S DRAFT FINDINGS

The value of distributed generation in the wholesale electricity market

The value distributed generation provides to consumers via the wholesale electricity market is a function of the amount and timing of electricity that is 'exported' to the grid, and is determined primarily by the wholesale electricity spot price.[1] The 'exported' electricity from distributed generation is a substitute source of electricity that consumers otherwise would have purchased, via their retailers, from the wholesale market.

This approach is in keeping with those of comparable processes in other Australian jurisdictions, as well as past Commission positions. As the wholesale electricity spot price varies every half hour, so the value of distributed generated electricity also varies every half hour.

The value of electricity produced by distributed generators and purchased by consumers, via their retailers, should also account for line losses that are avoided as a result of the electricity not being transported long distances (as would be the case for centrally dispatched electricity), and for any avoided market and ancillary fees. As above, this approach is consistent with the views of regulators in other Australian jurisdictions, and with past Commission decisions.

The environmental and social value and distributed generation

The Commission has concluded that the most readily identified, quantified and valued area of environmental value is the reduced emission of greenhouse gases. The electricity produced by distributed generation may displace more emissions intensive generation, and thereby contribute to the abatement of greenhouse gases. This benefit is provided by the total electricity output produced by a distributed generator (i.e. the gross output), not just the portion which is exported.

[1] Typically, some portion of the energy produced by distributed generation is consumed on site and some portion is exported.

The Commission has not sought to place a monetary value on the environmental value of avoided emissions. Instead, the Commission has proposed a methodology for calculating the *volume* of greenhouse abatement for various forms of distributed generation, to which a value for that abatement may be applied.

The Commission acknowledges that there may be other environmental and social benefits of distributed generation. The Commission did not find data capable of supporting a monetary value being assigned to these social and environmental benefits.

Assessment of the existing regulatory and policy framework

The current regulatory and policy framework provides a limited mechanism, via the minimum FiT, to compensate proponents of distributed generation for the value of its exported electricity to the wholesale market. By restricting the FiT to a single tariff across all times and locations, the current framework does not closely reflect of the value of those exports in the wholesale market.

The current FiT framework makes no provision for compensating owners of distributed generation for the environmental or social value produced by distributed generated electricity. A FiT is not suited to facilitating payments based on the gross output of a distributed generation system, as it was designed as a mechanism to facilitate payments for electricity that is exported (i.e. the net output).

Impact on electricity consumers

The Commission recognises that the proposed framework will have implementation costs for retailers which are likely to be passed through to customers over the longer term.

The Commission's considers that the proposed multi-rate feed-in tariff would not pose significant ongoing costs on Victorian customers relative to those posed by current feed-in tariff mechanism. The mechanism is designed to reflect, on average, the wholesale market price that retailers would have paid had they purchased electricity from the wholesale market instead of from a distributed generator. Compensating distributed generators for environmental and social value will increase the cost to Victorian electricity consumers, depending on the level at which the environmental and social values are set. The level of environmental and social values should be set having regard to the cost to consumers.

The Commission's draft recommendations

Draft Recommendation 1: Basis for calculating the Feed in Tariff

The feed-in tariff should continue to be calculated annually, having regard to wholesale market prices and any distribution and transmission losses avoided in Victoria by the supply of distributed generation electricity.

Draft Recommendation 2: Eligibility for payments

Solar photovoltaic (PV), wind, hydro and biomass remain eligible technologies for receipt of feed-in tariff payments[2], and eligibility be retained for units up to a generating capacity of 100kW.

Draft Recommendation 3: Multi-rate feed-in tariffs

The current single tariff should be replaced by a framework that allows for a time and location varying feed-in tariff that more closely reflects the underlying wholesale price of electricity.

Draft Recommendation 4: Time-varying feed-in tariffs

The Commission sets a multi-rate feed-in tariff to align with the time blocks operating for flexible retail prices (namely: peak, shoulder and off-peak). The time varying feed-in tariff should be supplemented with a 'critical peak' tariff that would be paid when the wholesale price of electricity is equal to or exceeds $300 per MWh. The time varying feed-in tariffs should be calculated by the Commission on an annual basis.

Draft Recommendation 5: Locational feed in tariffs

The Commission sets a multi-rate feed-in tariff that divides Victoria into two regions reflecting the different average line losses across the state. The two regions would

[2] The Commission notes that the legislation that establishes the FiT framework also provides a mechanism for other forms of distributed generation to be involved in the framework.

consist of (i) Melbourne, Geelong and the east of the state; and (ii) the north and west of the state. Higher line losses would apply in the north and west of the state.

Draft Recommendation 6: Fully reflective feed in tariff

If an electricity retailer is able to offer a feed-in tariff that fully reflects the half hourly prices in the wholesale market, and the distributed generator provides express and informed consent when accepting that tariff option, then the retailer's obligation to offer the regulated feed-in tariff rates as proposed in this draft report should be suspended for the duration of that agreement.

Draft Recommendation 7: The environmental and social value of distributed generation

The environmental and social value of distributed generation should be reflected in a deemed output tariff that is paid to a distributed generator based on the deemed output of the distributed generation system, where that output can be reliably estimated. The Commission considers that the deemed output of solar and wind systems can be reliably estimated using factors published in the *Renewable Energy Target (Electricity) Regulations 2001 (Cth).* The deemed output of other distributed generation systems cannot be estimated reliably at this time.

Draft Recommendation 8: The value of avoided emissions

The deemed output tariff for 2017 should be calculated to account for the value of the greenhouse gas emissions avoided as a result of distributed generation displacing the marginal generator in the wholesale electricity market. Avoided emissions should be calculated by the Commission on an annual basis for each of the eligible technologies.

Draft Recommendation 9: Minimum tariffs

The regulated tariff structure should continue to impose a minimum obligation on retailers. Retailers should be able to offer higher rates on any one or more of the components of the minimum feed-in tariff, deemed output tariff or both, as set on an annual basis by the Essential Services Commission.

Draft Recommendation 10: Reviewing tariffs

Each year, the Commission should review the value of the feed-in tariff and the deemed output tariff for the year ahead. If additional, reliable information becomes available, the deemed output tariff should be adjusted at yearly intervals to reflect other social and environmental benefits.

Draft Recommendation 11: Reviewing the tariff structure

The time block structure and location zones of the flexible feed-in tariff, once established, should remain unchanged for an appropriate period. As a starting point, this period should be three years unless market characteristics change widely enough to warrant the Commission reviewing the tariff structure in an earlier timeframe.

1 INTRODUCTION

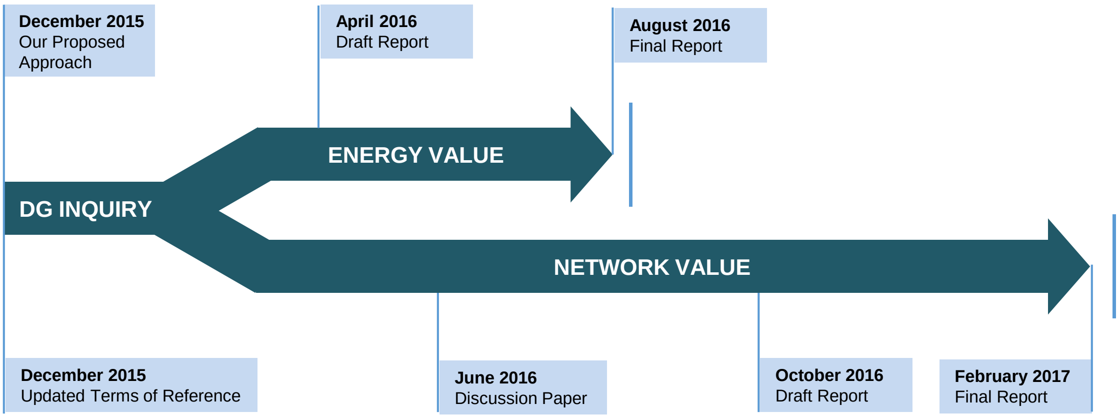
1.1 BACKGROUND

In September 2015, the Essential Services Commission (the Commission) received terms of reference from the Minister for Finance (in consultation with the Minister for Energy and Resources) under section 41 of the *Essential Services Act 2001*, to conduct an inquiry into the true value of distributed generation.

In December 2015, we released a paper setting out the Commission's proposed approach to the inquiry. In that paper we proposed splitting the inquiry into two parts, corresponding to the separate challenges of determining the true *energy value* and true *network value* of distributed generation. We also proposed an extension to the timeframes of the inquiry.

The Minister for Finance (in consultation with the Minister for Energy and Resources) accepted our proposal and issued amended terms of reference in December 2015 (attached).

FIGURE 1.1 INQUIRY STRUCTURE



Consultation on our approach paper closed on 12 February 2016. We received 2,553 submissions.

1.2 PURPOSE

This Draft Report sets out the Commission's draft findings with regard to the *energy value* of distributed generation, and our recommended amendments to the regulatory framework to enable that value to be translated into payments to owners of distributed generation.

This Draft Report does not address the *network value* of distributed generation.[3] As figure 1.1 illustrates, questions of network value will be addressed through a separate series of reports starting in June 2016.

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 scope of the inquiry
- Chapter 3 explains the Commission's method for determining the energy value of distributed generation
- Chapter 4 presents the Commission's preliminary findings with regard to energy value of distributed generation in the wholesale electricity market
- Chapter 5 presents the Commission's preliminary findings with regard to environmental and social value produced by the distributed generation electricity
- Chapter 6 presents the Commission's proposal for translating the value of distributed generation into a payment to owners of distributed generation
- Chapter 7 sets out the next steps for the inquiry including public consultation

[3] 'Network value' refers to the value of distributed generation for the planning, investment and operation of the electricity network, as well as any social and environmental benefits that arise as a result of those changes to the network.

2 CONTEXT

2.1 CONTEXT TO 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 over 880 megawatts (MW).[4] By way of comparison, total electricity generation capacity in Victoria is estimated at 13,169 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 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.

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[4] Small scale distributed generation refers to systems with a capacity of less than 100 kilowatts (kW). Data is ESC estimation, 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*, 1 March 2016. There is less publicly available data on the amount of distributed generation currently deployed in Victoria in the 100kW-5 megawatt (MW) range. However data from the Australian Energy regulator (AER) suggest the amount of deployed capacity in this range is small relative to that deployed in the small-scale category.

[5] ESC estimation, based existing in service scheduled, semi-scheduled and non-scheduled generation nameplate capacity in Victoria from Australian Energy Market Operator (AEMO) 2016, *Regional generation information pages: Victorian Summary,* 10 March 2016, data from the Clean Energy Regulator 2016 for small-scale systems, and data on 100kW-1MW solar systems from Sunwiz 2016, *Database of Australian Commercial Solar Power Projects, http://solardatabase.sunwiz.com.au/*, accessed 31 March.

[6] ESC estimation, based on data from CER 2016, *Postcode data for small-scale installations,* 1 March 2016, and estimated yearly Victorian solar PV electricity production from ACIL Allen Consulting.

[7] ESC estimation, based on data from CER 2016, *Postcode data for small-scale installations,* 1 March 2016, and estimated yearly Victorian wind power electricity production from ACIL Allen Consulting.

The small scale of most distributed generation limits the capacity of an individual distributed generator to access the wholesale market directly and therefore to negotiate a price for their exported electricity.

2.1.1 CURRENT REGULATORY FRAMEWORK

The regulatory schemes that currently apply directly to the energy value of distributed generation in Victoria are:

- Feed-in tariffs (Victoria)
- Renewable Energy Target (Commonwealth)

Indirectly, distributed generators can also take advantage of the Small Generation Aggregation Framework (SGAF) under rules that apply to wholesale market participants.

Each of these mechanisms is summarised below.[8]

FEED-IN TARIFFS

Since 2004, there have been a range of FiTs in Victoria, and their policy objectives have evolved over time.

The objectives of the early FiTs were focused on industry development.[9] They were set at a level designed to stimulate a high level of installation of distributed generation, particularly rooftop solar energy.[10] A description of each FiT is provided in box 2.1.

[8] Note, Virtual Net Metering (VNM) is not included in this discussion of the current regulatory framework because it is not enabled by a regulatory instrument and is instead a matter of commercial negotiation. VNM refers to arrangements whereby exported output from a distributed generator is used to meet another consumers' demand in a 'virtual' sense. There is no physical transfer of electricity, but the 'receiving' consumers' bill is reduced (netted-off) by the equivalent amount. Under a VNM arrangement, an entity that owns more than one building, such as a local council, could use the excess generation from, say, a solar system installed on one building it operates, to offset electricity demand on another building it operates.

[9] Batchelor P 2009, Minister for Energy and Resources, Electricity Industry Amendment (Premium Solar Feed-in Tariff) Bill Second Reading, Assembly, VicHansard, Book 3, Thursday 12 March 2009, p. 789.

[10] O'Brien M 2011, Minister for Energy and Resources, Electricity Industry Amendment (Transitional Feed-in Tariff Scheme) Bill Second Reading, Assembly, VicHansard, Book 14, Wednesday 12 October 2011, p. 3674.

BOX 2.1 FEED-IN TARIFFS IN VICTORIA

There are four FiT schemes in Victoria. Three are closed to new applications. Customers already receiving feed-in-tariff payments under one of the three closed schemes may continue to receive these payments for many years to come.

THE PREMIUM FEED-IN TARIFF (PFIT)

The PFIT started in late 2009 and closed to new applicants at the end of 2011.The scheme offered eligible households, businesses and community organisations with small-scale solar systems of five kilowatts (kW) or less a credit of at least 60 cents per kilowatt hour (kWh) for electricity fed back into the grid. Eligible properties with an effective PFIT contract will continue to receive this rate until 2024, provided they do not add extra solar panels to their system.

TRANSITIONAL FEED-IN TARIFF (TFIT)

The TFIT replaced the PFIT in 2011 and closed to new customers on 31 December 2012. The TFIT scheme offered eligible properties with small-scale solar PV systems of five kilowatts or less a minimum credit of 25 cents per kilowatt hour for excess electricity fed back into the grid. Eligible premises with an effective TFIT contract in place will continue to receive this rate until 31 December 2016, provided they do not add extra solar panels to their system.

STANDARD FEED-IN TARIFF (SFIT)

The SFIT commenced in January 2008 and closed to new applicants on 31 December 2012. Eligible properties with an effective SFIT contract will continue to receive payments under this scheme until 31 December 2016, provided customers maintain their eligibility under the scheme. The SFIT provided a 'one-for-one' payment for exports based on the retail electricity rates paid by the customer.

MINIMUM FEED-IN TARIFF (CURRENT)

The current Victorian FiT commenced on 1 January 2013. The FiT is designed to reflect the wholesale market value of the distributed generation. Renewable energy technologies such as solar, wind, hydro and biomass with a system size of less than 100 kW are eligible for the scheme.

Source: Essential Services Commission (ESC) (Victoria)

As the industry developed, the level of FiTs has been progressively reduced for new entrants. Two of the earlier FiT schemes will end at the end of 2016. Distributed generation producers who had previously been in these schemes will be eligible to transfer to the current FiT scheme from the start of 2017.

The current FiT is designed to enable individuals who deploy distributed generation to obtain a price for the electricity they export based on the wholesale electricity market price. That is, the FiT represents the price at which (on average) consumers would be indifferent between purchasing their electricity, via their retailer, in the wholesale market or purchasing it from distributed generators.

RENEWABLE ENERGY TARGET

The other element of the regulatory framework that has a bearing on the electricity produced by the most common (renewable) forms of distributed generation is the Commonwealth Government's Renewable Energy Target (RET). Distributed generation suppliers that use eligible technologies can receive payments under the RET in recognition of the renewable generation they provide. More information about the RET can be found in our approach paper and in section 5.3.1.

SMALL GENERATION AGGREGATION FRAMEWORK

Beyond the FiT and the RET, there is a furtheroption – aggregation under the Small Generation Aggregation Framework (SGAF) – that could provide a pathway for a distributed generator to realise value for the electricity they generate. Under the SGAF, generators under 5 MW in capacity can join a Market Small Generation Aggregator (MSGA) who will trade the generation into the market on their behalf. The Aggregator is a registered participant in the market and trades the aggregated output into the spot market and is paid the market price for the generation.

We understand that this option is neither fully developed nor considered mainstream, and nor does not appear to be well suited for small generators. So we did not consider the SGAF option further in this report. but we welcome input from stakeholders on the efficacy of this framework for small scale distributed generation.

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 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 terms of reference also state that the findings of the inquiry will help inform the design of the feed-in tariff arrangements in Victoria, and that the inquiry will not consider the question of whether the feed-in tariff should be deregulated.

Stakeholders expressed a range of views about how the terms of reference should be interpreted. Some submissions argued for a broad interpretation. Environmental Justice Australia, for example, argued the terms of reference imply the Commission should engage in a 'more wide ranging discussion of the value of distributed energy that includes its potential value and anticipated value in future'.[11] Meanwhile, Mr Alan Pears and the Melbourne Energy Institute (MEI) argued that the inquiry should extend beyond distributed generation to encompass other forms of energy services that change marginal demand profiles, such as energy efficiency and demand management.[12]

[11] Environmental Justice Australia 2015, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation,* February, p. 2.

[12] Alan Pears 2015, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation,* February, p. 7; Melbourne Energy Institute 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation - Proposed Approach Paper,* February, p. 5.

These broader policy considerations lie beyond the scope of the terms of reference for this inquiry, which are narrower than these proposals imply. Broader policy outcomes, including those raised by Environmental Justice of Australia, MEI and Mr Pears, are more appropriately considered in policy reviews such as the Inquiry into Distributed Generation conducted by the then Victorian Competition and Efficiency Commission (VCEC) in 2012.[13]

The terms of reference set out the Government's expectation that payments made via the FiT, or similar instrument, would reflect the 'true value' of distributed generation. This is understood as the direct value of distributed generation in the energy market as well as its indirect contributions to environmental and social benefits (see chapter 5).

The Commission's task in this inquiry is to identify the various direct and indirect benefits of 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 an appropriately designed payment mechanism.

Electricity generated by distributed generation and used by the host displaces demand for centrally dispatched electricity.[14] To the extent that some electricity from a distributed generator is exported, it also supplements the supply of electricity sourced by retailers via the wholesale market. We discuss the value of this exported electricity in chapter 4.

The electricity produced by distributed generation may also have indirect effects, such as reducing greenhouse gas emissions (to the extent that it displaces centrally dispatched generation with a higher emissions intensity). In chapter 5 we explore a range of indirect effects and their potential to produce social or environmental benefits.

The calculation of monetary value undertaken in this inquiry is limited to the direct and indirect benefits that can be associated with investment in distributed generation. The inquiry does not extend to examining:

[13] Victorian Competition and Efficiency Commission 2012, *Power from the People: Inquiry into distributed generation – Final Report,* July.

[14] Centrally dispatched electricity is also referred to as 'large scale generation' or 'centralised generation'.

- an expansion of the 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.

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.

In examining the value of social and environmental benefits from distributed generation, the Commission recognises that there is a range of possible policies and mechanisms by which these benefits could be realised. However, the terms of reference for this inquiry do not ask the Commission to evaluate the costs and benefits of different options for delivering environmental and social benefits across the economy, but ask us to focus on how any environmental and social benefit arising from the investment in distributed generation can be realised in the value of the FiT.

We anticipate that the FiT will be reviewed periodically and more broadly to determine whether it is an effective and efficient policy tool for reflecting these values, and to ensure it takes account of both technological and policy developments at a State, National and Commonwealth level.

2.2.2 GUIDING PRINCIPLES OF THE INQUIRY

In developing our approach to this inquiry, we adopted three principles to guide our work. The principles received broad support in submissions. However, in light of stakeholder comments we have refined our explanations of materiality and behavioural response. These refined principles are:

- **Simplicity.** The benefits must be readily convertible into a payment structure that is simple to understand (and administer) by all relevant market participants.
- **Behavioural response.** A proposed tariff structure must align signals for investment in, and use of, distributed generation with the benefits (direct and indirect) identified through this inquiry.

- **Materiality.** The monetary value of 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.[15] Additionally, the Commission has regard to its objectives under the *Electricity Industry Act 2000*, which include promoting the development of full retail competition and promoting protections for customers, including protections for customers facing payment difficulties.[16]

2.3 STAKEHOLDER FEEDBACK ON THE SCOPE OF THE INQUIRY

The large number of submissions we received indicates a strong interest in this inquiry. We received submissions from a wide array of stakeholders, including academics, energy industry organisations, renewable industry bodies and environmental groups. We also received around 2370 submissions from individuals, many of which were owners of solar PV panels.

Beyond views on the breadth of the inquiry that we discussed in the previous section, stakeholders expressed a range of views on the scope of the inquiry. These views broadly fell into three categories:

- the value of distributed generation to electricity networks
- Government support for the renewable energy and energy storage industries
- the basis for measuring 'true value'

Each of these is summarised below.

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[15] Section 8, *Essential Services Commission Act 2001* (Vic.), *http://www.esc.vic.gov.au/getattachment/d6250f4c-a1cc-44de-a756-5a2d634842b7/Essential-Services-Commission-Act-2001-incorporati.pdf*.

[16] Section 10, *Electricity Industry Act 2000 (Vic)*, *http://www.legislation.vic.gov.au/domino/Web_Notes/LDMS/LTObject_Store/ltobjst9.nsf/DDE300B846EED9C7CA257616000A3571/AD5D6A020E04FB43CA257F2A00025F1C/$FILE/00-68aa076%20authorised.pdf*

VALUE OF DISTRIBUTED GENERATION TO ELECTRICITY NETWORKS

Many submissions referred to the network value of distributed generation, including managing peak demand, and expressed concern about over investment in electricity networks. These submissions are not considered in this report but will be addressed in the second stage of the inquiry into network value in second half of 2016.

GOVERNMENT SUPPORT FOR RENEWABLE ENERGY AND ENERGY STORAGE INDUSTRIES

Other submissions made statements reflecting a policy preference that Government should promote industry development. Around 80 submissions that suggested the Government should take steps to support to the solar industry, while a further 13 stated that the Government should support the development of electricity storage technology. However, the terms of reference do not extend to the Commission examining options for industry development within the renewables sector or for energy storage.

THE BASIS FOR MEASURING 'TRUE VALUE'

A prevailing argument within submissions from owners of solar PV systems was of dissatisfaction with a perceived 'unfair advantage' that energy retailers obtain through the current FiT arrangements. This was reflected through a view that was present in a majority of submissions from solar owners and representatives such as the Dandenong Ranges Renewable Energy Association – namely, that a 'true value' FiT should be set based on a '1-for-1' principle.[17]

The concept of the 1-for-1 principle is that the rate a consumer is paid for their distributed generation exports should be equal to the rate they pay for the electricity they purchase from a retailer (their 'retail price'). Many submissions made the case that a feed-in tariff that was set lower than the retail price was not only 'unfair' but also enabled energy retailers to resell that energy at a profit.

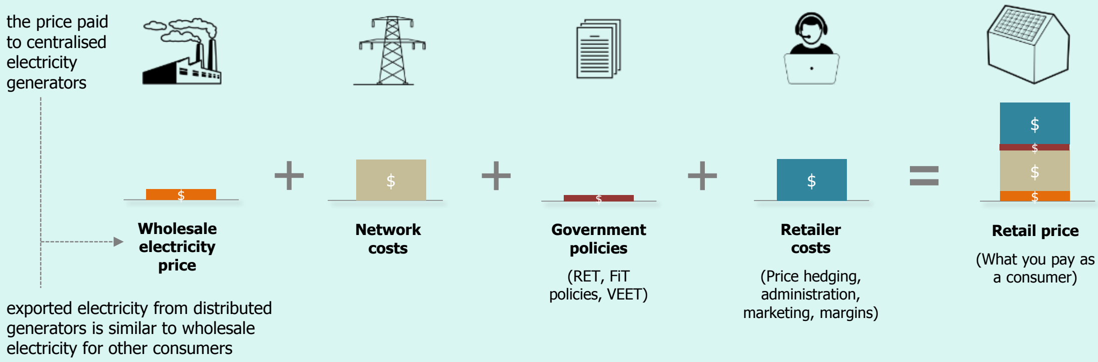
Box 2.2 explains why the 1-for-1 principle does not reflect the 'true value' of the electricity produced by distributed generation.

[17] Dandenong Ranges Renewable Energy Association 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation,* February, p. 1

BOX 2.2 WHY THE 1-FOR-1 PRINCIPLE DOES NOT EQUATE TO 'TRUE VALUE'

The price of electricity paid by the consumer (for example a household customer) is known as the retail price for electricity. The retail price is comprised of several components: the wholesale price of electricity, network costs, the retailer's cost of complying with government policies,[18] administrative costs to operate as an energy retailer, plus a return on the capital invested by the retailer. As shown in figure 2.1, the wholesale price of electricity is only one component of the retailer price that customers pay.

FIGURE 2.1 COMPOSITION OF THE RETAIL PRICE OF ELECTRICITY



Source: ESC, based on Australian Energy Market Commission *2015 Residential Electricity Price Trends*, December. The illustration of the extent of retail price breakdowns is broadly representative of AEMC data.

Exporters of distributed generation could, at least notionally, enter the supply chain at two points. They could enter the supply chain in competition to other generators at the wholesale end of the market. If they were to do so, they would be required to sell their energy at a price comparable (or better than) the price sought by other generators. If they failed to do so, it would be unlikely that they would find any buyers for their electricity. In this sense, no matter what costs they incurred in producing their electricity, distributed generators could earn no more the than 'going price' in the wholesale market.

[18] 'Government policies' refers to costs associated with complying with State and Commonwealth environmental policies such as the Renewable Energy Target (RET).

The second alternative (at least notionally) would see exporters of distributed generation entering the market at the retail end of the supply chain — in which case they would be competing with energy retailers rather than other generators. If that were the case, exporters of distributed generation would receive the 'going price' in the retail market rather than the wholesale price.

To do so, an exporter of distributed generation would need to avail themselves of all the regulatory and commercial requirements to operate as a retailer. This would include requirements such as marketing, billing, risk management and regulatory compliance costs. It would also include the cost of delivering the distributed energy to customers via the network. These costs would be deducted from the price exporters of distributed generators gain for their electricity.

In competitive and efficient markets without any barriers to entry, the net price exporters of distributed generation received for the electricity they sold would be identical under both scenarios. In other words, even if they were able to sell their electricity at the retail price, the net profit from doing so would be the same as that achievable from the sale of electricity into the wholesale market.

Source: ESC

ELIGIBILITY OF SOLAR CUSTOMERS FOR VARIOUS RETAIL TARIFFS

A small number of submissions indicated that having installed solar PV, the individual in question had been 'required' by their retailer to adopt a different retail tariff than the tariff they had been on before the installation.

Under amendments to the *Electricity Industry Act 2000* that commenced on 1 January 2016, a retailer is obliged to offer to customers with solar PV the same terms and conditions that it offers to non-solar customers.[19] Consumers who have a query about the retail electricity offers that are available to them should contact their electricity retailer.

[19] *Electricity Industry Act 2000*, s 23C.

2.4 CONCLUSION

Having set out the context to the inquiry, we explain our approach to the inquiry in the following chapter. The subsequent chapters outline our draft findings regarding the value of distributed generation in the wholesale electricity market (chapter 4) and its environmental and social value (chapter 5), before setting out a proposed tariff structure to return these values to distributed generators (chapter 6).

3 OUR APPROACH

3.1 INTRODUCTION

This chapter presents our overarching approach, encompassing our definition of distributed generation and a high level explanation of our method for conceptualising and measuring the ‘true value’ of the electricity produced by distributed generation.

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

- first, with regard to distributed generation exports in the wholesale electricity market, and
- second, in terms of the environmental and social effects of distributed generation.

It also describes the Commission’s method in ascribing a monetary value to any benefits in each context.

3.2 OUR APPROACH

We take the following approach:

- Define distributed generation for the purposes of this inquiry.
- Identify the values that can be attributed to distributed generation and whether methodologies exist to enable the quantification of these values. For this report, which focuses on energy value, the terms of reference requires us to focus on two distinct elements of the electricity produced by distributed generators:
  - the value of that electricity in the wholesale electricity market, and
  - the value of the environmental and social benefits caused by that electricity.

- Understand how the regulatory framework already accommodates the value of distributed generation. For this report the relevant elements of the regulatory framework are the existing feed in tariff (FiT) regime and the Renewable Energy Target (RET).
- Identify any regulatory changes needed to amend the framework for valuing and remunerating distributed generation.

Following this analysis, the next step is to make recommendations to Government on amending the FiT to reflect the broader value of distributed generation.

The remainder of this chapter explains the definition of distributed generation used in the inquiry, the way we conceive of 'value', and how we measured value in the context of the wholesale electricity market and in terms of the environmental and social effects of distributed generation.

3.2.1 DEFINITION OF DISTRIBUTED GENERATION

In its broadest definition 'distributed generation' refers to energy generation connected to a distribution network, as opposed to a transmission network.[20] Distributed generators can range in size and energy sources, from a household rooftop solar photovoltaic (PV) system of a few kilowatts (kW) capacity, to a multi-megawatt (MW) natural gas-fired co-generation system.

This broad definition can be further broken down via various legal and regulatory definitions that apply to different capacities of distributed generation and regulations that determine how they interact with the energy market. Given the wide ranging definition of distributed generation, the market rules governing the different sizes of distributed generation, and the differences in how different types and sizes of distributed generation interact with the market, it is important to determine which types of distribution generation will be the focus of this inquiry.

The Melbourne Energy Institute (MEI) raised in its submission the prospect that the definition of distributed generation could be extended to non-electric forms of energy

[20] Within the industry, distributed generation is also often referred to as embedded generation.

generation, such as solar hot water systems.[21] We restricted the inquiry to distributed electricity generation because the terms of reference focus on the impact of distributed generation of the electricity system (wholesale electricity market and the electricity network).

In our approach paper we proposed defining 'distributed generation' for the purpose of the inquiry as:

- **Distributed generation below 5 MW capacity.[22]** It is generally understood that distributed generators of this size are not stand-alone generators; they are normally installed in or on a host's property and supply electricity to the host's site.[23]

  These distributed generation producers tend not to be direct electricity wholesale market participants (although there are a small number who are registered generators in the National Electricity Market (NEM)). Small distributed generators are typically unable to negotiate a price for their output and are effectively price takers via the mandated FiT payment. However, distributed generators at the larger end of the spectrum may have the option of negotiating a price per unit of output with an interested buyer (an off-taker[24]).
- **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 and natural gas. Solar and wind are the most common.
- **Battery storage.** While not strictly generation, a battery storage system can supply electricity and as such can operate in a comparable way to a generator. Batteries can either be integrated with other distributed generation technologies, or stand alone to be primarily used as backup power.

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[21] MEI 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation – Proposed Approach Paper,* February*,* p. 5.

[22] The Australian Energy Market Operator (AEMO) defines larger generators also as distributed generation, ranging from non-scheduled generators between 5-30MW. AEMO also considers some generators that deliver electricity to transmission customers as distributed generation.

[23] These include those distributed generators that are; connected via an inverter prescribed by AS4777 (the Australian Standard for the Grid Connection of Energy Systems via Inverters, which sets out the technical standards that must be met when connecting a generator to the grid via an inverter), and systems larger than those connected via an inverter, but no more than 5 MW in size (and are exempt from the need to register as a generator with AEMO).

[24] An off-taker is a buyer who enters into an agreement with an energy generator to purchase future production at a given rate and amount.

Through submissions, stakeholders were broadly supportive of this definition. However, some proposed altering the capacity size threshold. Environmental Justice Australia (EJA) argued that limiting the size threshold to 5MW ‘doesn’t take full account of the benefits of distributed generation in terms of lowering the greenhouse gas emissions profile of the electricity sector’.[25] Others, such as Jemena, wanted the threshold reduced.[26] Origin Energy and Simply Energy both submitted that proponents of distributed generation systems with capacity in excess of 100kW would normally be backed by sufficient resources to enable them to negotiate a market price.[27]

The Commission has not been presented with evidence that there are practical impediments for generators in the 100kW-5MW range engaging as energy market participants (ie electricity generators). We have taken this into account when developing our recommendations in this report about alternative payment mechanisms for distributed generators. However, for the purpose of the wider inquiry we have retained the definition we proposed in our approach paper. This is to enable proper consideration of the value of variously sized distributed generation to the electricity distribution networks. (We will examine this question in the second stage of the inquiry, starting in June 2016.)

The Commission also received broad support for the inclusion of battery storage within the remit of the inquiry. In examining the role of batteries in the inquiry, our focus has been on the potential for this technology to provide network value (as opposed to energy value). Based on our initial analysis we did not find that batteries had a material impact on the question of energy value. The primary opportunity they provide to distributed generators is in the realm of ‘private value’ insofar as they enable the distributed generator to avoid retail tariffs by storing any excess energy for later use. We invite stakeholders to make submissions on this topic.

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[25] Environmental Justice Australia, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation – Proposed Approach Paper,* February, p. 2; Institute for Sustainable Futures 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation - Proposed Approach Paper,* February, p. 3.

[26] Jemena Electricity Networks 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation,* February, p. 4

[27] Origin Energy 2016, Submission to the Essential Services Commission Inquiry into the true value of distributed generation - Proposed Approach Paper, February, p. 5, Simply Energy 2016, Submission to the Essential Services Commission Inquiry into the true value of distributed generation - Proposed Approach Paper, February, p. 6.

We intend to revisit battery storage in more detail in the subsequent network stage of the inquiry, taking into account developments in the national framework(s).

3.2.2 THE MEANING OF 'VALUE' IN THIS INQUIRY

In this section, we lay out our working definition of value for the purposes of this inquiry.

The first distinction we make is between the 'internal' and 'external' effects of distributed generation. The term '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, firms or the physical environment in which the distributed generation unit operates.

There are two types of external effects. The first are 'direct external effects'. Direct external effects are those that manifest in the electricity market when, for example, a distributed generator exports their surplus electricity into the grid. This includes the effect it has on the production, transportation and sale of electricity in the market. This draft report is limited to matters of production and sale, as such, chapter 4 looks at the value of the exported electricity as it enters the electricity market. (A future report will consider the direct effect of distributed generation on the distribution network.)

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 (net of any negative consequences). By definition, benefits have positive value. For example, if distributed generation leads to a reduction in conventional electricity generation, then this can produce a benefit to society through reduced greenhouse gas emissions.

How that value is measured is not straightforward. However, because this review is focussed on identifying how value (or 'true value') might be reflected in a feed in tariff, and such a tariff is self-evidently a monetary mechanism, then we confine our approach to defining value in monetary terms only. Alternatively stated, in this review we are seeking to identify direct and indirect effects that produce benefits that can be valued in monetary terms.

We set out this typology of effects in figure 3.1.

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: public benefits deriving from externalities or spill-overs.) One of the purposes of this review is to identify and then quantify the value of the indirect benefits that arise from 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.

At a conceptual level, identifying the environmental benefits of distributed generation is the more straightforward exercise. We define environmental benefits to be those benefits that manifest themselves in the natural environment. One prominent example discussed in chapter 5 includes the lower greenhouse gas emissions to the atmosphere resulting from investment in distributed generation replacing fossil fuel based energy production. That chapter also discusses an example of an environmental effect that manifests itself as a social benefit — namely, avoided air pollutants providing beneficial health outcomes for communities.

Following further discussions with the department[28], and for the purposes of this inquiry, 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[29]).

Chapter 5 identifies some of the potential environmental and social benefits of distributed generation, including those discussed in submissions. As discussed in that chapter, assigning a value to those benefits has proven challenging. Two prominent

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

[29] As measured in economic terms.

constraints have been the lack of data quantifying those benefits and the lack of information about which of those benefits can be directly and reliably linked to distributed generation rather than other causal factors.

Some submissions acknowledged this lack of reliable information but went on to suggest that the Commission should, in effect, make its best informed decision about the value of these potential benefits. For example, Alan Pears stated that 'where existing data or methodologies are inadequate to evaluate and quantify a factor' the Commission should adopt one of a number of methods to nonetheless arrive at a measure of monetary value, including through use of assumed value ranges or through qualitative approaches.[30]

We consider that such an approach is too arbitrary for an economic regulator to adopt. We are acutely aware that the price we determine for payment to the producers of distributed generation in return for the benefits they produce, is a cost incurred by all electricity customers.[31] In determining the FiT, the Commission is therefore compelled to satisfy itself, with confidence, that the benefits it identifies are material and that paying for them is not imposing an unsubstantiated burden on those customers. If this were not the case, we would be compelling retail electricity customers to contribute towards payments to investors in distributed generation even though the true value of benefits being delivered is uncertain.

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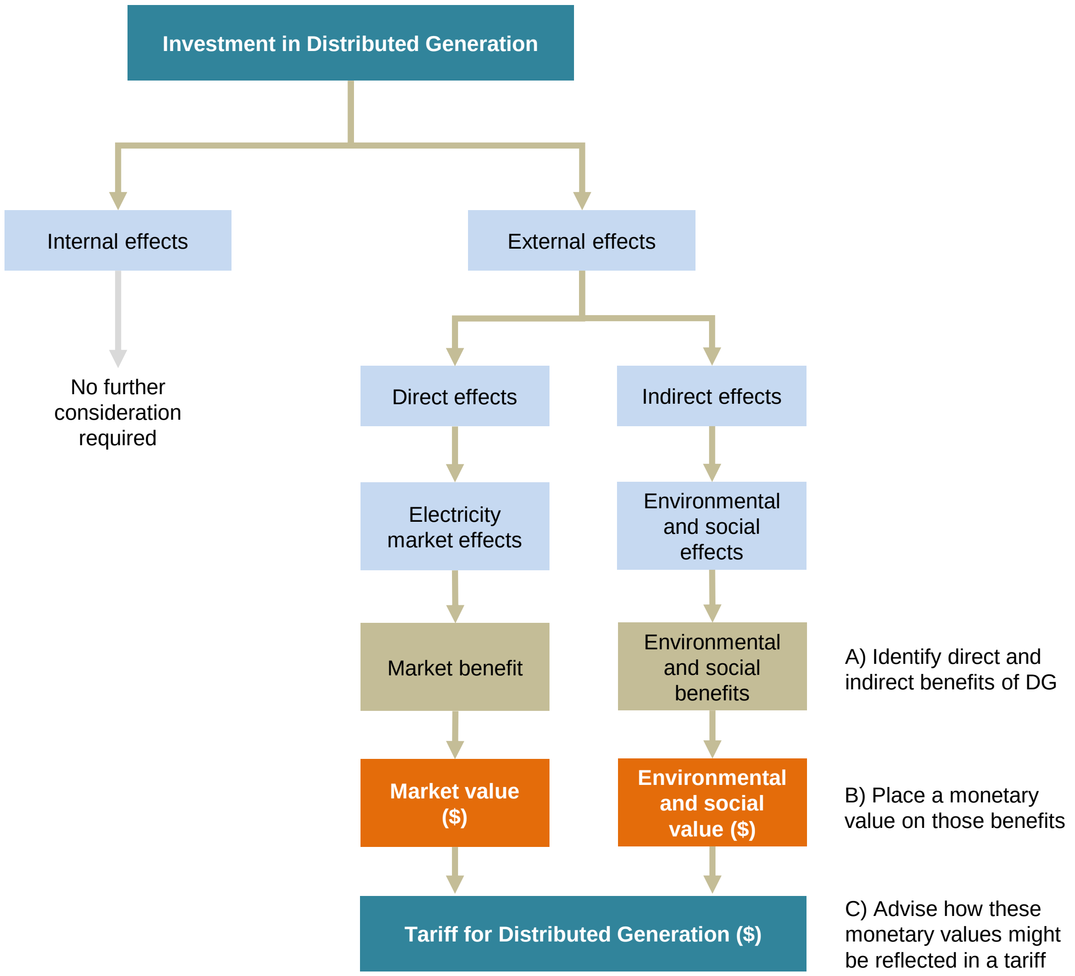
[30] Alan Pears 2015, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation – Proposed Approach Paper*, February, p. 3; MEI 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation – Proposed Approach Paper*, February, p. 5.

[31] That is, we expect energy retailers will pass the cost of complying with the FiT legislation on to their customers through their retail electricity tariffs.

FIGURE 3.1 TREATMENT OF VALUE IN THIS INQUIRY



Source: ESC

Importantly, our role is assessing the 'true value' of distributed generation will be repeated each year and for the year ahead as part of our annual determination of the FiT. In this sense, our analysis of 'true value' is static and repeated rather than dynamic. 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; or whether those benefits could be delivered by alternative means. We take the level of investment and the benefits generated as fixed at each point in time.

3.3 MODELLING

This section outlines at a high level the Commission's method for identifying and evaluating the direct and indirect effects of the electricity produced by distributed generation.

Having conducted its initial analysis, the Commission engaged ACIL Allen Consulting (ACIL Allen) to assist with the development and application of this method. We asked ACIL Allen to conduct modelling and analysis to:

- provide options for calculating the value of distributed generation exports in the wholesale electricity market (including by developing options for expressing the wholesale price within specific 'time blocks')
- provide options for calculating the line losses distributed generation exports cause to be avoided, and
- provide options for calculating the volume of reduced greenhouse gas emissions caused by distributed generation.

We did not request ACIL Allen to perform any modelling on the value of social benefits or any environmental benefits beyond emission reduction, because our analysis did not identify any social benefits or other environmental benefits that could be directly or reliably linked to the electricity produced by distributed generation (see chapter 5).

3.3.1 THE VALUE OF DISTRIBUTED GENERATION ELECTRICITY IN THE WHOLESALE ELECTRICITY MARKET

The terms of reference require the Commission to examine the value of the distributed generation electricity in the wholesale electricity market. The Commission's method for quantifying this value was to consider:

- only exported electricity (net output), and
- the costs avoided by the retailer when they service their consumers using electricity provided by distributed generation as opposed to centrally dispatched generation, and
- the following costs avoided by the retailer: wholesale electricity spot price, line losses and market fees.

3.3.2 CREATING PAYMENT OPTIONS BASED ON THE MARKET VALUE OF DISTRIBUTED GENERATION EXPORTS

Having assessed the current framework for its capacity to reflect the market value of distributed generation exports, we considered a range of options for re-structuring payments to owners of distributed generation. These efforts focused largely on options for accounting for the time and location of the exports. Because the wholesale price is highly variable, in exploring these options we made trade-offs between options that are more reflective of underlying market conditions, but difficult (and costly) to administer, and options that were less reflective but simple to implement.

Options that are highly reflective of the underlying electricity market are typically more difficult and costly to execute. Simpler options are less costly and easier to execute but will involve assumptions averaging outcomes across one or more customer groups, locations or time periods. Inevitably, judgement is required in deciding how to respond to these trade-offs. Subsequent chapters outline the judgements we made in reaching our recommendations about the 'true value' of distributed generation.

PAYMENTS BASED ON TIME OF EXPORT

The wholesale market spot price varies every half hour, meaning there are 17,520 wholesale prices in a given year. In developing options for a payment structure that accounted for the time that distributed generation electricity is exported (a 'time of export' structure), our task was to identify methods for simplifying the variable nature of the wholesale price. To do this, we looked at a range of options for reducing the number of time blocks from 17,520 to a smaller number of blocks more practically suitable to a payment structure.

Our approach to simplifying the wholesale electricity spot price involved:

1. analysing recent historical data to identify periods in which wholesale spot prices 'clustered' sufficiently to justify using those periods as the basis for simplified 'time bocks'. 'Time blocks' refers to specified periods of the year (for example, between 4pm and 7:30pm of each day).
2. testing the consistency and robustness of the time block options we identified by applying them to actual historical data from 2013, 2014 and 2015.

ACCOUNTING FOR LINE LOSSES

Line losses are another factor in determining the value of distributed generation exports. Line losses refer to the loss of energy that occurs when electricity is transported between the generator and the consumer through the transmission and distribution networks ('the grid'). When electricity is moved through the grid, some portion of it is lost as heat. This means that for every kilowatt hour (kWh) that reaches a consumer's premises, more than a kWh must be generated from a centralised generator located a significant distance away.

As with the wholesale market price, line losses can be accounted for in a number of ways, ranging from more precise to more simple. The Australian Energy Market Operator (AEMO) produces line loss data for 234 loss zones in Victoria. To reduce this to a smaller number of loss zones, we analysed options for grouping zones into one to five loss zones statewide, based on geography and existing distribution zones.

ACCOUNTING FOR AVOIDED MARKET AND ANCILLARY FEES

Retailers also pay market fees and ancillary charges to AEMO for the electricity that they purchase from the wholesale market. These fees are proportional to the volume of electricity purchased. Retailers do not have to pay these market fees on the electricity that they purchase from distributed generators.

3.3.3 THE VALUE OF THE ENVIRONMENTAL AND SOCIAL BENEFITS OF DISTRIBUTED GENERATION ELECTRICITY

The terms of reference require us to examine the monetary value of the environmental and social benefits of distributed generation. We applied a three-part process in examining whether a monetary value could be established on identified benefits.

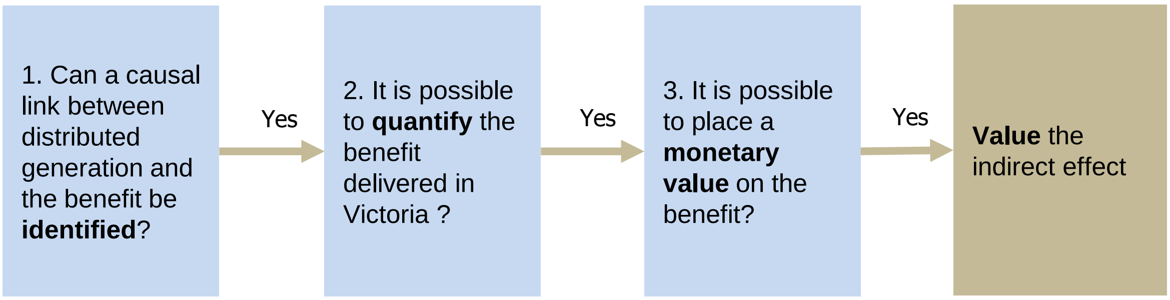
The three part process was:

a. **Identification** – We considered the potential benefits of distributed generation and whether it is possible to establish a causal link between the electricity output of distributed generation and the benefit.
b. **Quantification –** We considered whether it is possible to measure the quantum of benefit delivered in Victoria by a unit of distributed generation electricity.

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, is a monetary value on that environmental and social benefit determined (figure 3.2).

FIGURE 3.2 THREE-PART INDIRECT EFFECT TEST
Method for considering environmental and social value



Source: ESC

3.3.4 CREATING PAYMENT OPTIONS BASED ON THE VALUE OF ENVRONMENTAL AND SOCIAL BENEFITS OF DISTRIBUTED GENERATION ELECTRICITY OUTPUT

Having assessed the current framework for its capacity to reflect the value of any environmental and social benefits of distributed generation electricity, we looked at options for establishing payments based on such values.

As the main value of relevance was the value of avoided greenhouse gas emissions, a specific method was established for determining the amount of greenhouse gas reduction attributable to different types of distributed generation system. In particular, we considered the total electricity produced by distributed generation (gross output). We also looked at practical steps to overcome the reality that environmental and social effects are a function of the gross output of a distributed generator, which in most cases is not metered, so any payment mechanism would need to account for this.

4 ENERGY VALUE IN THE WHOLESALE MARKET

4.1 INTRODUCTION

In this chapter we examine the monetary value of distributed generation electricity in the wholesale electricity market. We explain how the electricity exported by a distributed generator has a monetary value based on the electricity wholesale price. We then assess how effectively the current feed-in tariff (FiT) framework returns that value to distributed generators. Finally, we look at options for constructing a FiT under an alternative framework that allows for a multi-rate tariff that varies by time and location.

SUMMARY

The current feed-in tariff (FiT) framework requires the Commission to set a single tariff that applies at all times of the day and in all locations across Victoria. However, the wholesale electricity price varies constantly throughout the day, while the market value of the electricity also varies based on where the distributed generator is located. By restricting the FiT to a single tariff, the current framework therefore provides only limited means to pay distributed generators of varying technology types the market-based monetary value of their exports.

We examine several options for making the FiT more reflective of the wholesale price. One option is for retailers to pay distributed generators the wholesale prices that applied at the time of their exports. Alternatively, for retailers and distributed generators who prefer a simpler or more predictable arrangement another option is to structure payments using 'time blocks' that simplify the variability of the wholesale price. As a concept, this option is analogous to the flexible pricing structures that have been available to retail electricity customers in Victoria, since September 2013.

We explore several ways of creating ‘time blocks’. We assess the options using an assessment criteria and having considered these results, we set forward our preferred approach – a multi-rate FiT that includes ‘peak’, ‘shoulder’ ‘off peak’ and ‘critical peak’ rates. We consider this approach best balances the trade-off between reflecting the wholesale price and creating a tariff structure that is reasonably straightforward to implement.

We also explore options for allowing the FiT to better reflect the impact of *location* on the wholesale price. This task involves examining ways to account for the role played by ‘line losses’ – electricity that is lost while being transported through the grid between a centralised generator and the consumer. Under the current framework, all locations in Victoria are treated identically in this respect. That is, the FiT received by every distributed generator is calculated using a ‘loss factor’ that is an average of the losses experienced across all Victorian locations.

We explore ways to make this process more market reflective by moving from one ‘loss factor’, as occurs under the current framework, to having two, three or five ‘loss factors’. We did this by looking at which areas of Victoria experience similar line losses and grouping those areas into regions, or ‘loss zones’. Our preferred approach is to apply factors based on two loss zones. As with our approach to selecting time blocks, this draft decision was based on a trade-off between market reflectiveness and simplicity.

The first zone encompasses Greater Melbourne, Geelong and eastern Victoria and has a loss factor of 105 per cent while the second zone covers northern and western Victoria and has a loss factor of 113 per cent (by comparison, a single state-wide loss factor would be 106.5 per cent).

This chapter focuses on how we developed these options and the process by which we chose between them. Chapter 6 sets out a ‘worked example’ in which we present example tariffs, based on forecast wholesale market price data for two ‘synthetic years’, using our preferred time blocks and location zones.

4.1.1 STRUCTURE OF THIS CHAPTER

4.1 Introduction

4.2 The value of distributed generation in the wholesale market

- Explanations of what we mean by ‘value in the wholesale market’ and the relevance of distributed generation exports (as opposed to total output).
- An explanation of why the monetary value of distributed generation exports is based on the wholesale price, as well as explanations of the role of lines losses and market fees in determining the full monetary value.

4.3 Operation of the current framework

- An assessment of how the current regulatory framework (the FiT) facilitates payments based on the monetary value of distributed generation exports in the wholesale market.

4.4 An alternative framework

- A proposed alternative to the current framework to allow the Commission to set multi-rate FiTs based on how the monetary value of distributed generation exports varies by time and location.
- An explanation of the evaluation criteria we used when choosing between different ways of structuring a multi-rate FiT.

4.5 Accounting for time of export

- An explanation of the variability of the wholesale market price.
- An exploration of the option to have FiT payments reflect directly the wholesale spot market.
- An exploration of four options to simplify the wholesale market price by introducing ‘time blocks’.

4.6 Accounting for location of exports (line losses)

- An explanation of how location affects the market value of distributed generation exports through variability in line losses.
- An exploration of four options to simplify the variability in line losses.

4.7 Conclusion and draft recommendations

4.2 VALUE IN THE WHOLESALE ELECTRICITY MARKET

The electricity that distributed generators export into the grid has a value in the wholesale electricity market, which is based on the wholesale electricity price, adjusted for avoided line losses, and market fees and ancillary charges ('market fees'). These 'adjustments' refer to the costs associated with line losses and the market fees that retailers avoid when they supply power to their customers using distributed generation exports instead of centrally dispatched electricity.

This section explains how we arrived at this position by setting out the background concepts and then stepping through the role of the wholesale price, line losses and market fees in determining the monetary value of distributed generation exports.

WHAT WE MEAN BY 'VALUE IN THE WHOLESALE MARKET'

Distributed generation interacts with the wholesale market in a number of ways. When a distributed generator consumes the electricity they produce (as opposed to purchasing or 'importing' that power from the grid), it displaces demand for centrally dispatched electricity. When they export electricity to the grid, it supplants the supply of centrally dispatched electricity that retailers would otherwise have purchased from conventional generators. As factors that influence supply and demand, both these dynamics can affect the wholesale market.

This inquiry does not attempt to isolate and evaluate the effects of distributed generation on the wholesale market at large. The influence of distributed generation on the wider trends of supply and demand is already expressed through the wholesale price that all consumers pay, via their retail tariffs.

Rather, in this inquiry we focus on identifying the market value of the electricity produced by distributed generation systems.[32]

[32] Our approach assumes that due to their small size distributed generators would be 'price takers'. That is, that the quantum of electricity they individually supply would not be material enough to affect the price in the market and therefore it is reasonable to assume they would simply 'take' the market price at a given point in time.

Where we have relied upon forecasts throughout this inquiry, we made use of a well-known electricity wholesale market model, PowerMark, developed by ACIL Allen Consulting. (We utilised forecasts to inform the work we discuss in chapter 5, where we provide a more thorough introduction to the model). Like similar market models, PowerMark is capable of generating forecasts of wholesale electricity prices. These forecasts account for a range of factors that combine to influence the modelled behaviour of the market participants and the resulting prices. This includes the influence of distributed generation.

THE RELEVANCE OF EXPORTED DISTRIBUTED GENERATION ELECTRICITY

Typically, some portion of the electricity produced by a distributed generator is consumed 'locally' (that is, on site) while some portion is 'exported'. By definition, the locally consumed electricity is not exported into the grid and therefore does not 'enter the market'. For this reason, when we examine the wholesale market value of distributed generation electricity we focus exclusively on the portion that is exported. This is sometimes expressed as the 'net output' (as opposed to the 'gross output') of the distributed generation system.[33]

THE RELEVANCE OF THE WHOLESALE MARKET PRICE

In line with our existing approach to setting FiTs and the approach adopted by other jurisdictional regulators, we use the wholesale price as the basis for identifying the monetary value of distributed generation exports. This is because when retailers purchase electricity exported by distributed generators, they no longer need to purchase that energy from the wholesale market. The price they would have paid for that energy in the wholesale market is therefore the relevant reference point for valuing the distributed generation exports.[34]

4.2.2 WHOLESALE PRICE, LINE LOSSES AND MARKET FEES - DETERMINING THE VALUE OF DISTRIBUTED GENERATION ELECTRICITY IN THE WHOLESALE ELECTRICITY MARKET

Energy retailers are required to purchase all distributed generation that is exported by distributed generators. This requirement reduces the amount of electricity that a retailer needs to purchase in the wholesale market to meet its customers' needs. Hence the benchmark for the value of the electricity exported is the wholesale price of electricity.

However, the amount of electricity that a retailer must purchase in the wholesale market does not depend solely on the amount of electricity that its customers consume.

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[33] By contrast, when measuring the monetary value of the environmental and social benefits in chapter 5 we focus on the gross output because the value generated in those contexts is a function of the entire output of the distributed generation system.

[34] Expressed in differently, this means '[t]he wholesale electricity spot market price corresponds to the marginal energy purchase cost that is avoided by an electricity retailer when one of its [distributed] generation customers exports an additional unit of electricity into the grid'; Essential Services Commission 2013, *Minimum Electricity Feed-In Tariffs – Final Decision*, p. 1.

It also depends on the distance these customers are located from the source of the generation. The difference arises because of a factor known as 'line losses'.

The term 'line losses' refers to the loss of energy that occurs when electricity is transported between the generator and the consumer through the transmission and distribution networks ('the grid'). When electricity is moved through the grid, some portion of it is lost as heat. This factor means that for every kilowatt hour (kWh) that reaches a consumer's premises more than a kWh must be generated.

Line losses are accounted for in the way retailers pay for electricity through the wholesale market. It occurs according to a settlement process managed by the Australian Energy Market Operator (AEMO). The amount of electricity that a retailer pays for in each financial settlement is, in fact, greater than the amount they deliver to the downstream consumer. The amount they pay for is adjusted to account for the losses that occur between the generator and the consumer's premises.[35]

Distributed generation reduces the average distance between generation and consumption. Because exported distributed generation electricity is conveyed over shorter distances through the grid before it is consumed, it therefore avoids the higher losses of centrally dispatched electricity.

Every unit of electricity that a retailer purchases from a distributed generator is a unit that it does not need to purchase via the wholesale market, meaning the retailer avoids both the cost of the wholesale price itself *as well as* whatever loss factor would then have been applied to that price through the AEMO settlement process. When thinking about the value of distributed generation exports, this approach is sometimes referred to as the 'avoided cost' approach – a reference to the costs avoided by the retailer when it supplies its customers using distributed generation exports rather than centrally dispatched electricity.

Retailers also pay market fees and ancillary charges to AEMO for the electricity that they purchase in the wholesale market. These fees are proportional to the volume of electricity purchased. Accordingly, retailers do not pay market fees on the electricity

[35] In practice the adjustment accounts for the losses between the Regional Reference Node (RNN) and the end consumer, because the losses between the generator and the RNN are already accounted for in the wholesale price itself.

that they purchase from distributed generators. This figure varies each year based on AEMO's revenue requirements and fee schedules. In our decision on the 2016 FiT, for example, we estimated that the market fees and ancillary charges saved per kilowatt (kW) of distributed generation export for 2016 would be 0.1c per kWh.

CONCLUSION – THE VALUE OF DISTRIBUTED GENERATION EXPORTS IN THE WHOLESALE ELECTRICITY MARKET

We consider the value of exported distributed generation electricity is equal to the wholesale market price at the time of the export, adjusted for the cost of line losses that would have applied at the location of the distributed generator, plus an amount to account for the market fees and ancillary charges (which vary each year) avoided by not purchasing that electricity via the wholesale market.

4.3 OPERATION OF THE CURRENT FRAMEWORK

The current framework for determining the price that distributed generators receive for their exported electricity is the minimum FiT. When setting the FiT, the Commission must have regard to the price of electricity in the wholesale electricity market and avoided line losses. Under the current legislative framework the FiT is set at a flat rate that applies irrespective of the location at which the electricity is generated or the time at which it is exported.[36]

The flat rate FiT is currently set by using a weighted forecast annual average of the wholesale market price. The weighting is applied to account for the fact that the dominant form of distributed generation in Victoria – solar photovoltaic (PV) – exports electricity at certain times of day according to a relatively predictable pattern.

This weighting process is one, albeit highly averaged, method for accounting for variability of the wholesale electricity price. It ensures that for solar PV distributed generation, overall, payments under the flat rate FiT better reflect the market value of their exports than they would if the rate was set using a simple average of the wholesale price. One implication of this method is that the current FiT is tailored to

[36] *Electricity Industry Act 2000 (Vic),* s40FBB.

solar PV distributed generation. The rate represents the average wholesale value of solar PV exports, and may not reflect the wholesale market value of exports from other forms of distributed generation technology.

Another implication is that although it accounts for the variability in the wholesale market in aggregate (ie over a period of a year), it does so in a way that produces an undifferentiated signal for behavioural response. The actual price of electricity paid by retailers in the wholesale market varies significantly with demand. At times of higher demand the wholesale price is generally higher. Because they only receive a flat rate, distributed generators that export their electricity at times of high demand do not receive the actual wholesale price (or true value) of that electricity,[37] nor do they have an incentive to modify their behaviour in response to actual market prices.

Similarly, although the current FiT framework accounts for line losses, it does so by applying a single rate to all customers irrespective of their distance from the source of centrally dispatched electricity. Currently, we set this rate by calculating an average loss factor for Victoria using AEMO estimates of the transmission and distribution loss factors that apply throughout the state.[38]

The price that distributed generators receive therefore does not reflect the actual avoided line losses that apply to their location. In locations where line losses are significantly above or below the average for the state, distributed generators will not receive a price that reflects the actual benefit of the avoided line losses.

The current framework, which we have used to set the FiT for the past three years, provides a flat tariff for all times during the day for the entire year– this tariff appropriately reflects the wholesale market and line losses on a yearly and state-wide

[37] This can alternatively be described from a retailer’s perspective. By purchasing electricity from a distributed generator at times of high demand in the centrally dispatched market, the retailer is avoiding these high costs and instead paying distributed generators the lower flat rate for their electricity exports.

[38] Specifically, the loss factor used by the Commission in previous FiT decisions takes into account the losses that occur between the Regional Reference Node (RNN) and the end-customer meters. This factor has two parts. First is the transmission line losses between the RNN and each bulk supply connection point (or terminal station), which are measured using marginal loss factors (MLF) published by AEMO. Second, the distribution line losses are measured using distribution loss factors (DLF) estimated by each distribution network service provider and published by AEMO. The single loss factor is calculated by multiplying the MLF by the DLF. Essential Services Commission 2015, *Minimum Electricity Feed-in Tariff to Apply from 1 January 2016 to 31 December 2016: Final Decision*, August 2015, p13.

average. For example, at times of high electricity demand[39] in locations where network losses are significant, an average FiT will undervalue the electricity exported by distributed generators compared with the high wholesale price at that time. At these times, distributed generators face a dampened signal about the 'true market value' of the electricity they could export.

The options we considered for structuring payments for distributed generators under an alternative framework are outlined below.

4.4 AN ALTERNATIVE FRAMEWORK FOR RETURNING WHOLESALE MARKET VALUE TO DISTRIBUTED GENERATORS

The Commission proposes that the FiT framework be amended to allow the setting of multi-rate tariffs so that payments under the FiT can vary based on the time and location of distributed generation exports.

This section explores how payments could be structured under this alternative, more flexible FiT framework. Specifically, it explores options to allow payments to distributed generators to be more 'market reflective' for any distributed generation technology type (that is, without weighting based on a given technology type) in such a way that introduces a differentiated signal for behavioural response.

The underlying assumption is that, all things held equal, more 'market reflective' payments are preferable because they lead to more efficient outcomes. That is, if distributed generators receive a price for their exports that is more 'market reflective', they are empowered to modify their behaviour to better capitalise on opportunities to extract value from their distributed generation system.

Having tariffs that are higher during periods of high demand would encourage distributed generators to reduce their consumption during those periods and instead supply (export) electricity into the system. This, in turn, could lead to reduced need for new generation capacity. This result is better for distributed generators because it

[39] For example, during the later afternoon in summer where demand for electricity is historically its highest.

provides them an opportunity to maximise the return on their investment. And it is better for consumers more generally because it leads to more efficient outcomes in the long term.

4.4.1 EVALUATING THE OPTIONS

In examining options for a framework in which payments to distributed generators are more 'market reflective', we focused on how such payments could reflect variations in the wholesale price at the 'time of export', as well as the varying effect of line losses at different locations around the state.

To assess the relative merits of the different options, we developed an assessment framework based on three criteria:

- **Market reflectiveness** – the extent to which the option provided an accurate reflection of the wholesale market price.
- **Simplicity of implementation** – the extent to which the option would be straightforward to understand and implement, from the perspective of both distributed generators and retailers, respectively.
- **Likelihood to stimulate an efficient behavioural response** – the extent to which the option provides a material signal for an efficient behavioural response.[40]

The criterion of 'market reflectiveness' can be assessed objectively.

The latter two criteria are assessed by the Commission's judgement, and are based on the 'guiding principles' for the inquiry that the Commission identified in section 2.2.2.

We explain how we applied these criteria when looking at the options in the relevant sections below.

[40] In the context of assessing options to make the FiT better reflect the market value of distributed generation exports, the 'materiality' of each option is a function of the spread of the rates relative to a single tariff; the greater the spread, the greater the materiality. Our assumption is that the size of the spread between rates is also the factor that influences likelihood of a given option prompting a behavioural response. In other words, in this context our guiding principle of 'materiality' is subsumed into our guiding principle of 'behavioural response'.

4.5 ACCOUNTING FOR TIME OF EXPORT

This section sets out the options we considered for structuring payments that better reflect the wholesale price at the time distributed generators export electricity.

4.5.1 VARIABILITY OF WHOLESALE ELECTRICTY PRICES

The electricity wholesale price is determined through auctions conducted every five minutes, averaged across the half hour. There are 17,520 half hour periods per year.

The wholesale price can vary significantly across these half hour intervals. Prices can rise to a market price cap of $13.80 per kWh and fall to a market floor of –$1.00 per kWh. [41] Recent prices, however, have rarely reached these extremes. During 2015, the wholesale electricity price in Victoria varied between $2.17 per kWh and –$0.32 per kWh.[42] By comparison, the FiT for 2015 was a flat rate of $0.062 per kWh (inclusive of line losses and market fees).

Through submissions, stakeholders expressed a range of views on altering the current framework so that payments are more reflective of the wholesale price at any given point in time. At one end of the spectrum, energy retailers AGL and Energy Australia and electricity distributor United Energy, favoured the existing single tariff arrangement.[43] On the other end of spectrum, Mr Gareth Moorhead argued that greater granularity was preferable and advocated for a system whereby retailers pay distributed generators the actual wholesale price for each half hour interval. Mr Moorhead described this option as follows:

> *The fundamental data on which this could be based – each consumer's exported power meter reading – is readily available and not significantly*

[41] Negative wholesale market prices are instances where generators pay to stay online, i.e. a situation where it costs less for a generator to stay online compared to shutting down and re-starting plant and equipment.

[42] Based on modelling and analysis on our behalf by ACIL Allen consulting.

[43] AGL, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation – Proposed Approach Paper*, February, p. 7; Energy Australia, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation – Proposed Approach Paper*, February, p. 3; United Energy Distribution *Submission to the Essential Services Commission Inquiry into the true value of distributed generation – Proposed Approach Paper*, February, p.1.

large either in total data volume or communication bandwidth requirements (it is, after all, read by the retailers.) Allowing for distribution losses, the wholesale price of electricity at each property entry point can be readily calculated at half-hourly intervals. Each retailer can make offers recognising that value according to retail market competitive conditions, and each current or prospective distributed generator can adjust their systems to maximise their returns.[44]

Between these two positions, stakeholders such as Marchment Hill Consulting and Mr. Clive Amery expressed support for the option – signalled in our approach paper – of moving away from a 'single tariff' system towards some form of 'time of export' arrangement.[45]

The Clean Energy Council (CEC) also proposed a 'critical peak' rate that would apply as a form of 'bonus' payment during periods that high demand is causing wholesale prices to spike.[46]

We examined a range of options for better expressing the wholesale price in payments to distributed generators. The following section sets out the options we reviewed.

4.5.2 PAYMENTS BASED ON THE WHOLESALE PRICE AT EACH HALF HOUR

There may be substantial costs to retailers in establishing systems that could calculate and compensate each individual distributed generator according to the wholesale price at the time they exported electricity. The Commission considers that if such a tariff system were *mandated* the costs of these system changes would very likely exceed the benefits. We therefore do not consider this option to be a viable basis for a mandated minimum FiT at the present time.

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[44] Gareth Moorhead, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation,* February, p. 4-5.

[45] Marchment Hill Consulting 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation,* February, p. 3; Clive Amery 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation,* February, p. 7

[46] Clean Energy Council, *Clean Energy Council's submission to the Essential Services Commission's Proposed Approach to the Inquiry into the True Value of Distributed Generation,* February, p. 4.

We recognise that while many distributed generators may prefer simplicity and certainty, others such as Mr Moorhead prefer a much greater degree of exposure to the wholesale market. We also recognise that business models may exist, or may emerge, to cost-effectively manage the complexity involved in providing rates based on the full granularity of the wholesale market.[47] Ideally, the framework for facilitating payments to distributed generators should not inadvertently disadvantage such business models.

The Commission proposes that in the event an electricity retailer is able to offer a feed in tariff that fully reflects the half hourly prices in the wholesale market, and the distributed generator provides express and informed consent when accepting that tariff option, then the retailer obligation to offer the regulated feed in tariff rates as proposed in this draft report should be suspended for the duration of that agreement.

Such a tariff would be paid *ex post* and be based on the wholesale price in each half hour interval during which a distributed generator is exporting.[48] Under this option, the distributed generator would have the opportunity to modify its exports in response to wholesale market movements to some extent based on projected wholesale market price information published by AEMO.[49]

In considering this option, our assumption is that a fully market reflective tariff would bring benefits because it would provide an incentive towards more efficient use of the capital resource (the distributed generation system). As stated above, tariff structure that encourages distributed generators to supply energy when demand is high would be expected to lead to more efficient market outcomes.

[47] An example of innovation in a closely aligned space is technology that is emerging to allow distributed generators to optimise their exports and storage based on actual wholesale electricity market prices. For example, a Canberra based company, Reposit Power, has developed a software platform that actively manages residential solar PV and storage systems to maximise the value of the system to the householder.

However, this technology is not yet mainstream and may not be appropriate for every distributed generation installation. It also poses a range of regulatory challenges. The AEMC explored these issues from a National Electricity Market perspective through its Integration of Energy Storage project. From a Victorian perspective, these issues are being explored through the ESC's review of the Electricity Licencing Framework and the concurrent departmental review of the General Exemption Order framework.

[48] By *ex post* we mean payments that are made after the event based on actual, rather than forecast, prices.

[49] As an example of data to support this behaviour, pre-dispatch data for next day wholesale market prices is available at AEMO, *Pre Dispatch, http://www.aemo.com.au/Electricity/Data/Market-Management-System-MMS/Pre-Dispatch,* Accessed 18 April 2016

4.5.3 SIMPLIFYING THE WHOLESALE MARKET VALUE

To provide simpler options for determining the wholesale market price, we commissioned modelling and analysis from ACIL Allen Consulting. We asked ACIL Allen to produce and test a series of 'time block' models that could be used to better accommodate the variability of the wholesale price than the current 'single tariff' FiT. We analysed the following broad options:

- a 'three part' model – peak, shoulder and off peak periods based on those in place for flexible retail pricing
- a 'two part' model – peak and off peak periods based on identifying the time periods in which wholesale electricity prices were highest
- adding a seasonal variation to both the 'three part' and 'two part' models
- adding a 'critical peak' tariff to both the 'three part' and 'two part' models.

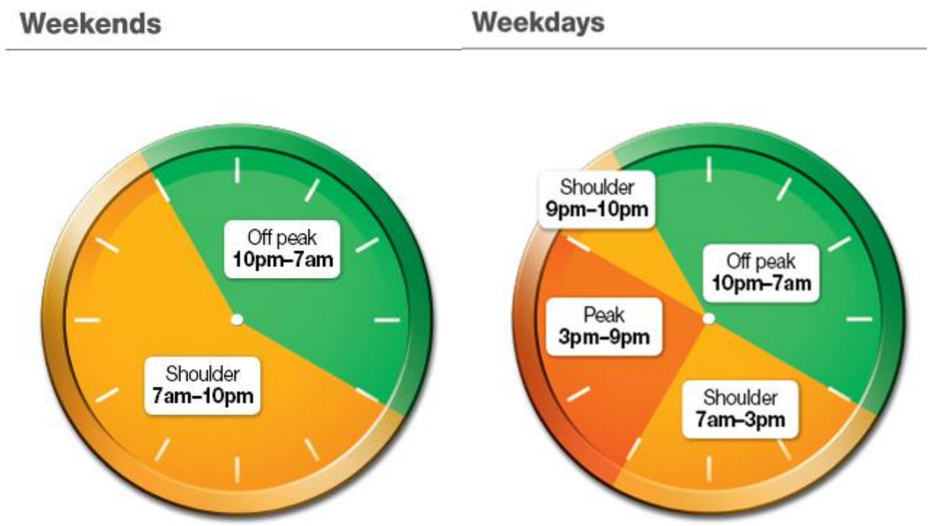
We tested the suitability of each time block model using historical wholesale market price data (for the three year period 2013-15). To do this, ACIL Allen calculated the average wholesale price that occurred in each year in each time block period. It used actual half hourly wholesale prices as its source data. This exercise demonstrated that the time block models produce relatively consistent results across different years.

The sections below present each of the time block models in greater detail.

OPTION A1 – 'THREE PART' MODEL BASED ON FLEXIBLE PRICING PERIODS

In our approach paper, we signalled our intention to explore using the 'peak', 'shoulder' and 'off peak' periods established for the introduction of flexible retail pricing in Victoria as a basis for structuring 'time of export' payments to distributed generators. These periods are set out in figure 4.1 below.

FIGURE 4.1 EXAMPLE OF TYPICAL FLEXIBLE PRICING PLAN



Peak: The price of electricity is higher during the 'peak' times, typically on weekday afternoons and evenings, when the demand for electricity is the highest.

Shoulder: The price of electricity is lower than the peak rate and higher than the off-peak rate.

Off-peak: The price of electricity is lowest when the demand for electricity is the lowest.

Source: Department of Economic Development, Jobs, Transport and Resources 2016, *Flexible Pricing, http://switchon.vic.gov.au/bills-pricing-and-meters/flexible-pricing*, Accessed 19 April 2016

Using actual wholesale prices, we asked ACIL Allen to compute the average price during each of these periods for 2013, 2014 and 2015. The results are set out in table 4.1. The rates decrease from 2013 to 2015 in line with the decrease in the wholesale electricity price in the latter years.

These figures demonstrate that the three part structure produces consistent results across the period. That is, consistently across the three years the model produced the expected results: rates in the peak periods were higher than the rates in the shoulder periods, which were higher again than the rates in the off peak periods. These results provide confidence that this time bock structure is broadly reflective of wholesale market price patterns.

TABLE 4.1 OPTION A1 – THREE PART MODEL
Average Victorian electricity wholesale market prices, during time block (c per kWh)

Year	Peak	Shoulder	Off peak
2015	4.17	3.73	2.51
2014	4.88	4.35	3.49
2013	5.95	5.38	4.75

Source: Based on modelling and analysis completed on our behalf by ACIL Allen Consulting

OPTION A2 – 'THREE PART' MODEL WITH SEASONAL VARIATION

Because peak wholesale prices are generally higher in the summer than in the rest of the year, we also computed a seasonal variation on the 'three part' model. We used two seasons – summer and non-summer.[50] This resulted in two sets of average prices for each year. The results are presented in table 4.2.

TABLE 4.2 OPTION A2 – THREE PART MODEL WITH SEASONAL VARIATION
Average Victorian electricity wholesale market prices, during time block (c per kWh)

Year	Season	Peak	Shoulder	Off Peak
2015	Summer	4.35	3.87	2.36
	Non-summer	4.12	3.69	2.56
2014	Summer	6.59	5.17	3.61
	Non-summer	4.33	4.08	3.45
2013	Summer	6.86	5.00	4.49
	Non-summer	5.65	5.51	4.83

Source: Based on modelling and analysis completed on our behalf by ACIL Allen Consulting

As expected, the 'summer rates' are generally higher than the 'non-summer rates'. The exception was 2013, when the shoulder and off peak rates were higher in the 'non-summer' periods which reflects the demand profile during the non-summer months of that particular year.

[50] Summer is defined in calendar terms as December, January, February. Non-summer is the remainder of the year.

OPTION A3 – 'THREE PART' MODEL PLUS A 'CRITICAL PEAK' TARIFF

In each year the wholesale electricity market experiences a small number of half hourly intervals during which the price rises significantly compared with the remainder of the year. An average wholesale electricity price mutes these high price events, thereby muting any price signal for distributed generators to modify their behaviour.

To allow better expression of this price signal, we considered a variation to the 'three part' model by including a critical peak pricing element. Under this approach, a rate of 30c per kWh would be payable in those half hours when the wholesale electricity price exceeds $300 per MWh.

We chose this level for the critical peak payment, based on advice from ACIL Allen, because of the contracts that retailers and generators would ordinarily enter into to mitigate their risk when the wholesale electricity price exceeds $300 per MWh. Retailers use these contracts to limit their exposure to very high price events in the wholesale electricity market.

In any given year, there would normally be only a very small number of half hour intervals in which distributed generators would be eligible for a critical peak payment. The frequency of intervals in which the wholesale price exceeded $300 per MWh in 2013, 2014 and 2015 is shown in table 4.3.

TABLE 4.3 FREQUENCY OF WHOLESALE ELECTRICITY PRICES IN EXCESS OF $300 PER MWH
2013-15

Year	Intervals with price above $300 per MWh
2015	7
2014	21
2013	18

Source: Based on modelling and analysis completed on our behalf by ACIL Allen Consulting

Using actual wholesale prices, ACIL Allen computed the average price during each of the 'three part' periods for 2013, 2014 and 2015, but with the addition of a critical peak period. The results are set out in table 4.4.

Because there are so few half hourly periods in which the wholesale electricity price has been above $300 per MWh, the inclusion of a critical peak pricing component only has a small impact on the rates in the peak, shoulder and off peak periods.

TABLE 4.4 OPTION A3 – THREE PART MODEL WITH CRITICAL PEAK
Average Victorian electricity wholesale market prices, during time block (c per kWh)

Year	Critical peak	Peak	Shoulder	Off peak
2015	30.00	4.06	3.73	2.51
2014	30.00	4.42	4.19	3.49
2013	30.00	5.47	5.27	4.75

Source: Based on modelling and analysis completed on our behalf by ACIL Allen Consulting

OPTION B – 'TWO PART' MODEL

In our approach paper, we signalled our intention to explore another basis for creating time blocks to simplify the variability of wholesale prices. This second option was broadly based on an approach used by Frontier Economics in analysis it provided to the Independent Pricing and Regulatory Tribunal (IPART) to inform its review of the 2014-15 New South Wales FiT.

IPART's approach was to define two time blocks – which it described as 'peak' and 'off peak' – based on when solar PV exports would have the greatest value based on the price of electricity in the wholesale market. Because of this approach, IPART's method for identifying these periods was inherently linked to solar PV. In this inquiry, we are seeking to take a technology neutral approach. As a result, we have taken an alternative approach to defining the equivalent period in each day for Victoria by focusing on the period during which wholesale prices are highest.

The time period when prices are highest is prone to change from year to year. ACIL Allen therefore considered wholesale electricity prices over a three year period – from 2013 to 2015. This period was selected (in preference to a longer or shorter period) because we considered it the most reliable basis to predict contemporary wholesale market patterns.

ACIL Allen analysed the wholesale price data to identify the time period in which higher wholesale prices most consistently occur. ACIL Allen's analysis showed that the period in which the wholesale electricity price is likely to be the highest in Victoria is between 4:30pm and 7:30pm.

Using actual wholesale prices, ACIL Allen computed the average price during each of the 'two part' periods for 2013, 2014 and 2015. The results are set out in table 4.5.

TABLE 4.5 OPTION B1 - TWO PART MODEL

Average Victorian electricity wholesale market prices, during time block (c per kWh)

Year	Peak	Off peak
2015	4.45	3.23
2014	4.88	4.06
2013	6.27	5.15

Source: Based on modelling and analysis completed on our behalf by ACIL Allen Consulting

These figures demonstrate that the two part structure produces expected results across the period. That is, rates in peak periods were higher than the rates in off peak periods. This provides confidence that this time block structure broadly reflects wholesale market price patterns in the immediately succeeding year(s).

OPTION B2 – 'TWO PART' MODEL WITH SEASONAL VARIATION

As we did when examining the 'three part' model, we also applied a seasonal variation to the years tested based on the 'two part' model. The results are presented in table 4.6.

TABLE 4.6 OPTION B2 - TWO PART MODEL WITH SEASONAL VARIATION

Average Victorian electricity wholesale market prices, during time block (c per kWh)

Year	Season	Peak	Off peak
2015	Summer	4.53	3.27
	Non-summer	4.43	3.22
2014	Summer	5.99	4.79
	Non-summer	4.52	3.82
2013	Summer	7.42	4.96
	Non-summer	5.89	5.20

Source: Based on modelling and analysis completed on our behalf by ACIL Allen Consulting

OPTION B3 - 'TWO PART' MODEL PLUS A 'CRITICAL PEAK' TARIFF

We also developed a version of the two part model with a critical peak pricing component. The same principle applies – a critical peak price of 30c per kWh is paid during the half hourly intervals when the wholesale electricity price exceeds $300 per MWh. The resulting rates are set out in table 4.7.

As with the three part model (Option A3), the inclusion of a critical peak pricing period with the two part time of export option has only a small impact on the peak and off peak rates.

TABLE 4.7 OPTION B3 - TWO PART MODEL WITH CRITICAL PEAK
Average Victorian electricity wholesale market prices, during time block (c per kWh)

Year	Critical Peak	Peak	Off Peak
2015	30.00	4.25	3.23
2014	30.00	4.56	3.90
2013	30.00	5.63	5.05

Source: Based on modelling and analysis completed on our behalf by ACIL Allen Consulting

4.5.4 COMPARING THE OPTIONS – TIME BLOCK MODELS

As explained in section 4.5.3 we developed an assessment framework based on three criteria: market reflectiveness, simplicity and behavioural response. In this section we apply this framework to the different time block models we examined.

MARKET REFLECTIVENESS

To evaluate the 'market reflectiveness' of each option, ACIL Allen undertook analysis that involved determining the variance between the actual prices observed in the wholesale market and the averages for each time period across the three years analysed.

Broadly speaking, the greater the number of time blocks the more market reflective the option. Option A2 (three part + seasonal variation) and Option B2 (two part + seasonal variation) along with Option A3 (three part + critical peak) and Option B3 (two part +

critical peak) were rated as the most market reflective. Option A1 (three part) and Option B1 (two part) were rated equally as the next most market reflective options.

A single time block was the least market reflective. Notably, it received a rating of 2 rather than the lowest rating of 1. This is to account for the fact that our method for setting the current FiT does increase the market reflectivity of using a single time block by using weights to account for the fact that solar PV (as the dominant form of distributed generation technology) typically exports at certain times of day.

In other words, payments (as opposed to prices) under the current tariff structure are designed to broadly reflect, in aggregate, payments that a solar PV distributed generator would receive if they were paid the wholesale price. But this does not apply to distributed generation of any other technology type. The ratings are presented in table 4.8.

TABLE 4.8 MARKET REFLECTIVENESS OF EACH MODEL
Rating of 1–5

Option	Market reflectiveness (rating)
Current tariff – single time block	2
Option A1 – Three part	4
Option A2 – Three part + seasonal variation	5
Option A3 – Three part + critical peak	5
Option B1 – Two part	4
Option B2 – Two part + seasonal variation	5
Option B3 – Two part + critical peak	5

Legend: 1 = not market reflective, 2 = great distance from being market reflective, 3 = market reflective to some degree, 4 = relatively market reflective, 5 = most market reflective
Source: ACIL Allen Consulting & ESC

SIMPLICITY

To evaluate the simplicity of each option the Commission applied its judgement as to the ease of understanding, and the ease of implementation, of each option, from the perspective of both a distributed generator and an electricity retailer.

Against this criterion, the comparison case of the existing single tariff structure was rated highest (or most simple). We rated Option A1 (three part) and Option B1 (two part) equally as the next most simple. The remaining options (A2, A3, B2, B3) we rated equally as less simple to understand and implement. The ratings we applied are presented in table 4.9 below.

TABLE 4.9 SIMPLICITY OF EACH MODEL
Rating of 1–5

Option	Simplicity (rating)
Current tariff – single time block	5
Option A1 – Three part	4
Option A2 – Three part + seasonal variation	3
Option A3 – Three part + critical peak	3
Option B1 – Two part	4
Option B2 – Two part + seasonal variation	3
Option B3 – Two part + critical peak	3

Legend: 1 = complex, 2 = relatively complex, 3 = moderately complex, 4 = relatively simple, 5 = simple
Source: ACIL Allen Consulting & ESC

BEHAVIOURAL RESPONSE

To evaluate the likelihood of each option provoking a behavioural response on the part of the distributed generator, the Commission applied its judgement, drawing upon the views of stakeholders expressed through submissions to our approach paper, where appropriate.

For clarity, 'behavioural response' refers to decisions around the utilisation of the distributed generation resource – in other words, behaviour that influences the time and volume of electricity exported – rather than decisions about whether or not to invest in distributed generation technology in the first place.

Against this criterion, we rated the options that included a critical peak as equal highest (Option A3 and Option B3). Although the proposed operation of a critical peak price means that distributed generators will not be able to predict with certainty when the price will apply, the fact the critical peak tariff is several times higher than the tariff at other times may be sufficient motivation for distributed generators to alter their behaviour to capitalise on likely critical peak events (during heat waves, for instance, when demand for electricity tends to spike in line with air conditioner use).

Further, while critical peak periods are not specified in advance, AEMO publishes on their website forecasts wholesale electricity prices for each half hour interval for the following day. These forecasts – known as pre-dispatch data – could be used by distributed generators to predict when critical peak periods are likely to occur.[51] When considered alongside the roll out of flexible retail tariffs, it is conceivable that the shift to a more flexible FiT that incorporates critical peak pricing may prompt innovation in consumer products, such as smartphone applications, designed to facilitate better visibility of real-time prices in the wholesale market.

We rated Option A1 (three part) and Option B1 (two part) equally as the next most likely to stimulate a behavioural response. The comparison case of a single time block we rated as providing an undifferentiated signal for behavioural response because it provides no rationale to export electricity at one time over another. The ratings we applied are presented in table 4.10.

TABLE 4.10 BEHAVIOURAL RESPONSE FOR RATING EACH MODEL Rating of 1–5

Option	Behavioural response (rating)
Current tariff – single time block	2
Option A1 – Three part	3
Option A2 – Three part + seasonal variation	3
Option A3 – Three part + critical peak	4
Option B1 – Two part	3
Option B2 – Two part + seasonal variation	3
Option B3 – Two part + critical peak	4

Legend: 1 = no incentive for a behavioural response, 2 = weak incentive for a behavioural response, 3 = moderate incentive for a behavioural response, 4 = reasonably strong incentive for a behavioural response, 5 = strong incentive for a behavioural response
Source: ACIL Allen Consulting & ESC

[51] Pre-dispatch data is available at AEMO, *Pre Dispatch*, http://www.aemo.com.au/Electricity/Data/Market-Management-System-MMS/Pre-Dispatch, accessed 18 April 2016

SELECTING A PREFERRED OPTION

A summary of the ratings we applied to each option under each criteria is presented in table 4.11.

TABLE 4.11 COMPARING THE TIME BLOCK OPTIONS
Rating of 1–5

Option	Market reflectiveness	Simplicity	Behavioural response
Current tariff – single time block	2	5	2
Option A1 – Three part	4	4	3
Option A2 – Three part + seasonal variation	5	3	3
Option A3 – Three part + critical peak	5	3	4
Option B1 – Two part	4	4	3
Option B2 – Two part + seasonal variation	5	3	3
Option B3 – Two part + critical peak	5	3	4

The results of the assessment were close. No time block option rated significantly higher than all others. Despite some minor variation when compared with a single time block all time block options were, broadly speaking, similarly preferable.

Of the two highest rated options, we favoured Option A3 (three part + critical peak). This option is followed by Option B3 (two part + critical peak), after which we favoured all remaining options equally, with the exception of a single time block which was favoured least.

We favoured the ‘three part’ option over the ‘two part’ option because it aligns with an existing set of time blocks in the retail electricity market and so should be more easily understood by market participants. We also favoured including a critical peak payment on the assumption that being significantly higher than the base rates it has the greatest potential to provide a strong signal for behavioural change.

In considering the seasonal variations (Option A2 and Option B2), our view was that all other factors being equal, the option did not produce enough benefits to justify the additional granularity and the requirement for distributed generators and retailers to make adjustments based on the time of year.

IMPLEMENTING A MULTI-RATE TARIFF – TIME BLOCKS

While multi-rate tariffs better match the underlying wholesale price of electricity when compared to a single flat FiT, they can be expected to impose a greater compliance cost on retailers.

Under the existing framework, the FiT is a single-rate tariff. We are mindful that any change to the framework than entails shifting to a multi-rate tariff will have implications for retailers, particularly in terms of the design of ICT systems. (As we noted earlier, in their submissions retailers preferred a single-rate tariff to a multi-rate tariff.)

Through the public consultation on this report, we are seeking feedback from all stakeholder, including retailers, on implementation challenges implied by each time block option under consideration. Absent further information, we assume that the implementation costs to retailers are proportionate to the number of rates in each multi-rate option. For example, options A2 and B2 (the options with seasonal variation) are assumed to be the most costly to implement, while option B1 (the basic two part option) is assumed to be the least costly alternative option to the current FiT. In chapter 7, we include a specific question for public consultation on this issue.

4.6 ACCOUNTING FOR LOCATION OF EXPORTS (LINE LOSSES)

This section sets out the options we considered for structuring payments that better reflect the effect of line losses on the wholesale market value of centrally dispatched generation. This task requires examining the effect of the location of the distributed generator on the value of the centrally dispatched electricity it displaces.

4.6.1 VARIABILITY OF LINE LOSSES

As explained previously, ‘line losses’ refer to the electricity that is lost as heat while power is transmitted through the grid between the generator and the consumer. These losses vary across the state. This variation is based on the proximity of a customer to the central generation facilities and also on the attributes of the specific transmission and distribution infrastructure that links their premises to the central facility.

In the National Electricity Market (NEM), there are three steps in the process by which electricity is delivered to customers from the central generation facility. The electricity is:

1. transmitted from the generator to the Regional Reference Node (RRN)
2. transmitted from the RRN to the distribution connection point
3. distributed from the distribution connection point to the customer

The wholesale electricity price is determined at the RNN and already takes into the account the electricity lost between that point and the generator. Consequently, the average wholesale prices quoted in section 4.5.3 already account for the losses between the generator and the RRN.

The remaining losses can be quantified using the 'loss factors' published annually by AEMO. There are a total of 234 'loss zones' in Victoria, defined by reference to the combination of transmission and distribution network losses.[52] The loss adjustment factors across these zones range from 102 per cent to 123 per cent.[53] Generally speaking, the lowest losses occur in the Latrobe Valley, which is close to very large generators, and in the Greater Melbourne area, which is supplied by high voltage (low loss) transmission lines. Higher losses occur in areas to the north and west of the state, which are further from the large generators. Line losses are at their highest at Red Cliffs, near Mildura.

The following sections outline the Commission's proposed approach to applying 'loss zones' in calculating FiT rates.

[52] Based on modelling and analysis completed on our behalf by ACIL Allen consulting. AEMO publishes a table of 45 distribution loss factors for Victoria. These are distinguished based on the way in which the customer's premises are connected to the distribution network, and in particular the voltage of that connection. The loss factors most likely to be relevant to small/residential customers are types 'D' and 'E'. Which of these is applicable to an individual customer depends on whether they are connected via a short sub-transmission line or a long sub-transmission line to: (i) the lower voltage terminals of a distribution transformer at 240/415 kV (type D), or (ii) a low voltage power line at 240/415 kV (type E). Of the five Victorian electricity distributors, all but CitiPower have long sub-transmission lines, so there are 18 distribution loss factors that apply. (That is - 4 long sub-transmission * DLF types E and D plus 5 short sub-transmission * DLF types E and D.) AEMO publishes transmission loss factors for 63 connection points in Victoria, of which nine relate to CitiPower's area.

[53] Which corresponds to losses of 1.96 and 18.7 per cent, respectively, between the RNN and the consumer.

4.6.2 SIMPLIFYING LINE LOSSES

The current Victorian FiT uses one loss zone, based on a weighted average loss adjustment of 106.5 per cent for all distributed generators, regardless of where they are located. This represents an average of 6.10 per cent of electricity lost between the RNN and the end consumer on a state-wide basis. This approach reduces the benefit paid to distributed generators located in northern and western Victoria below the true energy value.

Analysis of the loss factors suggests several possible options for grouping regions into loss zones that have a similar loss factor. The first level of simplification is to assume that all distributed generators are connected via a short sub-transmission line to a low voltage power line (type E).[54] This approach reduces the number of loss zones from 234 to 63.

The second level of simplification is to group regions into loss zones. We look at two ways of grouping these zones. The first is by electricity distribution area and the second is by geographical area.

LINE LOSSES BY ELECTRICITY DISTRIBUTION AREA

If the loss zones are grouped by electricity distribution area, the number of loss zones would reduce from 63 to five. Analysis provided to us by ACIL Allen indicated that the current loss factors for each electricity distribution area are:

- AusNet Services – 106 per cent
- CitiPower – 104 per cent
- Jemena – 105 per cent
- Powercor – 111 per cent
- United Energy – 104 per cent.

[54] Most distributed generators are likely to be in this category because most customers are connected to short sub-transmission lines, with a relatively small number of customers in rural areas connected to long sub-transmission lines in rural areas. And most customers are connected to a low voltage power line, with only a relatively small number of customers in rural areas connected to the lower voltage terminals of a distribution transformer.

The resultant loss factors for the Melbourne based electricity distribution areas (CitiPower, Jemena and United Energy) are similar, which suggests that the number of loss zones could be reduced further by combining these electricity distribution areas. This approach reduces the number of loss zones further to three, with loss factors of:

- AusNet Services (eastern Victoria) – 106 per cent
- Jemena, United Energy and CitiPower (Greater Melbourne) – 104 per cent
- Powercor (western Victoria) – 111 per cent.

LINE LOSSES BY GEOGRAPHIC AREA

One potential problem with defining loss zones by reference to the electricity distribution areas is that AusNet Services' distribution area includes the Latrobe Valley, where losses are low, and the north-east of the state, where losses are relatively high. We therefore consider defining 'loss zones' by geographic area rather than by electricity distribution area. Under this approach, the north-east of the state is assigned to a different loss zone than the Latrobe Valley.

We considered three loss zones defined geographically: one loss zone for the Latrobe Valley and Gippsland (eastern Victoria). The second loss zone would include Greater Melbourne and Geelong. Meanwhile, the third loss zone would include the remainder of the state, namely western and northern Victoria. The proposed loss factors for these three loss zones are:

- Greater Melbourne and Geelong – 105 per cent
- Western and northern Victoria – 113 per cent
- Eastern Victoria – 103 per cent.

If instead, we use two loss zones defined geographically: one loss zone would include Greater Melbourne, Geelong and eastern Victoria; the rest of Victoria would be included in another loss zone. The proposed loss factors for these two loss zones are:

- Melbourne, Geelong and eastern Victoria[55] – 105 per cent
- Western and northern Victoria – 113 per cent.

[55] Includes the Latrobe Valley and surrounding regions.

LOSS ZONE OPTIONS

Based on the preceding analysis, we consider the following options as ways to simplifying the role of line losses (along with the current approach as the comparison case):

- Current approach – a single state-wide loss factor
- **Option A** – five loss zones based on electricity distribution areas (*AusNet Services, CitiPower, Jemena, Powercor, and United Energy distribution areas*)
- **Option B** – three loss zones based on electricity distribution areas (*CitiPower/Jemena/United Energy, AusNet Services, and Powercor distribution areas*)
- **Option C** – three geographically based loss zones (*Greater Melbourne and Geelong, northern and western Victoria, and eastern Victoria*)
- **Option D** – two geographically based loss zones (*Greater Melbourne, Geelong and eastern Victoria, and northern and western Victoria*).

The loss factors that would be applied across the major regions of Victoria under each of these scenarios are set out in table 4.12.

TABLE 4.12 LOSS ZONE OPTIONS BY VICTORIAN REGION

Approx. loss factor that applies under each loss zone option (per cent)

Location	1 state-wide loss zone	5 distribution area loss zones	3 distribution area loss zones	3 geographic loss zones	2 geographic loss zones
Greater Melbourne	106.5	104 – 111[56]	104	105	105
Geelong	106.5	111	111	105	105
Western and north west Victoria	106.5	111	111	113	113
North east Victoria	106.5	106	106	113	113
Eastern Victoria	106.5	106	106	103	105

Source: Based on modelling and analysis completed on our behalf by ACIL Allen consulting

[56] Note that Greater Melbourne contains a number of distribution zones and hence a number of loss factors.

Higher loss factors imply a greater adjustment to the wholesale market price when calculating the value of the distributed generation exports. This is true no matter which method is used from section 4.5.3. Put simply, a higher loss factor implies a higher value for the distributed generation export – or in other words, a higher FiT. This result can be explained intuitively. A higher loss factor means that more electricity must be centrally generated in order to supply that area. If a distributed generator is located in an area with a high loss factor, it avoids this comparatively greater amount of electricity being generated and dispatched from central sources.

The different approaches to calculating loss zones will alter the loss factors applying at different locations around the state. For example, a distributed generator located in Mildura will receive a loss factor of 106.5 per cent under a single state-wide factor, but would receive either 111 per cent (Option A and Option B) or 113 per cent (Option C and Option D) under the other options being considered. Meanwhile, the loss factors applied to a distributed generator situated in Traralgon, as an example of an eastern Victorian location, would be slightly below the state-wide figure of 106.5 per cent.

For distributed generators situated in Greater Melbourne, the factors will be slightly lower under the alternative loss zone options than under a single state-wide loss factor. For Geelong, the rate that is paid to a distributed generator will be higher than when one state-wide loss factor is applied if the loss zones are based on distribution area (Option A and Option B), and will be lower if the loss zones are based on geographic area (Option D and Option C).

For distributed generators in Horsham, for example, the loss factor applied under all alternative scenarios would be higher than that applied under the state-wide factor. For locations in the north of the state, like Shepparton and Wangaratta, the factor would go down under either loss zone based on a distribution area (Option A and Option B) and go up under zones based on geographic area (Option C and Option D).

4.6.3 COMPARING THE OPTIONS – LOSS ZONES

As explained in section 4.4.1, we developed an assessment framework based on three criteria: market reflectiveness, simplicity and behavioural response. In this section we apply this framework to the loss zone options.

MARKET REFLECTIVENESS

To evaluate the 'market reflectiveness' of each option, ACIL Allen undertook analysis which involved considering notional distributed generators situated at five locations around the state, namely:

1. Melbourne (supplied by the Thomastown terminal station in Jemena's distribution area)
2. Mildura (supplied by the Red Cliffs terminal station in Powercor's distribution area)
3. Wodonga (supplied by the Wodonga terminal station in Ausnet Service's distribution area)
4. Traralgon (supplied by the Morewell terminal station in Ausnet Services' distribution area)
5. Shepparton (supplied by the Shepparton terminal station in Powercor's distribution area)

ACIL Allen 'placed' a notional distributed generator at each of these locations and computed the annual payment they would have received in 2015 under a nominal time block structure (in this case, the 'three part' time block model), based on the actual loss factor that applies to each location.[57] ACIL Allen then compared this annual payment to what each distributed generator would have received if the annual payment had instead been calculated under each of the different loss zone options we outlined above.

The analysis indicated that the most market reflective option was Option C (three geographic zones), followed by Option D (two geographic zones) and Option B (three distribution zones) which shared the same rating. Option A (five distribution zones) received a low rating, while the comparison case of the single state-wide zone was rated lowest. These ratings are presented in table 4.13.

[57] To select a distribution loss factor, ACIL assumed the customer is supplied by a low voltage power line via a short sub-transmission line. The notional customer was assumed to have a 3kW solar PV system.

TABLE 4.13 MARKET REFLECTIVENESS OF EACH LOSS ZONE OPTION
Rating of 1-5

Option	Market reflectiveness (rating)
Current tariff – state-wide loss zone	1
Option A – Five zones (distribution area)	2
Option B – Three zones (distribution area)	3
Option C – Three zones (geographic area)	5
Option D – Two zones (geographic area)	3

Legend: 1 = not market reflective, 2 = great distance from being market reflective, 3 = market reflective to some degree, 4 = relatively market reflective, 5 = most market reflective relative to options examined
Source: ACIL Allen Consulting & ESC

SIMPLICITY

As when looking at time block models, to evaluate the simplicity of each option the Commission applied its judgement about the ease of understanding and implementation of each option, from the perspective of both a distributed generator and an electricity retailer, respectively.

A single state-wide loss zone is the simplest option. After that, we considered the options based on distribution area (Option A and Option B) to be the next most simple because distribution areas are understood by existing market participants such as retailers and distribution businesses.

We considered defining zones based on geography (Option C and Option D) to be marginally less simple than working with existing distribution areas because their boundaries are not currently defined. However, we still considered geographic zones to be a simple option given that the options considered were limited to having either two or three zones across the state (as opposed to 10 or 20 zones, for example). Our expectation is that the boundaries of such zones could be defined relatively easily with reference to postcodes.

The ratings we applied are presented in table 4.14.

TABLE 4.14 SIMPLICITY OF EACH LOSS ZONE OPTION
Rating of 1-5

Option	Simplicity (rating)
Current tariff – state-wide loss zone	5
Option A – Five zones (distribution area)	4
Option B – Three zones (distribution area)	4
Option C – Three zones (geographic area)	3
Option D – Two zones (geographic area)	3

Legend: 1 = complex, 2 = relatively complex, 3 = moderately complex, 4 = relatively simple, 5 = simple
Source: ACIL Allen Consulting & ESC

BEHAVIOURAL RESPONSE

As when assessing time blocks, the Commission applied its judgement to evaluate the likelihood of each loss zone option provoking a behavioural response.

We considered Option C and Option D (three and two geographic zones) provided the greatest potential for behavioural response because they provided the strongest signal to the north and west of the state, where losses are greatest. They were both preferable to Options A and Option B (five and three distribution zones). The single state-wide loss zone provides an undifferentiated signal for behavioural response.

The ratings we applied are presented in table 4.15.

TABLE 4.15 BEHAVIOURAL RESPONSE FOR RATING EACH LOSS ZONE OPTION
Rating of 1-5

Option	Behavioural response (rating)
Current tariff – state-wide loss zone	2
Option A – Five zones (distribution area)	2
Option B – Three zones (distribution area)	2
Option C – Three zones (geographic area)	3
Option D – Two zones (geographic area)	3

Legend: 1 = no incentive for a behavioural response, 2 = weak incentive for a behavioural response, 3 = moderate incentive for a behavioural response, 4 = reasonably strong incentive for a behavioural response, 5 = strong incentive for a behavioural response
Source: ACIL Allen Consulting & ESC

SELECTING A PREFERRED OPTION

On the basis of these assessment criteria, our preferred option is Option D; that is, two zones defined by geographic area. Under this designation, Zone 1 would be Melbourne, Geelong and eastern Victoria with a loss factor of 105 per cent; Zone 2 would be western and northern Victoria with a loss factor 113 per cent.

Option D was considered the preferred option because, although it rated lower than Option C in terms of market reflectiveness and equal to that option in terms of simplicity and behavioural response, we judged that it would be more straightforward to implement. Further, although we rated marginally lower for simplicity than the options based on distribution zone, we considered the relatively small differential in terms of simplicity was outweighed by the higher potential for behavioural response represented by the geographic zone options. Hence we favoured it on the basis of practicality and behavioural response.

In descending preference order, Option D was followed by Option C (three zones defined by geographic area), Option B (three zones based on distribution area) and Option A (five zones based on distribution area). All options were preferable to a single state-wide factor.

A summary of the ratings we applied to each option under each criteria is presented in table 4.16.

TABLE 4.16 COMPARING THE LOSS ZONE OPTIONS
Rating of 1-5

Option	Market reflectiveness	Simplicity	Behavioural response
Current tariff – state-wide loss zone	1	5	1
Option A – Five zones (distribution area)	2	4	2
Option B – Three zones (distribution area)	3	4	2
Option C – Three zones (geographic area)	5	3	3
Option D – Two zones (geographic area)	3	3	3

IMPLEMENTING A MULTI-RATE TARIFF – LOCATION ZONES

As we acknowledged in our discussion of time block options above, we recognise that any change to the current single rate FiT framework will have implications for retailers. Similarly to our examination of alternative time block options, we are seeking feedback from all stakeholders, including retailers, on the implementation costs associated with each location zone option.

We assume that establishing location zones based on geographic area would be more costly than establishing zones based on distribution business area. The boundaries of the latter are already well understood by retailers, whereas the boundaries of the former are yet to be defined. We also assume that the cost is proportionate to the number of zones. Or in other words, fewer zones means lower implementation costs. In chapter 7, we include a specific question for public consultation on this issue.

4.7 CONCLUSION AND DRAFT RECOMENDATIONS

This chapter examined the monetary value of distributed generation electricity in the wholesale electricity market. It assessed the existing framework – the minimum FiT – for how effectively it facilitated payments of this value to distributed generators. It proposed a number of ways for the current framework to be amended to facilitate payments that better reflect the market price of centrally dispatched electricity that is displaced by exported distributed generation electricity.

The Commission makes the following draft recommendations.

Draft Recommendation 1: Basis for calculating the feed-in tariff

The feed-in tariff should continue to be calculated annually, having regard to wholesale market prices and any distribution and transmission losses avoided in Victoria by the supply of distributed generation electricity.

Draft Recommendation 2: Eligibility for payments

Solar photovoltaic (PV), wind, hydro and biomass remain eligible technologies for receipt of feed-in tariff payments[58], and eligibility be retained for units up to a generating capacity of 100kW.

Draft Recommendation 3: Multi-rate feed-in tariffs

The current single tariff should be replaced by a framework that allows for a time and location varying feed-in tariff that more closely reflects the underlying wholesale price of electricity.

Draft Recommendation 4: Time-varying feed-in tariffs

The Commission sets a multi-rate feed-in tariff to align with the time blocks operating for flexible retail prices (namely: peak, shoulder and off-peak). The time varying feed-in tariff should be supplemented with a 'critical peak' tariff that would be paid when the wholesale price of electricity is equal to or exceeds $300 per MWh. The time varying feed-in tariffs should be calculated by the Commission on an annual basis.

Draft Recommendation 5: Locational feed in tariffs

The Commission sets a multi-rate feed-in tariff that divides Victoria into two regions reflecting the different average line losses across the state. The two regions would consist of (i) Melbourne, Geelong and the east of the state; and (ii) the north and west of the state. Higher line losses would apply in the north and west of the state.

[58] The Commission notes that the legislation that establishes the FiT framework also provides a mechanism for other forms of distributed generation to be involved in the framework.

Draft Recommendation 6: Fully reflective feed in tariff

If an electricity retailer is able to offer a feed-in tariff that fully reflects the half hourly prices in the wholesale market, and the distributed generator provides express and informed consent when accepting that tariff option, then the retailer's obligation to offer the regulated feed-in tariff rates as proposed in this draft report should be suspended for the duration of that agreement.

5 ENERGY VALUE OF DISTRIBUTED GENERATION - ENVIRONMENTAL AND SOCIAL BENEFITS

5.1 INTRODUCTION

This chapter presents our preliminary findings with regards to the monetary value of the environmental and social benefits of distributed generation. Based on the available data we find that we can only proceed to estimate the value of the benefit of avoided greenhouse gas emissions. In examining the benefits, we applied the three-part process that we described in section 3.3.3. The process focused on identifying the environmental and social benefits that can be reliably and directly linked to distributed generation and also quantified.

The chapter then examines how effectively the current regulatory framework remunerates distributed generators for the environmental and social value they produce. It concludes by examining how this value might be calculated under an alternative framework that facilitated payments based on the environmental and social benefits of the electricity produced by distributed generation.

SUMMARY

The Commission has concluded that the only area of environmental value on which it can proceed with reasonable confidence is reduced emissions of greenhouse gases. That is, the electricity produced by distributed generation may displace more emissions intensive generation and thereby contribute to the abatement of greenhouse gases. This value is provided by all electricity produced by a distributed generator (that is, the gross output), not just the quantum of electricity exported.

We identify a method for calculating the *volume* of greenhouse abatement for various forms of distributed generation and to which a monetary value for that abatement may be applied.

Because the determination of a value for avoided emissions is a matter for Government policy, the Commission has not sought to place a monetary value on this benefit.

The Commission acknowledges that there may be other environmental benefits for distributed generation. The Commission did not find data capable of supporting a monetary value being assigned to these environmental benefits.

Similarly, the Commission acknowledges that there may be social benefits for distributed generation, but the Commission did not find data capable of supporting a monetary value being assigned to these social benefits.

5.1.1 STRUCTURE OF THIS CHAPTER

The chapter is structured as follows:

Section 5.1 Introduction

Section 5.2 Identification of environmental and social benefits

- Our approach to assessing benefits to be valued
- Assessment of the environmental and social benefits identified through submissions to determine those capable of being evaluated including: avoided

pollution (encompassing greenhouse gas reduction), avoided resource extraction, job creation, increased choice and competition, enhanced wellbeing.

Section 5.3 Value of avoided greenhouse gas emissions

- Do existing frameworks compensate distributed generators for avoided greenhouse gas emissions?
- Quantification of avoided greenhouse gas emissions as a result of distributed generation electricity
- Can a monetary value be placed on these benefits?

Section 5.4 Conclusion: Our draft decision on the environmental and social value of distributed generation electricity.

5.2 ENVIRONMENTAL AND SOCIAL BENEFITS

5.2.1 WHICH BENEFITS SHOULD BE VALUED?

Through stakeholder submissions the Commission received extensive feedback on the potential environmental and social benefits of distributed generation. In chapter 3, we presented the three-part process we used to assess these potential benefits (see below). In applying this process, we have sought evidence with a high standard of probity. It is likely the costs associated with issuing payments to distributed generators on the basis of any such benefits will be incurred ultimately by all electricity customers.[59] In light of the Commission's overarching objective to promote the long term interests of Victorian consumers, the Commission must rely upon robust evidence when exercising its decision making in this context.

Our three-part process is:

- **Identification** – We consider the potential benefits of distributed generation and whether it is possible to establish a causal link between the electricity output of distributed generation and the benefit..

[59] That is, we expect that retailers will pass through to consumers the compliance costs incurred by them in complying with requirement to make payments to consumers on the basis on such benefits. Alternatively, some or all of these costs may be borne by shareholders of the retailers.

- **Quantification –** We consider whether it is possible to measure the quantum of benefit delivered in Victoria by a unit of distributed generation electricity.
- **Valuation –** We consider whether it is possible to place a monetary value on the benefit.

The potential benefits of the electricity produced by distributed generation that were identified through the Commission's research and through stakeholder submissions are listed in table 5.1, including a summary of our assessment. The following sections steps through our analysis of each of the proposed benefits. This is followed by an evaluation of avoided greenhouse gas emissions.

The submissions to our approach paper provided feedback on the potential benefits caused by the *energy* produced by distributed generation. Many submissions also discussed the potential benefits of distributed generation arising through its effect on the electricity distribution *network*. This report is focused solely on the former category – the benefits relating to 'energy value'. We will respond to the proposed network benefits in a separate series of reports starting in the second half of 2016.

Through the questions for stakeholders set out in the final chapter of this report, the Commission invites stakeholders to provide additional evidence that might be used to reliably link and quantify the benefits of distributed generation that we were not able to quantify in this report.

TABLE 5.1 SUMMARY OF POTENTIAL ENVIRONMENTAL AND SOCIAL BENEFITS OF DISTRIBUTED GENERATION ELECTRICITY

Rating of 1-5

Category	Effect	Assessment summary
Avoided pollution	Avoided greenhouse gas emissions	**Identification** – Distributed generation (DG) reduces greenhouse gas (GHG) emissions by displacing higher emissions intensity generation. Reduced GHG emissions are a benefit to society. **Quantification** – We can estimate the reduction of GHG emissions by combining information about the estimated volume of electricity produced by DG with information about the emissions intensity of the conventional generation it is forecast to displace. **Valuation** – Because the determination of a value for avoided emissions is a matter for Government policy, the Commission has not sought to place a monetary value on this benefit.

Category	Effect	Assessment summary
	Avoided respiratory-related health impacts from air pollution	**Identification** – There is evidence that air pollution from conventional electricity generation can affect respiratory health. To the extent that DG displaces conventional generation, it may be causally linked to a reduction in those health effects. **Quantification** – We can estimate the quantity, type and location of conventional generation that is displaced using information about the estimated volume and timing of electricity produced by distributed generation. However the analysis indicated that the DG is likely to be located in other states. We were not able to quantify the quantum of this benefit that manifests in Victoria with enough certainty to form the basis for a payment. **Valuation** – Some studies, such as the 2009 ATSE study, estimate a dollar figure for the health costs saved through each MW of conventional fossil-fuel generation reduced in Australia. However there is a degree of uncertainty around how these figures should be applied in the Victorian context, making it problematic to use the figure as a basis for payments to distributed generators.
	Reduced land and water pollutants	**Identification** – To the extent that DG displaces conventional electricity generation, it may be causally linked to a reduction in land and water pollutants from conventional generation. **Quantification** – We can estimate the quantity, type and location of conventional generation that is displaced using information about the estimated volume and timing of electricity produced by DG. However the analysis indicated that the displaced generation is likely to be located in other states. We were not able to quantify the quantum of this benefit that manifests in Victoria with enough certainty to form the basis for a payment. **Valuation** – It was not clear what evidence could be used to quantify the monetary value of this benefit.
Avoided resource consumption and extraction	Reduced water consumption	**Identification –** To the extent that DG displaces conventional electricity generation, it may be causally linked to a reduction in the water used during conventional generation processes. **Quantification –** We can estimate the quantity, type and location of conventional generation that is displaced using information about the estimated volume and timing of electricity produced by DG. However the analysis indicated that the displaced generation is likely to be located in other states. We were not able to quantify the quantum of this benefit that manifests in Victoria with enough certainty to form the basis for a payment. In any case, it was not clear from the evidence considered whether the reduction in water use by conventional generators can be reliably estimated based on the reduction in electricity output – there are a number of factors that impact the amount of water used for centralised generation. **Valuation –** Because were we not able to quantify this benefit we did not proceed to calculate a value for it.
	Reduced environmental impact from mining	**Identification –** To the extent that DG displaces conventional generation electricity, it may be causally linked to a reduction in demand for fossil fuel extraction, which may in turn lead to a reduction in

Category	Effect	Assessment summary
	Avoided health impact from coal-mine fires	associated negative environmental and health impacts of the extraction process. **Quantification –** The causal link between a unit of DG electricity and the outcomes described above is too uncertain to reliably quantify the benefit. **Valuation –** Because were we not able to quantify this benefit we did not proceed to calculate a value for it.
Job creation	Job creation	**Identification –** It is not clear why jobs created through investment in distributed generation, as compared to jobs created elsewhere in the economy, warrant additional compensation through a feed-in tariff. **Quantification –** Because we did not consider this effect to be appropriate for inclusion in the calculation of 'true value', we did not proceed to quantify or value it. **Valuation –** As above.
Increased choice and competition	Increased choice	**Identification** – To the extent distributed generation provides its owner with more options with regard to the supply of their electricity, it may be causally linked to an increase in choice for that person. However this benefit accrues directly to owner/investor in distributed generator without regulatory intervention and is therefore out of scope of this inquiry. **Quantification** – Because we did not consider this benefit to be appropriate for inclusion in the calculation of 'true value', we did not proceed to quantify or value it. **Valuation** – As above.
	Increased competition for energy	**Identification** – While the entry of distributed generation, like the entry of any new generation, means existing retailers and generators must compete more vigorously for customers, it is not clear why distributed generators should be compensated for this benefit. **Quantification** – Because we did not consider this benefit to be appropriate for inclusion in the calculation of 'true value', we did not proceed to quantify or value it. **Valuation** – As above.
Enhanced wellbeing	Increased empowerment	**Identification** – DG may be causally linked to increased empowerment and wellbeing for the investor. However this benefit accrues directly to owner/investor in distributed generator without regulatory intervention and is therefore out of scope of this inquiry. **Quantification** – Because we did not consider this benefit to be appropriate for inclusion in the calculation of 'true value', we did not proceed to quantify or value it. **Valuation** – As above.
	Increased social cohesion and community cooperation	**Identification** – The deployment of DG may be causally linked to an increase in social cohesion of community cooperation. **Quantification** – It was not clear how this benefit could be quantified. **Valuation –** Because were we not able to quantify this benefit we did not proceed to calculate a value for it.

5.2.2 AVOIDED POLLUTION

One benefit of distributed generated electricity is avoided pollution to the extent it displaces energy from fossil-fuel generators. This was recognised in a number of stakeholder submissions. We grouped the following benefits into this category:

- reduced greenhouse gas emissions
- avoided respiratory-related health impacts from air pollution
- reductions in other pollutants.

REDUCED GREENHOUSE GAS EMISSIONS

In our approach paper we acknowledged avoided greenhouse gas emissions as the primary factor for consideration as an environmental benefit. This position was supported by a majority of stakeholders. Environmental Justice Australia, the APA Group and AGL stated the following:

> *We agree that distributed energy provides the environmental benefits … primarily by lessening the demand for electricity produced [by] more greenhouse gas intensive generators…*[60]

> *Emissions reduction is a potential environmental benefit provided by a DG. Renewable energy generators in particular, may provide clean energy to the site, to the grid, or both …*[61]

> *…the potential carbon benefit associated with distributed generators whose output is less emissions intensive than the NEM-average*[62]

All grid-connected electricity customers will purchase and use electricity sourced from the National Electricity Market (NEM). Electricity in the NEM is produced from a range of fuel sources. These fuel sources range from brown coal, which has an emissions intensity of up to 1.5 kilograms (kg) of CO_2e per kilowatt hour (kWh) of generated electricity, through to wind and solar, which have emissions intensities of zero.[63]

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[60] Environment Justice Australia 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation – Proposed Approach Paper*, February, p. 2

[61] APA Group 2016, *Submission to Essential Services Commission Inquiry into the True Value of Distributed Generation – Proposed Approach Paper,* February, p. 3.

[62] AGL 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation – Proposed Approach Paper*, February, p. 8

[63] Based on analysis provided by ACIL Allen consulting.

(‘Emissions intensity’ refers to the amount of greenhouse gas emitted per unit of energy produced.)

Distributed generators typically use lower emissions intensity fuel sources than centralised generators. The most common form of distributed generation is solar photovoltaic (PV) (which, similar to other renewables, has an emissions intensity of zero). Other forms of distributed generation, such as gas fuelled co- and tri-generation systems, have an emissions intensity of greater than zero, but often still less than a central generator.[64]

Any energy supplied by a distributed generator displaces generation from central generation sources. The electricity that is consumed locally (that is, on site) displaces electricity that the distributed generator would have otherwise sourced from conventional generators via the electricity grid. The electricity that a distributed generator exports into the grid, and which is then available for retailers to purchase and on-sell, displaces conventional generation that would otherwise have been produced for sale in the wholesale market. (Under the feed in tariff (FiT) as described in the Electricity Industry Act, retailers are obliged to purchase distributed generation exports ‘first’, before they fulfil their customers’ demand via the wholesale market.)

We have identified that the electricity produced by distributed generation displaces more emissions intensive central generation, which leads to a reduction in greenhouse gases emissions occurs.

To quantify these greenhouse gas emission reductions by a distributed generator we must identify the emissions intensity of the distributed generator and compare it to the emissions intensity of the conventional generation it is displacing (referred to in this inquiry as the displaced ‘marginal generator’). As will be explained in the section 5.3.2, these pieces of information for the basis of this analysis can be reliably obtained (or in some cases reliably estimated).

We have identified that distributed generation directly reduces greenhouse gas emissions and is reliably quantifiable. We therefore proceed to determine a method for

[64] This is due to the overall energy efficiency of these systems, as they produce both electricity, and heating and cooling energy. Biogas fuelled systems would have even lower emissions intensity.

placing a monetary value on the benefit of avoided greenhouse gas emissions and perform this evaluation in section 5.3.3.

AVOIDED RESPIRATORY-RELATED HEALTH IMPACTS FROM AIR POLLUTION

In discussing potential health benefits, some stakeholders referenced a 2009 study by the Australian Academy of Technological Sciences and Engineering (ATSE). ATSE reviewed and contextualised a European method for calculating the monetary cost of the 'externalities' – that is, negative impacts on society – of conventional large-scale electricity generation in Australia.[65]

This is a view held by BEAM Mitchell Environment Group[66] and Environment Victoria, who commented that

> *…the air pollution created by fossil fuel-based electricity generation is known to be responsible for negative health impacts on communities near those generators.*[67]

The Northern Alliance for Greenhouse Action also stated that that there may be health benefits for communities nearby to coal-fired power plants.[68]

We recognise that there is a link between air pollution discharged from fossil fuel-based power plants and respiratory health problems for local communities. The Commission also accepts that air pollution is discharged from fossil fuel-based power plants, with its major air pollutants being particulate matter ($PM_{2.5}$), sulphur dioxide (SO_2) and nitrogen oxides (NO_x). This is consistent with the view of the Environment Protection Authority of Victoria (EPA Victoria).[69] To the extent that distributed generation displaces conventional fossil fuel-based generation, it may be causally linked to a reduction in the costs associated with respiratory-related health impacts.

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[65] The health impacts we driven specifically by from PM_{10}, SO_2 and NO_x. Biegler T. 2009, *The Hidden Costs of Electricity: Externalities of Power Generation in Australia,* The Australian Academy of Technological Sciences and Engineering, p. i.

[66] BEAM Mitchell Environment Group 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation,* February, p. 1

[67] Environment Victoria 2016, *Submission to Essential Services Commission Inquiry into the True Value of Distributed Generation – Proposed Approach Paper,* February, p. 1.

[68] Northern Alliance for Greenhouse Action 2016, *Submission to Essential Services Commission Inquiry into the True Value of Distributed Generation – Proposed Approach Paper*, February, p. 2.

[69] EPA Victoria, CSIRO (2013) *Future Air Quality in Victoria*, July p. 4, 10.

However, as explained in our analysis in section 5.3.2, our modelling indicated that under current market conditions the central generators that are displaced by distributed generation are unlikely to be located in Victoria. This introduced a high degree of uncertainty regarding the extent to which any resulting health benefit may be realised in Victoria.

This locational uncertainty added to other uncertainties around attributing a quantum of health benefit, and the associated reduction in cost, to a given unit of distributed generation. The Commission recognises the work of ATSE in articulating and demonstrating methods to compare the extent of externalities between large-scale generation technologies. However ATSE acknowledges a number of uncertainties in the study, including around attributing health outcomes to changes in air pollutant discharge, and those associated with estimating monetary values.

When discussing the benefit in aggregate these uncertainties are of less consequence, but in the context of establishing payments based on specific benefits produced by distributed generation they become problematic insofar as it becomes difficult to link a given output of distributed generation electricity to a specific health outcome. Consequently, we did not agree that the monetary values quoted in this study could be used as the basis of payments made to distributed generators for the health benefits of reduced air pollution.

In light of the uncertainty around the relationship between air pollution and health outcomes, and in the absence of data that provides a robust estimate of the potential reduction in health costs in Victoria caused by distributed generation, we conclude that it is not possible to reliably attribute or quantify the health benefits of distributed generation. As a result, we have not attempted to place a monetary value on this potential benefit.

OTHER POLLUTANTS

When it displaces central generation, distributed generation may be causally linked to a reduction in the discharge of other pollutants (i.e. land and water pollutants) associated central generation. Keith Wein suggested that:

> *…burning fossil fuels results in large amounts of unwanted by-products found in their flue gas and waste. Flue gas contains carbon dioxide and water vapor, as well as… mercury, traces of other metals, and, for coal-fired plants, fly ash.* [70]

We would expect the release of other pollutants to be largely proportional to the quantity of fossil-fuels burnt. In this regard, it should be possible to estimate the reduced pollution caused by distributed generation displacing fossil-fuel generated electricity. However it remains unclear how we might attach a monetary value to the outcome of reduced pollution.

In any case, as with our other examples of benefits that are derived from a reduction in central generation, our modelling indicates that the generation displaced by distributed generation is unlikely to be located in Victoria. Even if questions of valuation were overcome, there is currently too much uncertainty around whether the benefit would be realised in Victoria to base a payment to distributed generators upon this benefit.

5.2.3 AVOIDED RESOURCE EXTRACTION AND CONSUMPTION

To the extent that distributed generation electricity displaces centralised generation it may be causally linked to a reduction in resource consumption and extraction associated with centralised generation.

Some stakeholders suggested that one such benefit could be avoidance of coal-mine fires. This view is based on the rationale that a reduction in centralised generation leads to a reduction in demand for fossil fuels (such as coal), which in turns leads to a reduction in the mining and extraction of those fossil fuels. To the extent there is reduced mining activity, there may by a corresponding reduction in the risk of the negative impacts of mining, such as negative environmental or health impacts.

A significant body of work is being undertaken to understand the community health impacts as a result of mine fires, such as the Hazelwood Mine Fire Inquiry which was re-opened in May 2015 as a long-term study. However, the causal chain linking distributed generation to this benefit is lengthy and uncertain. The evidence attributing

[70] Keith Wein 2016, *Submission to Essential Services Commission Inquiry into the True Value of Distributed Generation – Proposed Approach Paper,* February p. 7.

this benefit to distributed generation was not sufficiently robust for us to proceed to quantify or value this benefit.

Separately, the Northern Alliance for Greenhouse Action expressed that there is potential benefit in Victoria from reduced water consumption resulting from reduced conventional power generation.[71] This is based on the operational needs of large-scale power plants, which consume significant volumes of water for cooling purposes.

As stated above, our analysis indicates that under current energy market conditions distributed generation is unlikely to lead to a reduction in central generation in Victoria, meaning that the associated benefit of reduced water consumption was also not likely to manifest in Victoria.

Even if this locational uncertainty was overcome, it remains unclear what evidence could be used to be confident that a reduction in large-scale power generation could be used to reliably estimate a reduction in water usage. Put differently, it is unclear whether there is a direct relationship between the power produced by a large scale power generator and the volume of water consumed by the plant.

The salience of this point was underscored by industry evidence that water consumption from large-scale power generators can be dynamic in response to various external drivers such as the availability of water resources, as noted by the National Water Commission:

> *There is strong evidence that the electricity generation industry is actively investing in improvements in water–efficiency, in part due to the impact of lower water inflows in most areas and of the ongoing drought*.[72]

Reductions in water consumption from centralised electricity generators could be based on a range of factors such as declining electricity consumption in Victoria and from efficiency improvements and innovation occurring from centralised generators to reduce water requirements. Given this uncertainty and that any potential benefit would be outside of Victoria, the Commission cannot quantify the benefits of reduced water consumption to a given output of distributed generateion electricity.

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[71] Northern Alliance for Greenhouse Action, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation – Proposed Approach Paper*, February, p.13.

[72] National Water Commission 2009, *Water and the electricity generation industry: Implications of use*, Australian Government Waterlines Report Series No. 18, August 2009, p. 82.

5.2.4 JOB CREATION

Some stakeholders suggested distributed generation leads to industry development, for instance through the creation of new energy technology jobs. We recognise that distributed generation may lead to the expansion of employment in certain industries. We would expect this to apply particularly to the solar PV installation industry (as opposed to manufacturing, for example).[73]

However, it is unclear whether increased employment associated with distributed generation would simply represent a transfer of jobs from one sector to another, rather than net job creation. This point was recognised by Energy Australia in its submission.[74] If distributed generation drives other industries to contract, such as those industries closely linked to conventional power generation, conceivably it could in fact lead to a net reduction in employment across the economy.

And even if it were possible to identify the jobs associated with investment in distributed generation, seeking to include this benefit draws forth a more profound conceptual question. A consumer purchases a good or service when the benefits derived by the consumer equal or exceed the cost of the purchase. While the purchase price of a good or service is defined in monetary terms, the benefits derived by the consumer can be monetary and non-monetary in nature.

The monetary value of the jobs created in the production of a good or service is reflected in the purchase price of the good or service.[75] The purchase price is determined in the market place for that particular good or service.

Putting these concepts together implies that the benefits derived by virtue of making a purchase serve to 'compensate' consumers for the price they must pay when making that purchase. As the price of a purchase reflects the jobs created in the production of that good or service, it follows that consumers are fully compensated for the jobs they

[73] Australian Bureau of Statistics 2016, *4631.0 - Employment in Renewable Energy Activities, Australia, 2014-15.*

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

[75] If this were not true, producers would soon be out of business as their cost of production would exceed their revenues from sales.

create when making a purchase by the benefits they derive from having made that purchase.

It is for this reason that consumers of phones, hotel services and restaurant meals do not receive additional payment (from, say, the government) for the jobs created in the telecommunications, hospitality or catering industries.

In this regard, there is nothing unique about distributed generation.

Households, businesses and other organisations will purchase distributed generation equipment because the monetary and non-monetary benefits of that purchase will at least match the price of making that purchase (and that purchase price reflects the jobs created). Non-monetary benefits may include the satisfaction derived from a sense of independence, at least partially, from the broader electricity market. Monetary benefits consist of the savings derived from not purchasing electricity from the broader market; and, in the presence of FiT scheme, the monetary return generated from exporting surplus electricity into that market and at the market price (as discussed in chapter 4). The payment to exporters will already reflect the jobs created at the market price of the electricity exported. Therefore, no further consideration of job creation is required when determining a FiT.

However, to the extent that distributed generation is a part of the energy mix, it may lead to growth of employment (in the new energy technology sector) in the event that its relative labour intensiveness is greater than that of the conventional energy supply chain.

5.2.5 INCREASED CHOICE AND COMPETITION

In its submission, Environmental Justice Australia highlighted increased consumer choice and the associated benefit of increased competition.[76] By providing an option for individuals to reduce their reliance on centrally dispatched electricity, the existence of a market of distributed generation systems certainly increases the choice experienced by certain energy consumers.

[76] Environment Justice Australia 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation – Proposed Approach Paper*, February. p. 3.

To the extent distributed generation provides its owner with more options with regard to the supply of their electricity, it may be causally linked to an increase in choice for that person. However this benefit accrues directly to owner/investor in distributed generation without regulatory intervention and is therefore out of scope of this inquiry.

While it may be true that the entry of distributed generation means that existing generators and retailers need to compete more vigorously for the remaining customers, the same can be said following the entry of any new generator or retailer. It is not clear why new competitors should be compensated for entering a market (beyond the price they obtain from selling their product); and likewise, it is not clear why a subset of those entrants (in this case, exporters of distributed generation) should be compensated.

5.2.6 ENHANCED WELLBEING

A number of stakeholders proposed benefits from distributed generation that could be collectively described as 'enhancing wellbeing', for either individuals or communities. One example was the potential for customer empowerment resulting from greater control over bills, as suggested by the Institute for Sustainable Futures.[77] It was also suggested that such benefits could increase social cohesion.[78]

A benefit such as enhanced wellbeing accrues to the investor in distributed generation without the need for government intervention. As such, it is outside the scope of this inquiry. Meanwhile, benefits that are expressed as communal appreciation of a collective decision, such as the decision as a community to invest in distributed generation, defy easy quantification becaase they rely upon a subjective experience. As a result, the Commission has not endeavoured to place a monetary value on these potential benefits.

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[77] 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

[78] Simply Energy 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation – Proposed Approach Paper*, February, p. 5

5.2.7 CONCLUSION – ENVIRONMENTAL AND SOCIAL BENEFITS

We reviewed a range of potential benefits arising from the effects of the energy produced by distributed generation. We found that at this stage of our inquiry, only avoided greenhouse gas emissions can be both reliably attributed to distributed generation and quantified.

In the following section we examine ways to place a monetary value on this benefit.

5.3 VALUE OF AVOIDED GREENHOUSE GAS EMISSIONS

Having identified that avoided greenhouse gas emissions is a benefit of distributed generation electricity, we consider three questions regarding the value of avoided greenhouse gas emissions:

- To what extent does the existing regulatory framework compensate distributed generators for the benefit of avoided greenhouse gas emissions?
- How can the volume of avoided greenhouse gas emissions be calculated?, and
- Can a monetary value be placed on this benefit?

5.3.1 THE OPERATION OF THE CURRENT FRAMEWORK

As stated previously in our approach paper, there are two mechanisms by which payments are made to distributed generators in Victoria; the feed-in tariff and the Commonwealth Government Renewable Energy Target (RET).[79] The question we seek to answer in this section is whether either of these mechanisms provides a payment that rewards distributed generators wholly or partially for the benefit of reduced greenhouse gas emissions.

The current FiT in Victoria makes payments based on the price of electricity in the wholesale electricity market and any distribution and transmission losses avoided by

[79] The most relevant section of the RET to this discussion is the Small Scale Renewable Energy Scheme (SRES), however for simplicity's sake we refer only to the RET.

the supply of distributed generation electricity.[80] The setting of the current FiT does not include the value of reduction in greenhouse gas emissions.

Through submissions, we received a range of views on whether payments under the RET adequately reward distributed generators for the reduction in greenhouse gases they cause. Some stakeholders considered RET payments sufficient,[81] while others argued they fell short of reflecting the actual value of this benefit.[82]

The divergent views on this subject can be explained in part by the RET scheme's multiple objectives.[83] One of those objectives is the reduction of greenhouse gases. Some stakeholders interpreted this to mean that the value of the payments made via the scheme are a direct, or at least sufficient, reflection of the value of the greenhouse gas reductions that occur as a result the associated distributed generators (typically solar PV systems). Other stakeholders argue that, even accounting for the scheme's objectives, the payments under the scheme are not sufficiently large to cover the full value of the reduction in emissions.

In the Commission's view it is not possible to objectively apportion the value of payments under the RET between the three objectives of the RET legislation.

We do, however, make the following observations. At the moment, there is no economy-wide mechanism for determining the price of emissions currently in place. When such a mechanism existed in 2013-14, it operated alongside the RET scheme. Likewise, the Emissions Reduction Fund, which pays emitters to reduce (or avoid) their emissions, currently coexists with the RET scheme.

This suggests Commonwealth Government policymakers have not considered the RET to be a sufficient, standalone instrument for reducing greenhouse gas emissions. In other words, it appears the RET does not fully reflect the value these policy makers

[80] Electricity Industry Act 2000; ESC 2015, *Minimum Electricity Feed-in Tariff to Apply from 1 January 2016 to 31 December 2016, Final Decision,* August 2015.

[81] Australian Energy Council 2016, *Submission to Essential Services Commission Inquiry into the True Value of Distributed Generation – Proposed Approach Paper,* February p. 1.

[82] Environmental Justice Australia 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation – Proposed Approach Paper*, February, p. 4.

[83] The legislation that underpins the RET lays out three distinct objectives: to encourage additional generation of electricity from renewable sources; to reduce emissions of greenhouse gases in the electricity sector; and to ensure that renewable energy sources are ecologically sustainable.

have attached to the benefit of avoided emissions. However the Commission considers that whether distributed generation should attract additional compensation for greenhouse gas abatement and the size of any additional payment is a matter for government policy.

Nonetheless, the FiT provides a mechanism by which any additional environmental value of distributed generation could be compensated. The way in which such a mechanism could operate is outline in section 5.3.2 below.

5.3.2 QUANTITIFYING AVOIDED GREENHOUSE GAS EMISSIONS

In our earlier discussion of greenhouse gas emissions, we explained the way in which distributed generation electricity can cause a reduction in emissions. This occurs when low emission distributed generators displace higher emission conventional generators. In this section, we explore methods for quantifying that reduction in greenhouse gas emissions. At a high level, this task involves identifying the volume of distributed generation electricity and multiplying by the amount of greenhouse gas abatement, or in other words a ‘rate of abatement’ for each unit of distributed generation electricity. Performing this task involves a number of steps.

The first step involves calculating the *volume of electricity generation output* from a distributed generator. This figure can be determined by metering the distributed system. However most metering infrastructure in Victoria is not set up to perform this measurement (and instead measures only the exported amount, or ‘net output’). In lieu of meter readings, the output of distributed generators can be estimated based on widely accepted parameters. We step through this process in more detail below.

The second step involves establishing the ‘rate of abatement’ for each type of distributed generator, which is the figure that represents the amount of greenhouse gas reduction it causes. To identify this figure, we first need to identify which conventional generator a distributed generator will displace (referred to as the marginal generator).

ESTIMATING THE ELECTRICITY GENERATION OUTPUT OF DISTRIBUTED GENERATORS

In estimating the electricity output of distributed generators, we first divided distributed generation systems into a number of categories based on similarities in their output profile. Specifically, we split distributed generators into the following three categories:

- solar PV systems (passive)
- wind power systems (passive)
- operator-controlled systems (for example, co-generation and similar systems, hydro power, and any system that is battery-connected).

Because passive systems produce electricity based on patterns that are independent of the actions of an ‘operator’, their output can be reliably estimated, or ‘deemed’. One source of information that can be reliably used to make these estimates is the range of factors used in the regulations for the Small-scale Renewable Energy Scheme (SRES), administered by the Clean Energy Regulator (CER). The SRES approach to calculating small-scale technology certificates is an Australian-wide and industry accepted method for estimating yearly electricity generation from small-scale systems.[84] With the assistance of analysis performed on our behalf by ACIL Allen Consulting, we have applied the SRES factors for estimating the generation output of passive solar PV and wind power systems per kW installed, presented in table 5.2.

For *operator-controlled systems*, such as hydropower and co- or tri-generation systems, it is significantly more challenging to produce reliable estimates of electricity output because, by definition, the output of such systems can be controlled according to the preference of the operator. We do not consider it realistic to estimate the output of such systems.

To calculate the associated greenhouse gas reductions, an operator controlled system would need to be independently metered. There is also uncertainty in attributing the amount of renewable or low-emission electricity output generated by a battery-connected distribution system (including for solar PV and wind), as we indicated in our discussion on the definition of distributed generation (chapter 3). Through the

[84] *Renewable Energy (Electricity) Regulations 2001*, Australia.

consultation process we are seeking views on how the output of operator controlled distributed generators might be measured for the purposes of calculating the reduction of greenhouse gas emissions they cause.

TABLE 5.2 ESTIMATED ELECTRICITY OUTPUT OF DISTRIBUTED GENERATORS

Deemed annual output per kW of rated power installed (kWh)

Distributed generation system type	Deemed annual output (kWh) per 'nameplate capacity' kW installed
Solar PV[85]	1,185 kWh
Wind	1,900 kWh
Operator controlled (co- and tri-generation, hydro power, biomass based systems, any battery-connected systems)	N/A (the output cannot be reliably estimated)

Source: Clean Energy Regulator 2016, Renewable Energy (Electricity) Regulations 2001, Regulation 20, ACIL Allen

ESTIMATING THE 'RATE OF ABATEMENT'

Previously, we explained how distributed generation electricity can lead to greenhouse gas emission abatement by displacing more emissions intensive centralised generation (introduced as the 'marginal generator'). Two pieces of information are required to estimate the 'rate of abatement':

- the identity of the displaced marginal generator
- the difference in greenhouse gas emissions between the marginal generator and the distributed generator.

The amount of greenhouse gas emissions produced per unit of generated electricity (known as an emissions intensity factor, measured as kg CO_2-e per kWh generated electricity) depends on the technology and fuel of the generator. Renewable technologies have zero greenhouse gas emissions per unit of electricity generated. Conventional large-scale generators have high emissions intensity factors ranging from 0.40–0.63 kg CO_2-e per kWh for natural gas fired generators, and 0.89–1.07 kg CO_2-e

[85] For solar PV, the SRES uses a system of 'zones' to denote what output assumptions should apply across the different regions of Australia. As a majority of solar PV installations are within zone 4 (94% of Victorian installations, based on CER postcode data as of 1 March 2016), we have only applied zone 4 factors in estimations. This may be reviewed over time to consider any significant change in percentages of installations in zone 3 and 4.

per kWh for black coal fired generators.[86] By identifying the displaced marginal generator and accounting for the difference in emissions intensities with distributed generation, the 'rate of greenhouse gas emissions abatement' can be determined.

The identity of the marginal generator varies depending the time of day, largely as a result of fluctuating demand (we explain the role of demand when we explain the bid stack below). Solar PV systems generate electricity only during the day, while wind power systems could potentially generate electricity at any time (depending on wind conditions). This means that the marginal generator displaced by solar will typically be different to the marginal generator displaced by wind.

The electricity demanded from the grid is managed through the NEM (the wholesale electricity market). In the NEM, different generators make bids to supply electricity at certain prices – these prices depend on a generator's cost of producing a unit of electricity.[87] Bids occur every five minutes within the NEM.

The Australian Energy Market Operator (AEMO) manages trading in the NEM and purchases electricity from centralised generators depending on customer demand. AEMO will purchase electricity from centralised generators who offer the lowest bids (the cheapest) until all demand has been met. This concept is often referred to as the 'electricity bid stack'.

Distributed generation impacts the NEM by reducing the amount of electricity required from the grid – this occurs as long as the distributed generation system is generating electricity (not only when it exports electricity[88]) – figure 5.1 illustrates this effect as an example.

In the example, in a scenario without any distributed generation, Generator D is the last and most expensive generator selling electricity at that time (the marginal generator). In a scenario with distributed generation, the amount required from the NEM is reduced and Generator D is no longer required at that time – it becomes the displaced marginal

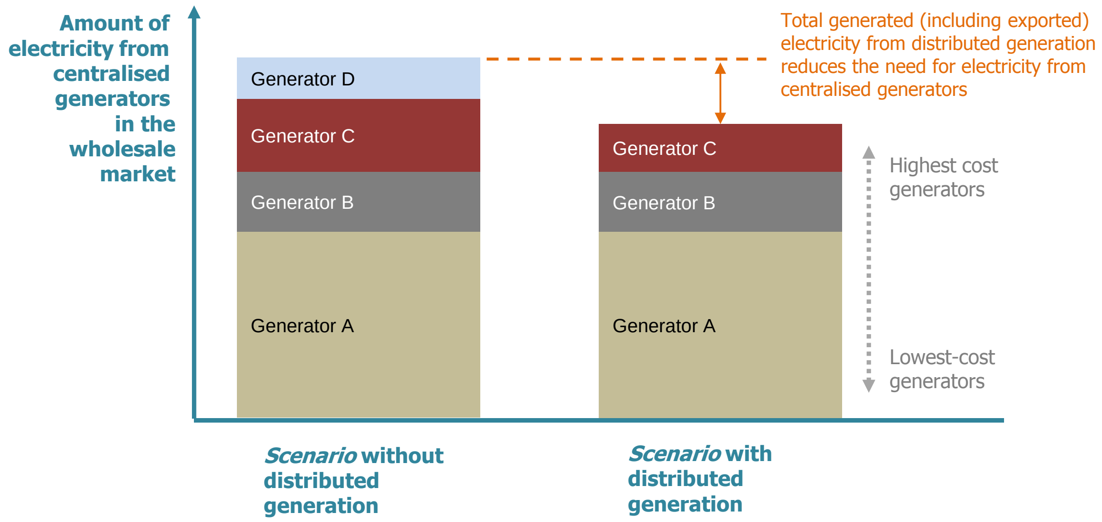
[86] Based on modelling and analysis completed on our behalf by ACIL Allen consulting.

[87] A variety of factors influence the cost of electricity generation for a generator, such as technology type, fuel cost, age and size of equipment, and operation or maintenance costs.

[88] Retailers must use any exported electricity from distributed generation prior to purchasing from the NEM.

generator[89]. In this example, the amount of greenhouse gas emissions abated at that time is the difference of emissions intensities of Generator D and the distributed generators.

FIGURE 5.1 ILLUSTRATION OF THE 'ELECTRICITY BID STACK'



Source: ESC

The situation illustrated in figure 5.1 occurs each time a bid occurs in the NEM (every five minutes). We have opted to use a modelling approach that makes forecasts about this process to determine a 'rate of abatement' appropriate for use in this inquiry.

We commissioned analysis by ACIL Allen, using their *PowerMark* wholesale market model (described in box 5.1), to estimate the approximate average emissions intensity of displaced marginal generators across a year (2016), based on the output profile of different distributed generation system types causing the displacement. The model projects typical greenhouse gas emissions in Victoria for 2016 and compares it with a scenario where distributed generators were replaced with centralised generation.

[89] Note that in this case, no electricity is purchased from Generator C and therefore it becomes the *displaced* marginal generator.

ACIL Allen used the market model to identify the centralised generator(s) that would most likely provide electricity if distributed generation did not exist – this is predominantly based on the marginal cost associated with those centralised generators and their capability to change the amount of energy generated at those given times.[90]

The following assumptions were applied to establish the alternative scenarios:

- For **solar PV systems** – removing the current estimated amount of electricity generated by rooftop solar PV systems in Victoria, and replacing it with centralised generators next on the 'stack'.
- For **wind systems** – removing 10 MW of wind generation[91], and replacing it with centralised generators next on the 'stack'.
- For **flat-profile systems** – reducing the demand for electricity in Victoria by 10 MW in each half hourly interval as an assumption for flat-profile distributed generation systems in Victoria, and replacing it with centralised generators next on the 'stack'.

BOX 5.1 POWERMARK – APPLYING WHOLESALE ELECTRICITY MARKET MODELS

Wholesale electricity market models are tools that, alongside other functions, are used to 'model', or project, the likely 'bid stack' of centralised generators based on a range of assumptions. These assumptions include projected electricity demand and the characteristics of centralised generators, such as the ability to supply electricity at different times, estimated using historical and industry-based data.

PowerMark is one such market model, developed by ACIL Allen Consulting. The model simulates electricity dispatch decisions for every hour (or half hour) in the year by determining the centralised generators that will be dispatched through simulating complex bidding behaviour and portfolio optimisation by generators in the wholesale

[90] Different centralised powerplants have different generation profiles or capabilities, such as the time it takes the generator to 'ramp up' to be ready for electricity generation. For instance, brown coal generators require a long 'ramp up' time to generate power (in the order of days), whilst gas turbines require a relatively short 'ramp-up' time (in the order of hours).

[91] This is an estimate of the total output of Victorian wind systems that are non-registered generators under AEMO and have less than 5MW of output capacity.

electricity market. In this case, the wholesale electricity market modelled is the NEM.

In analysing the results of the market model, the Commission drew upon the insights of independent experts to test the findings.

The findings from the *PowerMark* model indicated that the displaced marginal generators often are black-coal generators in New South Wales and Queensland, and natural gas fired generators across the NEM. Typically, Victorian brown-coal generators were not often displaced, because they are generally the lowest cost generators available and the last to be displaced by distributed generation. Higher cost generators such as natural gas or black coal generation are often the first generators to be displaced by distributed generation. The following table shows the modelled change in centralised generation by technology.

TABLE 5.3 MODELLED APPROXIMATE CHANGE IN CENTRALISED GENERATION OUTPUT WITH A CHANGE IN DISTRIBUTED GENERATION IN 2016

Centralised generator technology and fuel	Region	Emissions intensity (kg CO_2e per kWh)	Percentage of the total change in centralised generation as a result of distributed generation		
			Solar PV profile	Wind profile	Flat profile
Steam turbine (black coal)	New South Wales	1.00-1.07	56.1%	42.7%	53.6%
Steam turbine (coal)	Queensland	0.89-1.05	11.9%	37.5%	13.6%
Steam turbine (brown coal)	Victoria	1.24-1.56	0%	9.8%	6.4%
Steam turbine (gas)	South Australia	0.58	6.6%	-	-
Gas turbine combined cycle	NEM	0.42-0.63	21.7%	8.7%	20.2%
Other	NEM	Various	3.6%	1.3%	6.2%
Total			**100%**	**100%**	**100%**

t CO_2-e = tonne of carbon dioxide equivalent
Source: Based on modelling and analysis completed on our behalf by ACIL Allen Consulting

Based on the modelling, the ‘rate of abatement’ is between 0.86-0.98 kg CO_2e per kWh as a result of distributed generated electricity (depending on technology type) and shown in table 5.4.

ACIL Allen used the changes in energy generated by central generators under each of the scenarios to convert the change in greenhouse gas emissions to an emissions intensity factor for the marginal generator. The average emissions intensity of the marginal generators displaced by each type of distributed generation system type is presented in table 5.4. This number is used as the basis for the 'rate of abatement' when calculating the volume of reduced greenhouse gas emissions.

TABLE 5.4 FORECAST APPROXIMATE AVERAGE EMISSIONS INTENSITY OF THE MARGINAL GENERATOR IN 2016, BY DISTRIBUTED GENERATION TYPE

Distributed generation system type	Average emissions intensity of the marginal generator (kg CO_2e per kWh of distributed generation output)
Solar PV (passive)	0.86
Wind (passive)	0.98

Source: Based on modelling and analysis completed on our behalf by ACIL Allen Consulting

DETERMINING THE QUANTITY OF AVOIDED GREENHOUSE GAS EMISSIONS

Having established the methods to determine the deemed electricity generation output of distributed generators and the average 'rate of abatement' in a given year, we can now apply the following formula to quantify the volume of avoided greenhouse gas emissions as a result of distributed generation.

$$V_{GHG} = \left(e_{gen} \times r_{GHG}\right) \div 1000$$

$$r_{GHG} = EF_{MG} - EF_{DG}$$

where

- V_{GHG} is the volume of avoided greenhouse gas emissions (t CO_2e)
- e_{gen} is the estimated total electricity generation output (kWh) by the distributed generation system, based on the deemed outputs shown in table 5.2 multiplied by the installed capacity of the system
- r_{GHG} is the rate of abatement of greenhouse gas emissions (as a result of distributed generation) (kg CO_2e per kWh)

- EF_{MG} is the emissions intensity factor of the marginal generator (kg CO_2e per kWh), as related to the distributed generation system shown in table 5.4
- EF_{DG} is the emissions intensity factor of the distributed generation system (kg CO_2e per kWh), which is zero if the system is a renewable source

To illustrate how to quantify the amount of avoided greenhouse gas emissions from distributed generated electricity, the following worked example is provided in box 5.2.

BOX 5.2 WORKED EXAMPLE OF QUANTIFYING AVOIDED GREENHOUSE GAS EMISISONS FOR A DISTRIUTED GENERATION SYSTEM

A distributed generation producer owns and operates a passive 4.5kW wind power system, which is grid-connected in Victoria. The producer seeks to estimate its avoided greenhouse gas emissions in 2016, applying the method described in earlier in this section.

Based on the factors in table 5.2, the estimated total electricity generation output (e_{gen}) for a 4.5kW wind power system in Victoria is 8,550kWh in 2016.

Being a passive wind power system and a renewable technology, its emission intensity factor (EF_{DG}) is zero. Applying the factors shown in table 5.4, the average annual emissions intensity of the displaced marginal generator (EF_{MG}) is approximately 0.98 kg CO_2e per kWh. This results in a rate of abatement of greenhouse gas emissions of 0.98 kg CO_2e per kWh.

Applying the formula to determine the quantity of avoided greenhouse gas emissions, the example distributed generation system avoids 8.38 t CO_2e across the year in 2016.[92]

Source: ESC

[92] Or 8,379 kg CO_2e in the year.

5.3.3 A MONETARY VALUE FOR GREENHOUSE GAS EMISSIONS

In this section, we explore the possibility of assigning a monetary value for each tonne of avoided greenhouse gas emissions attributed to distributed generation. In the presence of an efficient market mechanism for pricing emissions, the price of emitting one tonne of emissions will be broadly equivalent to the value of avoiding one more tonne of greenhouse gas emissions.[93] In the absence of such a mechanism, it is not possible for us to quantify the monetary value of a tonne of greenhouse gas emissions. Likewise, we do not consider it appropriate for the Commission to place a value on avoided emissions.

Some stakeholders have suggested that in the absence of an efficient mechanism for pricing greenhouse gas emissions, the Commission should determine an appropriate monetary value for low-emission distributed generation systems. Australian Gas Networks, for instance, recommended that the Commission may be able to determine a 'proxy' value for avoided emissions that it could apply when assessing the environmental benefits of distributed generation.[94] Other submissions suggested a range of other reference points from which a price on avoided greenhouse gas emissions could be derived, from Australia and overseas. A range of mechanisms that have been proposed in various contexts as references for estimating a price of greenhouse gas emissions is described in box 5.3.

[93] An efficient market mechanism ensures the value of the last tonne of greenhouse gases emitted (which sets the market price) is marginally greater than value of the last tonne avoided.

[94] Australian Gas Networks 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation,* February, p. 3

BOX 5.3 MECHANISMS FOR GREENHOUSE GAS EMISSION ABATEMENT

There are a range of mechanisms that have been used by industry and other governments (internationally) to estimate a value for greenhouse gas emissions. These include:

- **The Commonwealth Emissions Reduction Fund (ERF).** The ERF operates via a series of auctions, managed by the Clean Energy Regulator. Emission reduction projects bid into the auction and funds are awarded to the projects that can deliver the lowest cost abatement.[95] The price per tonne of greenhouse gas emissions abatement, based on completed ERF auctions, was $13.95 in April 2015 and $12.25 in November 2015.
- **The European Union Emissions Trading Scheme (EU ETS)**. The EU ETS was designed as part of the European Union's package of climate change polices, and reflects the structure of Europe's economy and emissions profile covering more than 11,000 power stations and industrial plants across 31 countries.[96]
- **The Social Cost of Carbon.** In 2010, the United States Environmental Protection Agency developed a method monetize avoided greenhouse gas emissions, based on the social impact from avoided climate change.[97] Whilst the SC-CO2 has been applied to a number of rulemakings in the United States, it has not been applied to any Australian jurisdiction. Few Australian studies have attempted to comprehensively calculate the social cost of carbon, but instead taken findings from international studies and contextualised it to Australia[98].

[95] Department of the Environment 2016, *'Emissions Reduction Fund methods'*, http://www.environment.gov.au/climate-change/emissions-reduction-fund/methods, Accessed 23 March 2016

[96] European Commission 2016, *The EU Emissions Trading Scheme (EU ETS)*, http://ec.europa.eu/clima/policies/ets/index_en.htm, Accessed 12 April 2016

[97] United States Government 2010, *Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866*, Interagency Working Group on Social Cost of Carbon, February 2010

[98] A review by Ward and Power in 2014 referenced the SC-CO2 approach in relation to the Hazelwood brown-coal fired power station, but the Commission did not find this relevant to the study as Victorian brown-coal fired power stations were not the predominant displaced marginal generator as a result of distributed generation.

There is no objective framework by which the Commission can judge the relative merits of these or any other mechanisms. The determination of a value for avoided emissions is a matter for Government policy.

As described in box 5.3, there are a range of mechanisms by which a price of avoided greenhouse gas emissions can be determined. The estimated yearly value of avoided greenhouse gas emissions is shown in table 5.5, based on the methodology described in section 5.3.2 and a range of notional prices for avoided emissions.

TABLE 5.5 ESTIMATED VALUE OF AVOIDED GREENHOUSE GAS EMISSIONS BASED ON DEEMED ELECTRICITY GENERATION OUTPUTS BY DISTRIBUTED SYSTEM TYPE AND VALUE FOR AVOIDED EMISSIONS

Value for avoided emissions ($ per t CO_2e)	$ per kW output installed, by distributed generation system type	
	Solar PV systems	**Wind systems**
$5	$5.10	$9.30
$10	$10.20	$18.60
$15	$15.30	$27.90
$20	$20.40	$37.20
$30	$30.60	$55.90
$40	$40.80	$74.50

t CO2-e = tonne of carbon dioxide equivalent
Source: ESC based on modelling and analysis completed on our behalf by ACIL Allen consulting

5.4 CONCLUSION

The Commission concludes that the only environmental or social benefit on which it can proceed with reasonable confidence is reduced emissions of greenhouse gases. To calculate the volume of this benefit, we developed a method using factors derived from the *Renewable Energy Target Regulations 2001* and a deemed rate of abatement based on forecasts of which conventional generator is displaced by distributed generation. Because the determination of a value for avoided emissions is a matter for Government policy, the Commission has not sought to place a monetary value on this benefit.

6 THE COMMISSION'S PROPOSAL: A NEW DISTRIBUTED GENERATION TARIFF

6.1 INTRODUCTION

Building upon our analysis of value in chapter 4 and chapter 5, in this chapter we present a framework designed to compensate distributed generators for the value of their electricity in the wholesale market and any environmental and social benefits caused by their electricity generation. When looking at environmental and social benefits, we focus exclusively on reducing greenhouse gas emissions.

SUMMARY

In chapter 4, we concluded that the value of exported distribution generated electricity is based upon a calculation of the wholesale market price. In chapter 5, we concluded that certain forms of distributed generation can cause the benefit of reducing greenhouse gas emissions, and that this benefit can be assigned a value depending on the monetary value that policymakers place on avoided emissions.

We also concluded that the current framework does not effectively return these values to all forms of distributed generation. The existing feed-in tariff (FiT) framework is limited to a single rate, whereas the wholesale price varies constantly. Moreover the FiT currently makes no provision for payments based on environmental or social value.

To better reflect the values of distributed generation identified in this inquiry the FiT could be amended to allow for multi-rate payments. This would allow the FiT to better reflect the wholesale electricity price and the varying degrees of line losses across the state.

The extant FiT framework also requires amending if it is to incorporate the value of environmental and social benefits. To incorporate that value, the framework would need to allow payments for environmental and social benefits to be based on the total output of distributed generation electricity, not just exports. We refer to this alternative framework as the ‘distributed generation tariff’ (DGT)

In this chapter, we set out the design of a DGT that contains two elements: one accounting for market value, and the other accounting for environmental and social value. We provide a worked example of payment to a distributed generation producer under a DGT using modelled data for two synthetic years.

6.1.1 STRUCTURE OF THIS CHAPTER

6.1 Introduction

6.2 A distributed generation tariff

- A description of the structure of a DGT to reflect true value.
- A component of the tariff reflecting the value of distributed generated energy in the wholesale electricity market, and an illustration of its application using assumptions and modelled data based on two ‘synthetic years’.
- A component of the tariff reflecting the environmental and social value of distributed generated energy, and an illustration of its application using assumptions and modelled data based on two ‘synthetic years’.

6.3 A worked example of the distributed generation tariff

- Illustration of the potential payment provided to distributed generation producers in two ‘synthetic years’ under the proposed DGT.

6.4 Conclusion and draft recommendations

6.2 A DISTRIBUTED GENERATION TARIFF

The purpose of a ‘distributed generation tariff’ (DGT) would be to provide a two part mechanism to make payments to distributed generators that recognise both the value to the wholesale electricity market of the energy that they export (in a similar fashion to the current FiT) but also the value of any contributions that distributed generation electricity makes to environmental and social outcomes (where the value of such outcomes can be identified).

In forming this proposed mechanism, we sought to conceive of a tariff structure that clearly distinguishes between two elements:

- an element designed to compensate distributed generation owners based on the value of their exports in the wholesale electricity market (a ‘wholesale market’ based payment), and

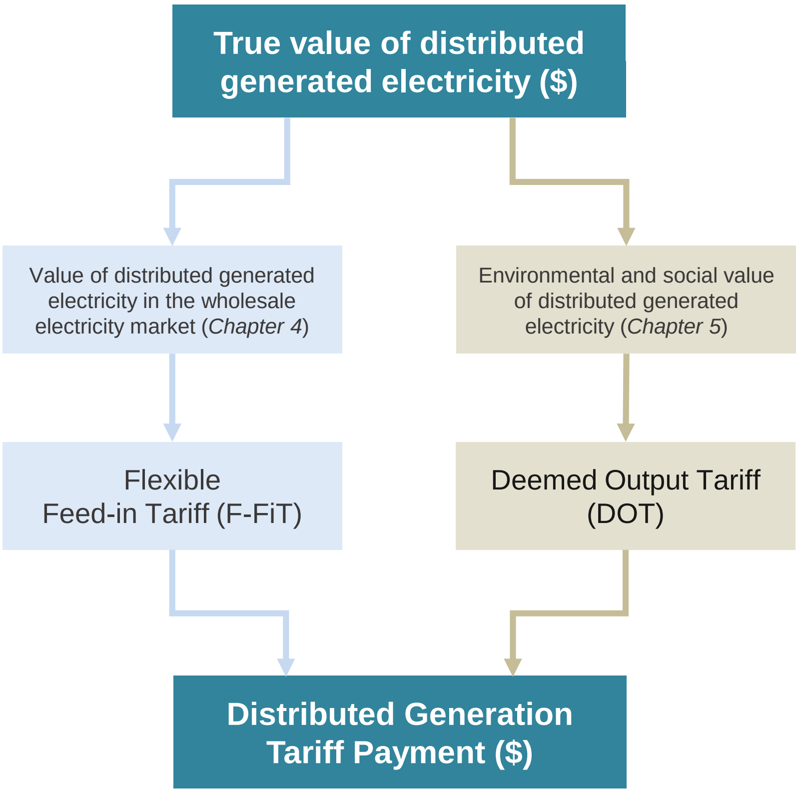
- an element designed to compensate distributed generation owners based on the quantifiable monetary value of environmental and social effects produced by their generation (an 'environmental and social benefit' based payment).

Drawing this distinction is desirable because the method for determining the appropriate payment in each of the two contexts is different. A two part structure also allows for the transparent setting and review of both 'environmental and social benefit' payments and 'wholesale market' payments. The tariff would therefore be structured in the following way:

1. **A flexible feed in tariff (F-FiT) for exports based on the time and location of the export.** The payment would be 'flexible' in the sense of having different rates for different times of day, and for different locations.
2. **A deemed output tariff (DOT) for generation based on the annual monetary value of the environmental and social benefits of the distributed generation system's deemed output.** The payment would be calculated for the year in advance, using a defined methodology, based on each system type and size.

Figure 6.1 presents the two part mechanism of the DGT, and how it relates to the exercise of examining the monetary value of distributed generation. Table 6.1 summarises the potential payment structures and the basis of calculation is provided in sections 6.2.1 and 6.2.2.

FIGURE 6.1 STRUCTURE OF THE DISTRIBUTED GENERATION TARIFF



Source: ESC

TABLE 6.1 DISTRIBUTED GENERATION TARIFF
Components and their attributes

Component	Basis for calculation	Operation of payment
Flexible FiT	The forecast wholesale electricity price (adjusted for avoided line losses and market fees)	Payment made on each kilowatt hour (kWh) of exported electricity
Deemed output tariff	The forecast monetary value of the social and environmental benefits of a distributed generators' deemed electricity output in the year to which the tariff applies.	Payment calculated on a forward annual basis for a distributed generation system based on the system's characteristics

We explain these components in further detail in the following sections.

ELIGIBILITY FOR PAYMENTS UNDER A DISTRIBUTED GENERATION TARIFF

The question of eligibility for payments under a DGT has two dimensions, distributed generation technology type and system size. Under the current FiT framework, wind, solar, hydro and biomass distributed generation technologies are eligible to receive payments. The legislation that establishes the framework also provides a mechanism for other forms of distributed generation to be included within the framework.[99] As a result, we do not propose to recommend that the current framework be altered in this respect.

The current FiT framework enables payments to be made to distributed generators up to a capacity size of 100kW. The basis of the 100kW threshold is that distributed generators above this scale are better placed than smaller generators to participate in the market (including through negotiating a price for their exports) without the aid of regulatory intervention.[100] The Commission has not been provided with evidence that suggests this threshold needs to be revisited and so does not propose the current threshold be changed.

OPTION FOR A FULLY REFLECTIVE FEED IN TARIFF

In keeping with the discussion in section 4.5.2, the Commission proposes to recommend that in the event an electricity retailer is able to offer a FiT that fully reflects the half hourly prices in the wholesale market, and the distributed generator provides express and informed consent when accepting that tariff option, then the retailer obligation to offer the regulated flexible feed in tariff (F-FiT) rates as proposed in this draft report should be suspended for the duration of that agreement. The retailer would still be required to provide payments under a deemed output tariff (DOT) component of the DGT.

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[99] Section 40F(2) of the *Electrical Industry Act 2000*.

[100] Victorian Competition and Efficiency Commission 2012, *Power from the People: Inquiry into distributed generation – Final Report,* July, p189.

6.2.1 FLEXIBLE FEED-IN TARIFF COMPONENT OF THE DISTRIBUTED GENERATION TARIFF

The flexible FiT component of the DGT is based on the monetary value of exported electricity of a distributed generation system, which is determined by reference to wholesale electricity prices. It would constitute a minimum. That is, it would represent the minimum rate that retailers should pay distributed generators for their exports in each specified time period.

In each year, the rates payable for exports in each time block would be determined in a manner broadly analogous to the method used to determine the current FiT. That is, the process would involve drawing upon forecasts of the electricity wholesale market price for the year in which the tariff will apply and applying adjustments based on avoided line losses and market fees.[101]

The Commission proposes the time block structure and location zones, once established, should remain unchanged for an appropriate period. As a starting point, this period could be three years unless market characteristics change widely enough to warrant reviewing the tariff structure in an earlier timeframe. We would consult before initiating a review to assess whether circumstances warranted revisiting the tariff structure. This approach provides stability and certainty to retailers and distributed generators.

Alternatively, a retailer could be exempt from paying the regulated rates for each time period if the distributed generator and the retailer reach an agreement, involving the full and informed consent of both parties, for payments instead to be made for distributed generation exports that reflect the wholesale spot price at the time the export occurred (as discussed in section 4.5.2).

[101] When setting the minimum FiT under the current framework, the Commission has traditionally applied weights to the average wholesale price. This is because when averaged across the entire year, as opposed to in smaller discrete time blocks, the unweighted wholesale price does not necessarily reflect of the value of solar PV exports – presently the dominant form of distributed generation technology in Victoria – which only occur during daylight hours.

BASIS OF CALCULATION

This section draws on earlier analysis contained within the report. It provides a truncated description of how the flexible FiT component of a DGT is determined by drawing on analysis conducted in chapter 4.

In chapter 4, we determined that the value of exported distributed generation electricity in the wholesale electricity market is determined based on a number of factors. These factors include: the wholesale market price at the projected time when the electricity is exported (section 4.5), an adjustment for avoided line losses (section 4.6), and an amount for avoided wholesale market fees (section 4.2.2).

We concluded that our preferred approach to reflecting the variability of the wholesale electricity market price is through a three part plus critical peak time block option (table 4.4). We also concluded in chapter 4 that the preferred method of reflecting avoided line losses is through two loss zones, based on two geographic areas. The rates applicable during each time period and each location zone would then be calculated using the forecasts of the wholesale electricity prices in those periods. For a worked example, see box 6.1.

6.2.2 DEEMED OUTPUT TARIFF (DOT) COMPONENT OF THE DISTRIBUTED GENERATION TARIFF

The deemed output tariff (DOT) component of the DGT is based on the annual monetary value of the environmental and social benefits attributable to a distributed generation system’s total deemed electricity output (rather than exported electricity).

BASIS OF CALCULATION

In chapter 5, we identified avoided greenhouse gas emissions as the only directly and reliably quantifiable benefit of distributed generation. On this basis, the method for calculating the DOT component of the DGT is to multiply the quantified avoided greenhouse gas emissions as a result of distributed generation with a value placed on avoided emissions.

We propose the same methodology described in section 5.3.2 as follows:

1. **Estimate a deemed electricity output of the system**

This estimate is calculated by multiplying the stated capacity of the distributed generation system by the deemed annual output factor for that technology (table 5.2).

2. **Estimate the deemed emissions avoided by the system**

   This estimate is calculated by multiplying the deemed output calculated in step 1 by the average emissions intensity of the marginal generation that system is assumed to displace (table 5.4).

3. **Calculate the value of avoided emissions**

   This value is calculated by multiplying the deemed emissions avoided in step 2 with the nominated value of emissions (see discussion below).

A modelled deemed output tariff component of the DGT is shown in table 6.2 using estimates based on modelling by ACIL Allen (see section 5.3).

TABLE 6.2 MODELLED 2016 DGT DEEMED OUTPUT TARIFF COMPONENT ANNUAL PAYMENT, PER INSTALLED OUTPUT CAPACITY
BY DISTRIBUTED SYSTEM TYPE, BASED ON A RANGE OF VALUES FOR AVOIDED EMISSIONS

Value for avoided emissions ($ per t CO_2e)	$ per kW output installed, by distributed generation system type	
	Solar PV systems	Wind systems
$5	$5.10	$9.30
$10	$10.20	$18.60
$15	$15.30	$27.90
$20	$20.40	$37.20
$30	$30.60	$55.90
$40	$40.80	$74.50

Note: t CO_2-e is a tonne of carbon dioxide equivalent
Source: Based on modelling and analysis completed on our behalf by ACIL Allen consulting

6.3 A WORKED EXAMPLE OF THE DGT

To illustrate how a DGT might operate in practice, box 6.1 presents a worked example of the payment that a distributed generation producer would potentially receive under the DGT. To place the payment from the DGT in context, we calculated an example single ‘flat rate’ tariff determined using the same method used to calculate the FiT in previous years.

We asked ACIL Allen to use its wholesale electricity market model to generate price forecasts of two 'synthetic years' based on contemporary market conditions. These synthetic years represent two possible sets of annual prices that might occur if market conditions were very similar to the way they are today. These synthetic years were then used to compute example FiTs under both the existing single-rate FiT model and the alternative multi-rate FiT model that we propose so the options can be compared. Using two synthetic years rather than one illustrates how the result can vary subtly year-on-year based on variations in the wholesale market prices.

We then asked ACIL Allen to estimate the annual ‘payoffs' for a typical solar PV household under each scenario. We defined a typical solar PV household as one with a 3kW solar system because this system size is the most common in Victoria. ACIL constructed an assumed export profile for this household using a dataset of actual exports in recent years from around 250 Victorian solar PV households with 3 kW systems. The estimates assume the household makes no change to their export behaviour between the flat-rate FiT scenario and the multi-rate FiT scenario. That is, they export the same amount at the same time under both scenarios.

Like any estimate, the annual payoff figures are for demonstrative purposes only. They should not be construed as a forecast of the actual payoffs that any individual household with 3 kW solar PV systems would receive under either scenario in a future year. Actual payoffs depend on an array of factors including wholesale price volatility and weather, and how a household uses energy.

BOX 6.1 WORKED EXAMPLE OF PAYMENTS TO DISTIRBUTED GENERATION PRODUCERS UNDER THE DGT

A distributed generation producer owns and operates a passive solar PV system, which is grid-connected and located in Geelong. The system has an installed output capacity of 3kW. By applying the proposed DGT as described in section 6.2, we determine the payments that the producer may receive under the DGT in two ‘synthetic years’: Year A and Year B.

FLEXIBLE FEED-IN TARIFF COMPONENT

The solar PV system is net metered and the amount of exported electricity within each of the time periods (peak, shoulder, off-peak and critical peak) is known. The payment depends on the amount of electricity exported, and the tariff that applies, in each time period.

We commissioned ACIL Allen to calculate what these multi-rate tariffs (the flexible FiT component of the DGT) would have been in the two synthetic years, Year A and Year B. The multi-rate tariffs are shown in table 6.3. The rates include adjustments for avoided line losses and avoided market and ancillary fees (avoided market and ancillary fees are estimated in this example to be 0.1 c/kWh). To calculate the payments, we relied on ACIL Allen's estimates of exports from a typical 3kW solar PV system in Victoria.

TABLE 6.3 FLEXIBLE FEED IN TARIFF COMPONENT RATES OF EXAMPLE DGT (c per kWh)

Location zone	Critical Peak	Peak	Shoulder	Off Peak
Year A				
Melbourne, Geelong and eastern Victoria	31.6	6.5	5.2	3.7
Northern and western Victoria	34.0	7.0	5.5	4.0
Year B				
Melbourne, Geelong and eastern Victoria	31.6	5.1	3.9	2.8
Northern and western Victoria	34.0	5.4	4.2	3.0

Source: Based on modelling and analysis completed on our behalf by ACIL Allen consulting

In this example, the annual payment resulting from the F-FiT component of the DGT and the household's assumed export profile is approximately $88.90 in Year A, and $70.70 in Year B.

DEEMED OUTPUT TARIFF COMPONENT

Based on the factors in table 5.2, a 3 kW solar PV system is deemed to generate 3,555 kWh in 2016.

As a renewable technology, the distributed generation system emissions intensity factor is zero and the marginal generator's emissions intensity factor is 0.86 kg kilograms of carbon dioxide equivalent per kilowatt hour (kg CO_2e per kWh) (table 5.4) in both Year A and Year B.[102] This results in a rate of abatement of greenhouse gas emissions of 0.86 kg CO_2e per kWh.

For the purposes of this worked example we apply a nominated value on avoided greenhouse gas emissions of $20 per tonne of CO_2e.

The example annual payment resulting from the DOT component of the DGT is $61.20 for both Year A and Year B (table 6.2).

COMPARISON WITH A SINGLE FLAT-RATE TARIFF

Applying a single flat-rate tariff as currently calculated based on projected wholesale market prices and applying a state-wide loss factor in each synthetic year, a comparison annual payment amount can be determined. The example annual payment resulting from a flat-rate FiT is approximately $86.30 in Year A, and $75.10 in Year B.

A comparison of annual payments under both the single flat-rate tariff, and the DGT is shown in table 6.4. In Year A the flexible FiT component produces a slightly higher annual payment than does the flat rate FiT, while the opposite is the case in Year B. This illustrates how the outcome in any given year depends upon the market conditions that exist in that year.

When the payments under both elements of the DGT are combined, both years show increases in total annual payments under the proposed framework relative to the current framework.

[102] The marginal generator's emissions intensity factor is approximately the same for both representative years.

TABLE 6.4 COMPARISON OF PAYMENT TO A DISTRIBUTED GENERATOR IN YEAR A AND YEAR B UNDER A DGT AND A SINGLE FLAT-RATE TARIFF

Based on a worked example 3kW solar PV system based in Geelong

Tariff type	Payment in Year A ($)	Payment in Year B ($)
Single flat-rate FiT	$86.30	$75.10
Distributed generation tariff	$150.10	$131.90
Flexible FiT component	*$88.90*	*$70.70*
DOT component	*$61.20*	*$61.20*

Source: Based on modelling and analysis completed on our behalf by ACIL Allen consulting

This result is as expected. A multi-rate FiT is not expected to materially change the annual payoff received by a typical Victorian solar PV household[103] when compared to the existing single flat-rate FiT.[104] In some years, the annual pay off would be higher; in some years it would be lower.

The advantage of moving to a multi-rate tariff (the flexible component of the proposed DGT) is that the tariff is more ‘market reflective’. That is, it provides the distributed generator with a market reflective incentive to modify its behaviour in response to the wholesale price.[105] Additionally, it means that the tariffs under the FiT are equally reflective of the market value of exports from any type of distributed generation technology.

[103] As used in this worked example: a Victorian household with a 3 kW system and typical electricity export profile.

[104] The reason is that the weighting method applied when setting the flat rate FiT is designed to ensure that annual payments to a typical solar PV distributed generator are, in aggregate, a reasonable approximation of the wholesale market value of those exports. The multi-rate FiT model seeks to achieve the same result, but in a way that is not tied to a particular technology or to the export patterns of distributed generators.

[105] Optimisation by a distributed generation producer could be through modifying the amount and time of electricity exports during peak times or potentially at critical peak periods.

6.4 CONCLUSION AND DRAFT RECOMMENDATIONS

This chapter presented a proposed framework in the form of a 'distributed generation tariff' (DGT) to compensate distributed generators for the value of their electricity in the wholesale market and for any environmental and social benefits (exclusively avoided greenhouse gas emissions, as determined in chapter 5) caused by their electricity generation.

Draft Recommendation 7: The environmental and social value of distributed generation

The environmental and social value of distributed generation should be reflected in a deemed output tariff that is paid to a distributed generator based on the deemed output of the distributed generation system, where that output can be reliably estimated. The Commission considers that the deemed output of solar and wind systems can be reliably estimated using factors published in the Renewable Energy Target (Electricity) Regulations 2001 (Cth). The deemed output of other distributed generation systems cannot be estimated reliably at this time.

Draft Recommendation 8: The value of avoided emissions

The deemed output tariff for 2017 should be calculated to account for the value of the greenhouse gas emissions avoided as a result of distributed generation displacing the marginal generator in the wholesale electricity market. Avoided emissions should be calculated by the Commission on an annual basis for each of the eligible technologies.

Draft Recommendation 9: Minimum tariffs

The regulated tariff structure should continue to impose a minimum obligation on retailers. Retailers should be able to offer higher rates on any one or more of the components of the minimum feed-in tariff, deemed output tariff or both, as set on an annual basis by the Essential Services Commission.

Draft Recommendation 10: Reviewing tariffs

Each year, the Commission should review the value of the feed-in tariff and the deemed output tariff for the year ahead. If additional, reliable information becomes available, the deemed output tariff should be adjusted at yearly intervals to reflect other social and environmental benefits.

Draft Recommendation 11: Reviewing the tariff structure

The time block structure and location zones of the flexible feed-in tariff, once established, should remain unchanged for an appropriate period. As a starting point, this period should be three years unless market characteristics change widely enough to warrant the Commission reviewing the tariff structure in an earlier timeframe.

7 NEXT STEPS

This paper is the second of three papers that the Commission will release as part of the inquiry into the true energy value of distributed generation.

The first paper, our approach paper, was released on 22 December 2015 and outlined the Commission's approach to addressing the terms of reference. This paper, our Draft Report, outlines the Commission's preliminary findings on the energy value of distributed generation.

7.1 CONSULTATION

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

7.1.1 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 proposed approach to creating a framework for payments to distributed generators. Times and locations for the public forums will be made available on our website.

7.1.2 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

Wholesale market value of distributed generation exports

The proposed multi-rate tariff is intended to make payments to distributed generators better reflect the 'market value' of the generator's exports. To achieve this outcome, the multi-rate structure includes payments that vary according to time and location.

1. Does the proposed multi-rate feed-in tariff (FiT) allow for payments to distributed generators to better reflect the market value of their exports? If not, why not?
2. Do you support the proposal to amend the FiT framework to enable multi-rate tariffs for distributed generation? If so, which of the options do you favour and why? If not, why not?

Environmental and social value of distributed generation electricity

Our analysis of the environmental and social value of distributed generation focused on establishing that a given benefit could be reliably linked to a given unit of output from distributed generation.

3. Are there additional data and analyses that the Commission should consider in assessing the environmental and social benefits of distributed generation, specifically in terms of identifying, quantifying and valuing those benefits of distributed generation?

Implementation (retailers and distributors)

Implementing the proposed distributed generation tariff (DGT) framework would impose administrative costs on retailers and distributers.

4. What would be the implications for electricity retailers and distributors of moving to the proposed DGT framework? Specifically, what are the cost implications of implementing the proposed DGT framework? And what evidence can be provided with regard to those costs? Are there ways these costs could be reduced?

Batteries

Electricity storage (batteries) products are becoming more widely available in the Australian market.

5. What impact, if any, would increased deployment of electricity storage systems have on the assumptions and analysis underpinning the proposed distributed generation tariff framework outlined in this draft decision?[106]

Readers are invited to examine this report and provide comment, preferably in electronic format, by Friday **3 June 2016**.

Submissions should be marked Submission to Draft Report (Energy Value) of Distributed Generation Inquiry, and sent

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

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

The Commission can also be contacted on 03 9032 1300.

The Commission's normal practice is to make all submissions publicly available on its website. Please identify clearly any confidential or commercially sensitive information that you do not wish to be disclosed publicly.

[106] Batteries will also be considered in the context of our work on the network value of distributed generation, commencing in June.

7.2 FINAL REPORT

Our final report into the energy value of distributed generation will be released in August 2016, which will finalise the Commission's assessment of the energy value of distributed generation.

If you would like to be kept informed please register your interest with us by contacting us on 03 9032 1300 or subscribing to our website. Publications will be available on the inquiry website: www.esc.vic.gov.au/Energy/Inquiry-into-the-true-value-of-distributed-generat.

7.3 NETWORK VALUE OF DISTRIBUTED GENERATION

We will address network value in a separate series of reports in the second half of 2016.

APPENDIX A – 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 B – LIST OF REFERENCES

AGL, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation – Proposed Approach Paper*, February, (http://www.esc.vic.gov.au/getattachment/964dd077-2f4c-42f8-90b6-31186f1ca097/AGL.pdf).

Amery, Clive, 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation - Proposed Approach Paper,* February, (http://www.esc.vic.gov.au/getattachment/fac72bfa-6923-4c84-9f1f-af8e807a2c6c/Clive-Amery.pdf)

APA Group 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation - Proposed Approach Paper,* February, (http://www.esc.vic.gov.au/getattachment/964dd077-2f4c-42f8-90b6-31186f1ca097/AGL.pdf).

Australian Bureau of Statistics 2016, *Employment in Renewable Energy Activities,* Australia, 2014-2015, cat. no. 4631.02, Canberra (http://www.abs.gov.au/ausstats/abs@.nsf/mf/4631.0).

Australian Energy Council 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation - Proposed Approach Paper,* February, (http://www.esc.vic.gov.au/getattachment/37a14e2f-3fcb-4076-9a16-4e27f8cd5f2c/Australian-Energy-Council-(AEC).pdf).

Australian Energy Market Commission (AEMC) 2015, Integration of Energy Storage – Regulatory Implications, Final Report, (http://www.aemc.gov.au/Major-Pages/Technology-impacts/Documents/AEMC-Integration-of-energy-storage,-final-report.aspx).

Australian Energy Market Commission (AEMC) 2015 Residential Electricity Price Trends, December, (http://www.aemc.gov.au/Markets-Reviews-Advice/2015-Residential-Electricity-Price-Trends).

Australian Energy Market Operator (AEMO), *Pre Dispatch,* April, http://www.aemo.com.au/Electricity/Data/Market-Management-System-MMS/Pre-Dispatch.

Australian Gas Networks 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation - Proposed Approach Paper,* February, (http://www.esc.vic.gov.au/getattachment/94cd618f-fc56-47e9-a370-65f265f915b7/Australian-Gas-Networks.pdf)

Batchelor P, Minister for Energy and Resources, 2009, Electricity Industry Amendment (Premium Solar Feed-In Tariff) Bill Second Reading, Assembly, VicHansard, Book 3, Thursday 12 March, p. 529.

BEAM Mitchell Environment Group 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation - Proposed Approach Paper,* February, (http://www.esc.vic.gov.au/getattachment/5edc6df2-9c66-45a7-a77a-409a364dca70/BEAM-Mitchell-Environment-Group.pdf)

Biegler T, 2009, *The Hidden Costs of Electricity: Externalities of Power Generation in Australia,* Australian Academy of Technological Sciences and Engineering , March, (http://www.atse.org.au/Documents/Publications/Reports/Energy/ATSE%20Hidden%20Costs%20Electricity%202009.pdf).

Clean Energy Council 2016, *Clean Energy Council's submission to the Essential Services Commission's Proposed Approach to the Inquiry into the True Value of Distributed Generation,* February, (http://www.esc.vic.gov.au/getattachment/36bdbcea-5a86-420c-b0d0-20caaac52a25/Clean-Energy-Council-(CEC).pdf)

Clean Energy Regulator 2016, *Postcode for small-scale installations,* March, (*http://www.cleanenergyregulator.gov.au/RET/Forms-and-resources/Postcode-data-for-small-scale-installations)*

Dandenong Ranges Renewable Energy Association 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation - Proposed Approach Paper,* February, (http://www.esc.vic.gov.au/getattachment/ca7b330d-0be0-4f76-82cf-18643153c8f4/Dandenong-Ranges-Renewable-Energy-Association.pdf)

Department of Economic Development, Jobs, Transport and Resources 2016, *Flexible Pricing,* April, (*http://switchon.vic.gov.au/bills-pricing-and-meters/flexible-pricing*)

Department of Economic Development, Jobs, Transport and Resources, Review of the General Exemption Order, http://www.energyandresources.vic.gov.au/energy/about/legislation-and-regulation/georeview.

Department of the Environment 2016, *Emission Reduction Fund methods,* (http://www.environment.gov.au/climate-change/emissions-reduction-fund/methods*).*

Electricity Industry Act 2000 (Vic.) (www.austlii.edu.au/au/legis/vic/consol_act/eia2000261/s23chtml).

Energy Australia 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation - Proposed Approach Paper,* February, (http://www.esc.vic.gov.au/getattachment/4c9f76e7-80f6-47f1-8bcb-7d2918a768b7/EnergyAustralia.pdf).

Environment Protection Authority Victoria 2013, *Future air quality in Victoria – Final Report*, July, (http://www.epa.vic.gov.au/~/media/Publications/1535.pdf).

Environment Victoria 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation - Proposed Approach Paper,* February, (http://www.esc.vic.gov.au/getattachment/96aa6e76-22a4-4451-8fea-444cf51f16b5/Environment-Victoria.pdf).

Environmental Justice Australia 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation – Proposed Approach Paper,* February, (http://www.esc.vic.gov.au/getattachment/5405388a-b731-44cc-aec5-78f0a96d1ff7/Environmental-Justice-Australia.pdf).

Essential Services Commission 2015, *Minimum Electricity Feed-in Tariff to Apply from 1 January 2016 to 31 December 2016 – Final Decision,* August, (http://www.esc.vic.gov.au/getattachment/93edcf18-1659-4518-9057-eee1215bf194/Minimum-Electricity-Feed-in-Tariff-to-apply-from-1.pdf).

Essential Services Commission 2016, Energy Licence Framework Review, http://www.esc.vic.gov.au/Energy/Modernising-Victoria-s-Energy-Licence-Framework, Accessed 13 April 2016

Essential Services Commission Act 2001 (Vic.) *http://www.esc.vic.gov.au/getattachment/d6250f4c-a1cc-44de-a756-5a2d634842b7/Essential-Services-Commission-Act-2001-incorporati.pdf*

European Commission 2016, *The EU Emissions Trading Scheme (EU ETS),* April, (http://ec.europa.eu/clima/policies/ets/index_en.htm)

Institute for Sustainable Futures 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation - Proposed Approach Paper,* February, (http://www.esc.vic.gov.au/getattachment/5e4e0299-695d-4ed5-94dd-c94f57cad580/Institute-for-Sustainable-Futures-(ISF).pdf).

Interagency Working Group on Social Cost of Carbon, United States Government 2010, *Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866, February,* (https://www3.epa.gov/otaq/climate/regulations/scc-tsd.pdf).

Jemena Electricity Networks 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation - Proposed Approach Paper,* February, (http://www.esc.vic.gov.au/getattachment/dadffb16-e383-447b-ada7-2d45635bb2b7/Jemena-Electricity-Newtworks.pdf)

Marchment Hill Consulting 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation - Proposed Approach Paper,* February, (http://www.esc.vic.gov.au/getattachment/6d0487ab-8bf8-49eb-82e2-9d828fc8f137/Marchment-Hill-Consulting.pdf)

Melbourne Energy Institute 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation - Proposed Approach Paper,* February, (http://www.esc.vic.gov.au/getattachment/338e75dc-c41f-4b9a-999e-843a5267e51e/Melbourne-Energy-Institute-(MEI).pdf).

Moorhead, Gareth, 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation - Proposed Approach Paper,* February, http://www.esc.vic.gov.au/getattachment/4a12abc4-5e19-413f-a3e0-8fcf55ce911e/Gareth-Moorhad.pdf).

Multiple submissions ‘I want a fair go for solar’, 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation - Proposed Approach Paper,* February, (http://www.esc.vic.gov.au/getattachment/647bff13-ef6f-42e9-a07b-5d40c4b7130d/Multiple-Submissions-Template-2.pdf).

Multiple submissions ‘Rooftop solar power is more valuable and delivers more benefits than dirty, polluting fossil fuels’ 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation - Proposed Approach Paper,* February, (http://www.esc.vic.gov.au/getattachment/647bff13-ef6f-42e9-a07b-5d40c4b7130d/Multiple-Submissions-Template-1.pdf).

National Water Commission 2009, *Water and the electricity industry: Implications of use*, Australian Government Waterlines Report Series No. 18, August, (http://www.nwc.gov.au/__data/assets/pdf_file/0010/10432/Waterlines_electricity_generation_industry_replace_final_280709.pdf).

Northern Alliance for Greenhouse Action 2016, Submission to Essential Services Commission Inquiry into the True Value of Distributed Generation – Proposed Approach Paper, February, (http://www.esc.vic.gov.au/getattachment/87003e1f-e470-460a-825d-129feef96f7d/Northern-Alliance-for-Greenhouse-Action-(NAGA).pdf)

O'Brien M 2011, Minister for Energy and Resources, Electricity Industry Amendment (Transitional Feed-in Tariff Scheme) Bill Second Reading, Assembly, VicHansard, Book 14, Wednesday 12 October 2011, p. 3674

Origin Energy 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation - Proposed Approach Paper,* February, (http://www.esc.vic.gov.au/getattachment/d1219324-856b-407e-9a55-ab9c4ee0779b/Origin-Energy.pdf).

Pears, Alan, 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation - Proposed Approach Paper,* February, (http://www.esc.vic.gov.au/getattachment/680ee354-e6b2-4adb-a35e-d198909dddb0/Alan-Pears.pdf).

Renewable Energy (Electricity) Regulations 2001 (Cth.) (http://www.austlii.edu.au/au/legis/cth/consol_reg/rer2001392/).

Simply Energy 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation - Proposed Approach Paper,* February, (http://www.esc.vic.gov.au/getattachment/84c34a88-5495-4deb-b57a-77fa736cb9ac/Simply-Energy.pdf).

The Treasury and DICCSRTE 2013, *Climate Change Mitigation Scenarios, Modelling report provided to the Climate Change Authority in support of its Caps and Targets Review* (http://www.environment.gov.au/system/files/resources/a28424ae-cce9-48c9-aad2-56b3db0920a5/files/climate-change-mitigation-scenarios.pdf).

United Energy Distribution 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation - Proposed Approach Paper,* February, (http://www.esc.vic.gov.au/getattachment/54f1d4de-2149-4edb-9f99-5303d1119a82/United-Energy-Distribution.pdf)

Wein, Keith, 2016, *Submission to the Essential Services Commission Inquiry into the true value of distributed generation - Proposed Approach Paper,* February, (http://www.esc.vic.gov.au/getattachment/6e811a46-83a9-4e4d-a589-3b38ca34b623/Keith-Wein.pdf).

Woolcock Institute of Medical Research, Centre for Air Quality and Health Research and Evaluation (CAR) 2015, *Review of the health impacts of emission sources, types and levels of particulate matter air pollution in ambient air in NSW,* December, (http://www.car-cre.org.au/images/content/Health%20impacts%20of%20PM%20report_final%20for%20web.pdf

Victorian Competition and Efficiency Commission 2012, *Power from the People: Inquiry into distributed generation – Final Report,* July (http://www.vcec.vic.gov.au/files/cbddc4f4-91e7-4466-a060-a35a00f0d432/Power-from-the-People-Final-Report.pdf).

Combet G 2009, then Minister Assisting the Minister for Climate Change, Renewable Energy (Electricity) Amendment Bill 2009 Second Reading, House of Representatives, Official Hansard, No.9, Wednesday 17th June, p. 6251.

Combet G 2009, then Minister Assisting the Minister for Climate Change, Renewable Energy (Electricity) Amendment Bill 2009 Second Reading, House of Representatives, Official Hansard, No.9, Wednesday 17th June, p. 6252.

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