

Acknowledgements

This work was funded by the Australian Greenhouse Office.

The authors would like to thank the following people for their invaluable assistance: Don Anderson (EnergyAustralia), Keith Baker (AGO), Darren Brown (Aurora Energy), David Cornelius (Victorian Essential Services Commission), Michael Dadour (Origin Energy), Ray Deacon (EECA – NZ), Dominic Drenen (Origin Energy), Paul Driver (ETSA Utilities), Ian Gibb (Aurora Energy), Steve Gough (Country Energy), Tracy Greenhalgh (Unisearch), Colin Jenkins (Powercor), Dennis Jones (Orion Group), Sinta Knox (TXU), Kerry Llewellyn (Western Power), Nicole Maundrell (Energex), Craig Midson (AGO), Siva Moorthy (United Energy), Rebecca Myers (Ergon Energy), Paul Myors (EnergyAustralia), Travis Nadge (Australian Inland Energy), Max Rankin (TXU Networks), Fred Robson (Australian Inland Energy), Jill Taylor (ORER), Lisa Vosinthavong (ATO), Rebeka Weiley (Integral), Trevor Whitlow (Whitlow & Associates Ltd.).

Disclaimer

The opinions of the authors as expressed in this report are derived from a consultative process with a diverse group of stakeholders. While every reasonable step has been taken to ensure the viewpoint of each stakeholder has been accurately presented, the authors accept no liability for any misinterpretations that may have occurred.

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1. Introduction

Connection to the electricity grid allows owners of residential-scale renewable energy systems to export energy when in excess of their requirements, and import energy when in deficit. An energy storage system is not needed, and so maintenance requirements, and initial and ongoing costs are reduced. Australian Standards that cover the technical aspects of small-scale renewable energy systems have now been developed—see Appendix 6.1. However, there are separate retail and network issues and no standardised approach exists for the connection agreements between the system owner and the electricity retailer and distributed network service provider.

Agreements currently used vary widely and cover a variety of issues including metering and billing, technical connection requirements, and treatment of credits such as Renewable Energy Certificates (RECs) and Green Power. They are often negotiated on an individual basis, which can overly complicate the connection process and result in long delays and increased costs.

Although the *Guide for the Connection of Embedded Generation* (BCSE, 2003) has recently been released by the Business Council for Sustainable Energy (BCSE) and the Commonwealth Department of Industry, Tourism and Resources (DITR), it focuses on generators generally exceeding 100 kW_p in capacity.

Residential-scale renewable energy systems are typically less than 10 kW_p¹ in capacity with most being around 1.5 kW_p, and are connected to the low voltage distribution network – see Figure 1.

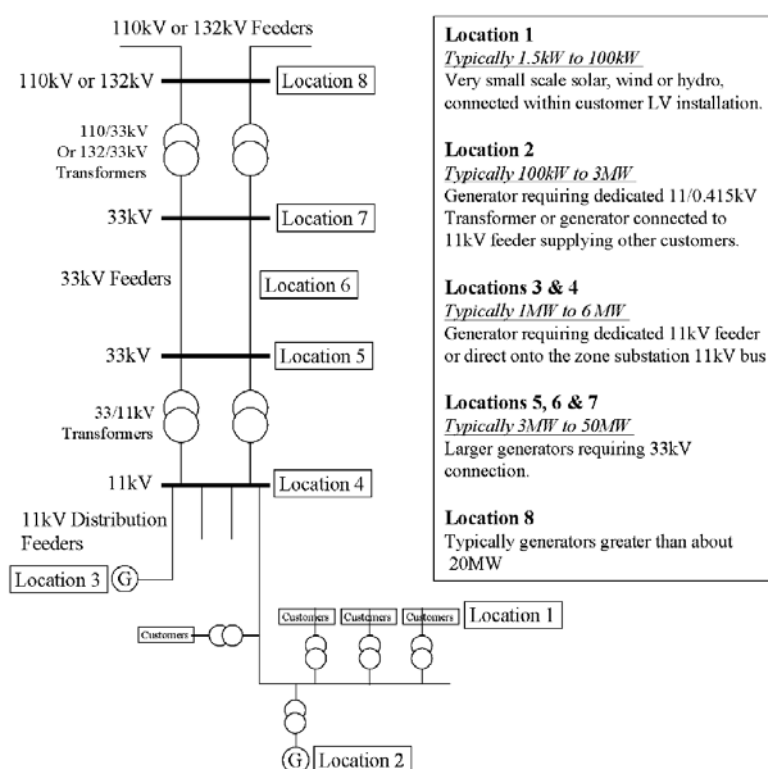


Figure 1 Typical connection locations for embedded generation
From BCSE (2003)

¹ The size of a grid-connected photovoltaic system is typically measured in kilowatts-peak (kW_p), based on the peak DC output of the photovoltaic array under standard conditions of temperature and illumination. The kVA rating of the inverter(s) connecting such a system to the grid is typically 75–100% of this value.

The vast majority of such systems use photovoltaic panels, with a small proportion using wind turbines, and an even smaller proportion using microhydro generators. A fair indication of the relative proportions of different types of generators can be obtained from the number of RECs registered by the Australian Registry for Renewable Energy Certificates. As at November 2003, a total of 1,695 RECs (95% of SGU RECs) were registered for PV small generating units (SGUs), 84 for wind SGUs and none for microhydro units. Thus although this Discussion Paper is relevant to all small-scale grid-connected renewable energy systems, the needs of PV systems are emphasised.

1.1. Relevant National and State Guidelines

The National Electricity Code (NEC) aims to provide a regime of 'light-handed' regulation of the Australian electricity market. It provides a set of market-oriented rules authorised by the ACCC governing market operations, power system security, network connection and access, and network services pricing. According to Clause 1.4 of the NEC, it provides, among others things:

- detailed market rules (including bidding, dispatch, spot price determination and settlements arrangement);
- detailed operational requirements (including power system operations and power system security, emergency operations, metering and maintenance scheduling);
- terms and conditions of access and technical standards that will apply for connection to the network; and
- the methods to be used for pricing network services.

However, the NEC also allows the Jurisdictional Regulator² to develop regulations and guidelines within its jurisdiction, including those regarding grid connection of embedded generators. To date, NSW, South Australia and Victoria have developed, or are developing, guidelines relevant to embedded generators. They are referred to throughout this document, where relevant.

1.2. Development of a Standard Connection Agreement

The Australian Greenhouse Office has provided funding for development of a standard connection agreement template for small (less than 10 kVA) renewable energy systems throughout Australia. This agreement need not be mandatory but would help simplify the grid-connection process for all concerned by providing greater certainty regarding performance, timing and costs.

The project extends work carried out by Coelacanth Consulting (now Greenwatt Pty Limited) and the Australian CRC for Renewable Energy (ACRE) Energy Policy Group (known as AEPG). Coelacanth Consulting produced the report *Metering of embedded generators in Australia* for the Australian Greenhouse Office in October 2001 (Roche, 2001). The AEPG work involved contacting a range of stakeholders including DNSPs, electricity retailers, system owners and system installers, for background information regarding development of a standard connection agreement (Passey *et al.*, 2002).

The process of developing a standard connection agreement has been divided into two stages, the first of which is summarised in this report.

The **first stage** involved surveying DNSPs and electricity retailers regarding agreements they currently use, and the processes they follow for approving grid connection of small systems. Surveys were sent by email, and late responders were sent at least three follow-up emails, before being

² Independent Pricing and Regulatory Tribunal (IPART) in NSW; Essential Services Commission (ESCOSA) in South Australia; Essential Services Commission (VESC) in Victoria; Independent Competition and Regulatory Commission (ICRC) in the ACT; Office of the Tasmanian Energy Regulator (OTER); Utilities Commission in the Northern Territory; Queensland Competition Authority (QCA).

offered the opportunity to provide input directly by phone. Input was also sought from system owners, the Office of the Renewable Energy Regulator and the Australian Taxation Office. This discussion paper summarises the survey results, highlights and discusses the main issues raised, and recommends how these issues should be addressed.

In the **second and final stage**, the responses from stakeholders to the formal discussion paper will be used to propose a standard connection agreement template. This template will be made publicly available for use by DNSPs, electricity retailers, system installers and system owners. A Final Report will summarise the overall project and its outcomes.

Section 2 of this Discussion Paper summarises the issues raised and the author's recommendations on how they could be addressed, **Section 3** outlines and discusses the survey results, and **Section 4** discusses how the costs and benefits of embedded generation could be assigned. At this stage, prior to more extensive input to the process via the Discussion Paper, proposal of a standard connection agreements for either retailers or DNSPs is considered premature.

1.3. Process for Response to Discussion Paper

Responses to the Discussion Paper are due by **6th February, 2004**. Submissions should be submitted in electronic format.

Responses are particularly requested in relation to the points raised in the 'Issues Boxes' throughout the document. Keep in mind that some connection agreements have been criticised for being overly long and complex. The new Australian Standards should facilitate use of a shorter agreement of no more than two or three pages. Additional information can always be supplied separately. Responses are also requested regarding;

- any inaccuracies in the Discussion Paper
- any issues that have not been adequately addressed
- issues specific to non-PV technologies that have been overlooked.

Responses should be directed to:

Dr Robert Passey
Email: r.passey@unsw.edu.au
Phone: 02 9385 4061
Mobile: 0421 783 122

Following input to the Discussion Paper, our intention is to release a Final Report with a proposed standard connection agreement. Based on the issues and recommendations herein, if you consider it unlikely the final agreement will be suitable for your operations, please provide details regarding the process you consider necessary to develop a more appropriate agreement. For example, you may simply require an additional round of written input, or you may require face-to-face contact with other stakeholders via a round-table discussion.

Important Dates:

Surveys sent to retailers and DNSPs:	12 th October, 2003
Surveys ideally returned by:	24 th October, 2003
Discussion Paper released:	16 th January, 2004
Responses to Discussion Paper:	due 6th February, 2004
Final Report released:	20 th February, 2004

1.4. Definitions

Throughout this report, a single embedded generator is assumed to be operated in conjunction with a set of conventional loads, both of which are owned by a *customer* who buys electrical energy from (or in some cases sells it to) a *retailer* via an electrical distribution network or *grid* owned and/or operated by a *distributed network service provider* (DNSP). The combined loads and generator are referred to as the customer's *system*. The terms *import* and *export* are used from the perspective of the customer. That is, electrical energy is imported from or exported to the grid. *Gross imports* refers to the total unidirectional flow of electrical energy from the grid to the customer's system. *Gross exports* refers to the total unidirectional flow of electrical energy from the customer's system to the grid. *Net imports (exports)* refers to gross imports less exports (exports less imports). *Generation* refers to the total flow of electrical energy out of the customer's generator.

Electrical energy units used in the paper are kilowatt-hours (kWh) rather than megawatt-hours (MWh), since the generation from most residential-scale systems is more readily measured in kWh, and most electricity bills are given in kWh.

MRET Review

On the day this Discussion Paper was released, the recommendations of the MRET Review Panel were also released. These included the recommendation that the deeming period for PV systems of not more than 10 kW_p (or 25 MWh per annum) be increased from 5 to 15 years. At this stage the Federal Government has not stated how it will act on these recommendations. Should any announcements be made, the relevant details will be updated in the proposed grid connection agreement and Final Report.

2. Summary of Issues Raised, and Recommendations

Some of the following issues relate to the agreement between the system owner and the retailer, some relate to the agreement between the DNSP and the system owner, and some relate to both agreements.

Issue 1 System size

What should the upper limit of small-scale grid-connected renewable energy systems be?

Recommendation

The upper limit should be consistent with AS 4777: no less than 10 kVA for single phase units, and 30 kVA for three-phase units. Retailers may include a caveat that systems should be appropriately sized to meet demand. DNSPs may include a caveat that system size may be limited by local grid characteristics.

Issue 2 Metering Scheme

Should a standard metering scheme be used, and if so, what type?

Recommendation

Either scheme 2a or 2b should be used as standard. This would be in keeping with the trend in Jurisdictional regulation, and would allow measurement of the system's gross export.

Issue 3 Additional Technical Connection Requirements

Should DNSPs impose technical connection requirements in addition to those imposed by Australian Standards and State or Territory regulators?

Recommendation

Technical connection requirements in addition to those imposed by Australian Standards and State or Territory regulators should not be required for a standard connection agreement where a certified renewable energy installer is used.

Issue 4 Requirement for Specially Certified or Accredited Electricians

Should DNSPs be allowed to require that electricians connecting a system to the grid be specially certified or accredited beyond existing legal requirements.

Recommendation

The DNSP should not require electricians to be specially certified or accredited.

If you do believe that electricians should be specially certified or accredited, can you suggest ways in which the complexity and cost of this requirement could be minimised. For example, the DNSP could have a list of approved installers with a well-defined procedure for getting onto that list.

Issue 5 Metering Costs

Should DNSPs charge for installation of metering, and if they do, what can they do to minimise costs?

Assuming a standard charge should be levied, how should it be calculated?

Recommendations

- (i) If DNSPs do require the system owner to pay additional metering costs, they should allow suitably qualified system installers to perform the installation in order to reduce the installation cost component.
- (ii) A standard charge of no more than \$200 should be applied to recoup the shallow connection costs only.
- (iii) In the longer term, interval meters should be installed on all new premises, or where meters are being replaced, so as to facilitate future use of distributed generation, as well as demand management options.

Issue 6 Retail and Reference Rates

Should the reference and retail rates be the same?

Recommendations

- (i) Retailers may offer reference rates that are higher than retail rates,
- (ii) Retailers should not offer reference rates that are less than retail rates, even when there is net export.
- (iii) The reference rate should either be fixed or pegged to the retail rate for the term of the connection agreement.

Issue 7 Cap on Net Exported Electricity

Should retailers place a cap on net exported electricity for which they will pay?

Recommendations

- (i) Retailers should not place a cap on net exported electricity.
- (ii) The option of placing a cap on total distributed generation receiving the current tariffs should be considered, along with a greater certainty that tariffs for current installations will be maintained.

Issue 8 Payment for Net Export

How should credit for net export be paid?

Recommendation

Credit for net export should be carried forward until reaching at least \$50 and then paid.

Issue 9 Duration of Contract, Notice for Termination, and Disconnection Process

For how long should the agreement apply, how much notice should the system owner, retailer and DNSP be required to give to terminate the agreement, and what should be the process for disconnection?

Recommendations

- (i) The duration of the agreement should be at least five years. .
- (ii) Early termination of an agreement by a retailer or DNSP should be allowed only under exceptional circumstances, such as an intractable safety issue arising or say, long-standing non-payment of electricity bills etc. For legal reasons, where the system owner sells the system or property, the existing contract will need to be terminated and a new contract entered into with the new owners.
- (iii) Where an agreement is to be terminated by any party, one month notice should be given, and a contract should be open for negotiation one month prior to the termination date.
- (iv) The disconnection process should be clearly stated in any grid-connection agreement.

Issue 10 Treatment of Renewable Energy Certificates

How should the deemed RECs be treated in a grid connection agreement?

Recommendation

The system owner should be given the option of transferring the RECs to an agent (such as their electricity retailer, the system supplier or a government agency), who would compensate the system owner using the ORER deeming formula and at least the current value of RECs.

Issue 11 Treatment of NSW Greenhouse Gas Abatement Certificates

How should NGACs be treated in a grid-connection agreement?

Recommendation

Since it is unlikely NGACs will be generated by residential-scale renewable energy systems, they should not be included in the agreement.

Issue 12 Treatment of Green Power Rights

How should GPRs be treated in a grid-connection agreement?

Recommendations

- (i) Retailers should sell exported electricity as Green Power.
- (ii) Retailers should apply net billing so the system owner is effectively paid the Green Power tariff on any gross exports offset against gross imports.
- (iii) Retailers should not have to pay the system owner the Green Power tariff for net exported electricity, even if the system owner is a Green Power customer. This is based on the assumption that the system owner would benefit more from up-front payment of RECs than from an ongoing Green Power tariff.

3. Survey of Electricity Retailers and DNSPs

Fifteen Retailers and 15 DNSPs were sent separate written surveys during October 2003—see Appendix 6.2 for surveys. Responses were received from ten retail operations and ten DNSP operations—see Table 1. There are three retailers, three DNSPs, and 12 companies that have both retail and network service businesses in Australia—see Table 2.

All respondents, with the exception of Auspower which focuses on large customers, allow grid connection of small renewable energy systems. As can be seen from Table 3, Table 4 and Table 5, the nature and extent of the services differ greatly, ranging from a full connection service to a much more limited service. Some retailers offer a grid-connection service nationally whereas others limit this service to within their franchise area.

Table 1 Retailers and DNSPs that responded to the survey

Responses received from	
Retailers	DNSPs
Aurora Energy	Aurora Energy
Australian Inland Energy	Australian Inland Energy
Country Energy	Country Energy
Energex	EnergyAustralia
EnergyAustralia	ETSA
Ergon	Integral Energy
Integral Energy	Powercor
Origin	TXU Networks
Western Power	United Energy
TXU	Western Power
Responses not received from	
Retailers	DNSPs
Actew AGL	Actew AGL
AGL	AGL
Auspower	Energex
NT Power and Water Corporation	Ergon
Powerdirect	NT Power and Water Corporation

Table 2 Electricity Retailers and DNSPs in Australia

Head Office Location	Company	Retailer / DNSP	Cater for grid connection?	Areas serviced by retailer	Retailer cap on system size?	DNSP cap on system size?
NSW	Australian Inland Energy	retailer and DNSP	Y	NSW distribution area only	Yes, likely to be less than 10 kVA	Yes, likely to be less than 10 kVA
	Country Energy	retailer and DNSP	Y	All NEM participating States	-	Yes < 10 kVA >10kVA negotiated
	EnergyAustralia	retailer and DNSP	Y	NSW	No	No, but depends on local grid characteristics
	Integral Energy	retailer and DNSP	Y	NSW	10 kVA	10kVA
Vic	Citipower (recently bought by Origin)			-	-	
	Origin Energy	retailer only	Y	Nationally with representation in Vic, SA and Qld.	No	
	TXU and TXU Networks	retailer (TXU), DNSP (TXU Networks)	Y	Victoria	2 kW	2 kW
	United Energy	DNSP only	Y	-	-	10 kVA, but is limited by network capacity
	Auspower	retailer for Yallourn Energy	N	-	-	
	Powerdirect	retailer for Australian Energy	Y		-	
	Powercor AGL	DNSP only retailer and DNSP	Y Y	- -	- -	20 kVA -
Qld	Energex	retailer and DNSP	Y	South East Queensland franchise area	10kVA	
	Ergon Energy	retailer and DNSP	Y	QLD but only within franchise area	1.5kW	
SA	ETSA	DNSP only	Y	-	-	Single phase 15kW, three phase 45 kW
WA	Western Power Corporation	retailer and DNSP	Y	WA	Single phase 10kVA, three phase 30 kVA	Single phase 10kVA, three phase 30 kVA
Tas	Aurora Energy	retailer and DNSP	Y	Tas	3kVA	None
ACT	Actew AGL	retailer and DNSP	Y	-	-	
NT	NT Department of Mines and Energy	retailer and DNSP	Y	-	-	

3.1. System upper size limit

Of the respondents, not all had an upper size limit for embedded generators. For those that did, the upper limit ranged from 1.5 to 20 kW_p for single phase, and up to 45 kW_p for three phase, although the limit for a particular system may depend on local grid characteristics.

The system size limit to which Australian Standard AS 4777 applies is 10 kVA for single phase units, and 30 kVA for three-phase units, although the Standard may be used for guidance in the case of larger systems. Thus it would seem reasonable for retailers and DNSPs to adopt similar size limits. However, retailers may be concerned with systems that are oversized with respect to demand, and so likely to have a significant net export. This problem could be overcome by setting a reasonable limit on the amount of export for which they pay the system owner. DNSPs concerned with impacts on the local network could include a caveat stating that the upper limit would depend on local grid characteristics. Alternatively, as occurs in some US contracts, the conditions may apply only until a specified number or capacity of systems is installed on the system (eg. 10 MW_p or 1000 systems), after which the DNSP or retailer reserves the right to change them.

Issue 1 System size

What should the upper limit of small-scale grid-connected renewable energy systems be?

Recommendation

The upper limit should be consistent with AS 4777: no less than 10 kVA for single phase units, and 30 kVA for three-phase units

- Retailers may include a caveat that systems should be appropriately sized to meet demand
- DNSPs may include a caveat that system size may be limited by local grid characteristics

Table 3 Connection Services Offered by Retailers in Australia

Company	Full connection service?	Panels, inverter, wiring and incidentals	Perform or organise system installation	AGO Rebate Application	AGO Rebate final report	State Rebate Application	Network grid connect meter application	Network grid connect meter final contract	Renewable Energy Certificates	NSW Greenhouse Abatement Certificates	Electrical Chief Inspectors Office form	Embedded Generation contract
Australian Inland Energy	Y ⁱ	Y ⁱ	Y ⁱ	N ⁱⁱ	N ⁱⁱ	N ⁱⁱ	N	N	Y	N	N	N
Country Energy	N	N	N	N	N	N	Y	Y	Y	Y	N	if > 10 kVA
EnergyAustralia	N	?	?	?	?	?	?	?	?	?	?	?
Integral Energy	N	N	N	N	N	N	N	N	N	N	N	N
Origin Energy	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y
TXU	N	N	N	N	N	N	na	na	N	na	N	na
Powerdirect	-	-	-	-	-	-	-	-	-	-	-	-
AGL	-	-	-	-	-	-	-	-	-	-	-	-
Energex	Y ⁱⁱⁱ	Y	Y	Y	Y	Y	Y	Y	Y	-	Y	Y
Ergon Energy	N	N	N	N	N	N	N	N	Y	Y	N	N
Western Power Corporation	N	N	Y ^{iv}	N ^v	N ^v	N ^v	Y	Y	N	N	N	Y
Aurora Energy	N	N	N	Y	Y	N	N	N	-	N	N	Y
Actew AGL	-	-	-	-	-	-	-	-	-	-	-	-
NT Department of Mines and Energy	-	-	-	-	-	-	-	-	-	-	-	-

i Is performed through a partner arrangement with a local supplier for purchase and installation.

ii Is performed by the partner and the customer.

iii Customers are able to purchase solar systems including installation from Energex and where this occurs Energex assists the customer to complete all required paperwork including PVRP forms. For all customers Energex assist with connect to network applications, Network and Retail agreements and purchase Renewable Energy Certificates.

iv Meters only

v Arranged by the Sustainable Energy Development Organisation (SEDO)

Table 4 Connection Services Offered by DNSPs in Australia

Company	Full connection service?	Panels, inverter, wiring and incidentals	Perform or organise system installation	AGO Rebate Application	AGO Rebate final report	State Rebate Application	Network grid connect meter application	Network grid connect meter final contract	Renewable Energy Certificates	NSW Greenhouse Abatement Certificates	Electrical Chief Inspectors Office form	Embedded Generation contract
Australian Inland Energy	N	N	N	Y ⁱ	Y ⁱ	Y ⁱ	Y	Y ⁱ	Y ⁱ	Y ⁱ	Y ⁱ	Y ⁱ
Country Energy	N	N	N	N	N	N	Y	Y	Y	Y	N	if > 10 kVA
EnergyAustralia Network	N	N	N ⁱⁱ	N	N	N	N	N	N	N	N	N
Integral Energy	N	N	N	N	N	N	N	N	N	N	N	N
TXU Networks	N	N	N	N	N	N	na	na	N	N	N	na
United Energy	N	N	N	N	N	N	Y	Y	N	N	N ⁱⁱⁱ	N
Powercor	Y	N	N	N	N	N	N	Y	N	N	N	Y
AGL	-	-	-	-	-	-	-	-	-	-	-	-
Energex	-	-	-	-	-	-	-	-	-	-	-	-
Ergon Energy	-	-	-	-	-	-	-	-	-	-	-	-
ETSA	N	N	N	N	N	N	N	Y	N	N	N	N
Western Power Corporation	N	N	Y ^{iv}	N ^v	N ^v	N ^v	Y	Y	N	N	?	Y
Aurora Energy	N	N	N	Y	?	?	Y	Y	?	?	?	Y
Actew AGL	-	-	-	-	-	-	-	-	-	-	-	-
NT Department of Mines and Energy	-	-	-	-	-	-	-	-	-	-	-	-

i As required by regulation

ii Currently metering is typically installed by EnergyAustralia

iii But they do require a Certificate of Electrical Safety that can only be provided by inspectors certified by the Office of Chief Electrical Inspectors.

iv Meters only

v Arranged by the Sustainable Energy Development Organisation (SEDO)

Table 5 Installation

Retailer	Perform installation?	Perform installation?	DNSP
Australian Inland Energy	Y ⁱ	N	Australian Inland Energy
Country Energy	N	N	Country Energy
EnergyAustralia	N	N ⁱⁱ	EnergyAustralia Network
Integral Energy	N	N	Integral Energy
Origin Energy	Y		
TXU	N	N	TXU Networks
AGL	-	-	AGL
		N	United Energy
		N	Powercor
Powerdirect	-		
Energex	Y	-	Energex
Ergon Energy	N	-	Ergon Energy
		N	ETSA
Western Power Corporation	Y ⁱⁱⁱ	Y ^{iv}	Western Power Corporation
Aurora Energy	N	N	Aurora Energy
Actew AGL	-	-	Actew AGL
NT Department of Mines and Energy	-	-	NT Department of Mines and Energy

i Is performed through a partner arrangement with a local supplier for purchase and installation.

ii Currently metering is typically installed by EnergyAustralia

iii Meters only

iv Meters only

3.2. Metering schemes

Metering schemes generally consist of three legs joined at a common connection point: the grid leg, generator leg and load leg—see Figure 2.

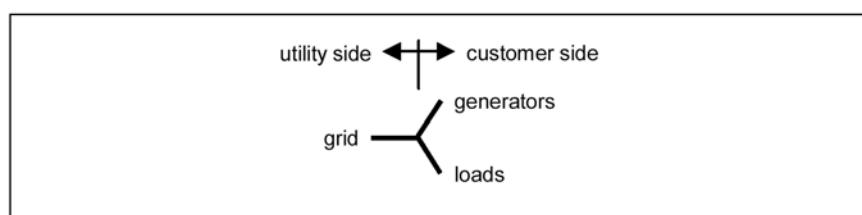


Figure 2 Basic star circuit topology of a grid-connected electrical system
From Roche (2001)

As described in *Metering of embedded generators in Australia* (Roche, 2001), five metering schemes (1 through to 3b in Table 6) are typically used to connect small-scale renewable energy systems to the grid. Six additional hybrid schemes that provide more information on electricity flow, but are more complex and not generally used in Australia, are also possible—see Table 7. See Appendix 6.3 for more detailed diagrams of each of these schemes.

Table 6 Types of metering schemes typically used in Australia







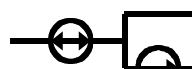




Type of metering scheme		Description
1		Net metering using a single bidirectional meter on the grid side of the common point between the customer's generator and loads legs
2a		Import-export metering using two unidirectional meters on the grid side of the common point between the customer's generator and loads legs
2b		Import-export metering using a dual-element electronic meter on the grid side of the common point between the customer's generator and loads legs
3a		Generation-consumption metering using two unidirectional meters to measure energy flows in the generator and load legs.
3b		Generation-consumption metering using a dual-element electronic meter to measure energy flows in the generator and load legs.

Table 7 Additional hybrid types of metering schemes

Type of metering scheme		Description
4a		Net metering using a single bidirectional meter on the grid side of the common point between the customer's generator and loads legs, and a single unidirectional meter on the generator leg
4b		Net metering using a single bidirectional meter on the grid side of the common point between the customer's generator and loads legs, and a single unidirectional meter on the load leg
5a		Import-export metering using a dual-element electronic meter on the grid side of the common point between the customer's generator and loads legs, and a single unidirectional meter on the generator leg
5b		Import-export metering using a dual-element electronic meter on the grid side of the common point between the customer's generator and loads legs, and a single unidirectional meter on the load leg
6a		A single unidirectional meter to measure export on the grid leg, and a unidirectional meter on each of the generator and load legs
6b		A single unidirectional meter to measure import on the grid leg, and a unidirectional meter on each of the generator and load legs

3.2.1. Types of metering schemes currently used in Australia

A variety of metering schemes are currently used in Australia. Some DNSPs use more than one scheme, and a number are in the process of changing schemes—see Table 8. In some cases, where an off-peak hot water tariff is applied, an extra meter would be required (unless an interval meter is used).

Table 8 Type of Metering scheme

Company	Metering scheme
Australian Inland Energy	3b Likely; subject to retailer's requirements
Country Energy	1 at present, or a separate meter on generator output. Are moving away from net metering, and returning to separate metering for installation (load) and generator output.
EnergyAustralia Network	Initially 2a however more recently 2b . EnergyAustralia Network is currently reviewing it's position on metering requirements for private generation facilities installed on customer's premises.
Integral Energy	3a
TXU Networks	2b
United Energy	3a for three-phase customers (whether or not the RE system is single phase) and 3b for single-phase customers. Also UE require that the meters on both the generation and load legs be interval meters, not accumulation meters. This is because of concerns about larger systems in future (up to 10kVA) that could have a greater impact on grid stability—. As noted below UE pays for all meters.
Powercor	2a or 2b , although an extra meter may be required for off peak hot water
AGL	
Energex	
Ergon Energy	
ETSA	1 for installations prior to 1 July 2001. After July 2001, the regulator (ESCoSA) changed the Metering Code to require 2b . Some installations, but not all, have been retrospectively changed over.
Western Power Corporation	2a
Aurora Energy	1
Actew AGL	
NT Department of Mines and Energy	

3.2.2. Net metering

System owners in particular have stated a preference for net metering where a single meter runs either forward or backward providing a single value for net electricity consumption or production over a given period. Currently 37 States in the USA have mandatory net metering for small systems, as do New Zealand, Germany, Switzerland, the Netherlands, and Great Britain (only for PV). In the US, some states have had net metering agreements since the early 1980s, while others have only recently implemented them. In most states net metering agreements are incorporated into some form of legislature, while in others they are optional (DOE, 2002).

Net metering is not commonly employed in Australia, in part because most electromechanical meters are not calibrated to run backwards. Overseas experience and local anecdotal evidence suggest that electromechanical meters can be operated accurately in either direction.³ However, unless they are

³ Pacific Solar, for example, tested two standard electromechanical meters connected in series, but with one connected in a reverse manner. They found the reversed meter registered about 0.3% less energy than the forward meter—a difference

calibrated in both directions, the legality of their use as bidirectional meters is questionable. Moreover, if a system owner wishes to be rewarded for network system support, especially during times of peak demand, simple net metering is insufficient to measure this capability. At the very least, the gross amount of electricity being exported into the grid should be known, preferably with interval metering. Although interval metering currently costs more, with increased uptake this cost would decrease. If the full value of embedded generation is to be quantified and therefore recognised, the generation profile must be correlated with the network load profile, and for this to occur, interval metering is required.

Regardless of these technical considerations, the Jurisdictional Regulators in NSW, Victoria and South Australia⁴ have released rulings stating that *new* meters on non-market generators⁵ must be able to measure positive and negative flows of electricity separately. Thus in these States, for newly installed meters, the simple net metering scheme 1 would not be allowed. Of the schemes in Appendix 6.3, only 2a, 2b, 5a and 5b would be permitted.

3.2.3. Impacts of different metering schemes on billing

One of the principal features of metering scheme 1 is that it forces a retailer to buy and sell electricity at the same rate; in other words to implement true net metering. All the other schemes, in contrast, allow a retailer to buy and sell electricity at different rates, even though most have implemented identical rates as a standard policy.

Metering schemes 2a and 2b enable a retailer to distinguish between imports and exports, whereas metering schemes 3a and 3b enable the retailer to distinguish between generation and consumption. Since generation will always exceed exports (and consumption will always exceed imports), generation-consumption metering is further from true net metering, in terms of revenue flows, than is import-export metering. In other words, if a retailer were to pay less for generated/exported electricity than they charge for consumed/imported electricity, the customer would be better off with scheme 2a or 2b. Conversely, if the retailer were to pay more for generated/exported electricity than they charge for consumed/imported electricity, the customer would be better off with scheme 3a or 3b. Under a net metering arrangement where buy and sell rates are the same, schemes 1, 2 and 3 all provide (at least in theory) the same returns to the customer. There are, however, several complicating factors, such as the Goods and Services Tax (GST; Section 3.6.5), Renewable Energy Certificates (RECs; Section 3.7.1), NSW Greenhouse Abatement Certificates (NGACs; Section 3.7.2) and Green Power Rights (GPRs; Section 3.7.3). Their financial impact will be determined by both the nature of the agreement with the retailer, and the metering scheme used by the DNSP.

3.2.4. The benefits of a standardised metering scheme

Development of a standardised metering scheme has a number of advantages. These include:

- Ease of installation and maintenance, and therefore reduced time and costs for the householder, electricity retailer and DNSP;
- Facilitating increased use of embedded generation resulting in improved system reliability, reduced network upgrades, greenhouse benefits etc.;
- With retail competition it is possible to have a local DNSP and a retailer from elsewhere (including interstate). A standardised metering scheme would help with compatibility of billing systems and metering schemes.

within the accuracy limits of these devices. The small discrepancy may be caused by increased frictional losses on the vertically-mounted worm gear when operated in the reverse direction (Edmiston, 2003).

⁴ Independent Pricing and Regulatory Tribunal (IPART) in NSW; Victorian Essential Services Commission (VESC); Essential Services Commission (ESCOSA) of South Australia.

⁵ Non-market generators must have their entire output purchased directly by the local retailer or by a customer located at the same connection point. Residential-scale renewable energy systems are classified as non-market generators.

Issue 2 Metering Scheme

Should a standard metering scheme be used, and if so, what type?

Recommendation

The report authors recommend that;

Either scheme 2a or 2b should be used as standard. This would be in keeping with the trend in Jurisdictional regulation, and would allow measurement of the system's gross export.

3.3. Technical Installation Requirements

Australian Standards that cover the technical aspects of small-scale renewable energy systems have been developed⁶—see Appendix 6.1. In addition to these Standards, some jurisdictions may have statutory requirements; for example the NSW Service and Installation Rules, the Victorian Certificate of Electrical Safety (Prescribed Electrical Installation Work), the South Australian Certificate of Compliance, or the WA Electrical Requirements. By law all systems must conform to these Standards and statutory requirements and as such they are an obligatory component of any connection agreement. Thus with respect to statutory requirements, connection agreements would probably differ slightly between different jurisdictions.

Of the DNSPs that responded to the survey, only two imposed technical requirements in addition to the above—see Table 9. Aurora Energy have their own technical standards covering all system sizes, although it is unclear whether these are more demanding than the Australian Standards. Western Power requires that:

“The application shall address the technical issues and shall also include a combined power, protection and control schematic in accordance with Australian standards for the proposed electrical system. The contents of the Application must be certified by a Chartered Professional Engineer with NPER [National Professional Engineers Register] standing with the Institution of Engineers Australia, unless an exemption is allowed. If a previous Application has been certified in this manner, and is identical (within the sections of Schematic Diagram, System Details, Protection Settings and Technical Compliance of System) to the proposed Application, then an exemption to certification requirement above may be allowed. The applicant must confirm that a Chartered Professional Engineer with NPER standing within the Institute of Engineers Australia has already certified an identical Application and must give full details of the prior certified Application in order for an exemption to be considered.”

Requiring a Chartered Professional Engineer with NPER standing to certify connection drawings for a system significantly increases up-front installation costs—by about \$500. Even if a previous system is identical and has been certified, locating it and providing details would still be a significant barrier to installation.

⁶ From the survey results, a number of DNSPs seemed to be using the now outdated ESAA Australian Guidelines for grid connection of energy systems via inverters. This could be very confusing for system owners focussing on compliance with current Australian Standards and statutory requirements.

Table 9 Installation

DNSP	Additional technical requirements	Specially certified or accredited electrician?
Australian Inland Energy	N	--
Country Energy	N	N
EnergyAustralia Network	N	see text Section 3.4
Integral Energy	N	N
TXU Networks	N	N
United Energy	N	--
Powercor	N	N
AGL		
Energex	--	--
Ergon Energy	--	--
ETSA	N	see text Section 3.4
Western Power Corporation	see text above	N
Aurora Energy	Y	N
Actew AGL	--	--
NT Department of Mines and Energy	--	--

Issue 3 Additional Technical Connection Requirements

Should DNSPs impose technical connection requirements in addition to those imposed by Australian Standards and State or Territory regulators?

Recommendation

The report authors recommend that;

Technical connection requirements in addition to those imposed by Australian Standards and State or Territory regulators should not be required for a standard connection agreement where a certified renewable energy installer is used.

3.4. Specially certified or accredited electrician

DNSPs were asked whether they required the electrician connecting an embedded system to their grid to be specially certified or accredited. Of the DNSPs that answered this question, only two had such a requirement—see Table 9.

EnergyAustralia required that all electricians working on or near their transmission and/or distribution system must be authorised by EnergyAustralia. Suitably qualified employees of Accredited Service Providers (ASP's) can be authorised.⁷ Currently, EnergyAustralia typically install the meter(s), owing to the complexity of the metering arrangement: however, work is under way to allow all ASPs to install meters.

ETSA require the installer to be an A Class Licensed Electrical Worker with SEI (Sustainable Energy Industry) Certification/Endorsement.

The requirements for certification to work on the network is separate from the certification for installing a renewable energy system. The latter pays particular regard to system design, safe installation and DC wiring issues.

Requiring a specially certified or accredited electrician may add complexity and cost to the installation. However, it is understandable that DNSPs wish to ensure that electricians working on their network are adequately qualified. Since this requirement should not be a major impediment to grid connection, the report authors seek input as below.

Issue 4 Requirement for Specially Certified or Accredited Electricians

Should DNSPs be allowed to require that electricians connecting a system to the grid be specially certified or accredited beyond existing legal requirements.

Recommendation

The DNSP should not require electricians to be specially certified or accredited.

If you do believe that electricians should be specially certified or accredited, can you suggest ways in which the complexity and cost of this requirement could be minimised. For example the DNSP could have a list of approved installers with a well-defined procedure for getting onto that list.

3.5. Metering and Installation Costs

Each of the five metering schemes shown in Table 6 requires installation of at least one additional meter (in scheme 1 a mechanical meter may be replaced with an electronic meter), although in some cases the installed meter replaces an existing meter that can, at least in principle, be reused. In the case of schemes 2a and 3a, this meter is in addition to the customer's existing meters, whereas in the case of schemes 1, 2b and 3b, the newly installed meter replaces the existing consumption meter.

Apart from the price of the additional meter, costs include installation and any further associated work such as installation of a new meter board to accommodate an additional meter. Of the DNSP

⁷ The NSW state government requires that all work must be performed by ASPs, where accreditation is obtained from the Department of Energy Utilities and Sustainability (formerly the Ministry of Energy and Utilities).

respondents, only one (EnergyAustralia) said they installed the metering systems themselves: although there are plans for this to be performed by network service providers accredited by the NSW Department of Energy, Utilities and Sustainability (formerly the Ministry of Energy and Utilities).

Table 10 Metering and Installation Costs

Company	Meter & installation cost	Who pays costs / who owns meter	Additional fees for owner	Total cost for system owner
Australian Inland Energy	\$200 to \$600 – single phase to three phase	DNSP / DNSP	\$14 to \$65 ⁱ	\$14 to \$65
Country Energy	No cost to system owner if they use Country Energy as retailer. Otherwise meter cost + \$75 to \$225 for labour	DNSP / DNSP	\$14 to \$65 ⁱ	\$14 to \$560 for single phase
EnergyAustralia	approximately \$400	System owner / DNSP ⁱⁱ	No	\$400
Integral Energy	\$35 + labour cost	DNSP and system owner ⁱⁱⁱ / DNSP	\$15 to \$24 ⁱ	\$15 to \$24 & labour cost
TXU Networks	up to \$455.25	system owner / DNSP	No	up to \$455.25
United Energy	\$200	DNSP / DNSP	No	0
Powercor	\$285.99 or \$516.69 ^{iv}	Retailer / DNSP	\$523.60	\$809.59 to \$1,040.29 ^v
AGL				
Energex				
Ergon Energy				
ETSA	\$345 plus GST	system owner / DNSP	No	\$345 plus GST
Western Power Corporation	\$398 to \$528 single phase ^{vi} \$863 to \$993 for three phase	system owner / DNSP	\$107, possibly plus about \$500 ^{vii}	\$505 to \$1,100, possibly plus about \$500 ^{vii}
Aurora Energy	About \$500 for small-scale systems	system owner / DNSP	generally zero	About \$500 for small-scale systems
Actew AGL				
NT Department of Mines and Energy				

i This charge is for Notification of Service Electrical (NOSE) works fees, with the range due to whether an A grade electrician (lower cost), or a C grade electrician is used (higher cost).

ii Note that EnergyAustralia's metering policy for this type of installation is currently under review and may be changed in the future.

iii System owner organises and pays for installation and Notification of Service Electrical works fees, DNSP pays for meter

iv The lower price is for new installations, the higher price is for replacement installations. GST included.

v Assumes retailer passes on all installation costs.

vi Range depends on whether new or replacement, and on type of tariff.

vii Due to the possible requirement for a Chartered Professional Engineer to certify the connection drawings.

The costs of installation varied greatly between DNSPs. In three cases these were paid by the DNSP, while in others they were paid by the system owner. In one case the cost was passed on to the retailer; however according to at least one retailer that services the relevant franchise area, this cost would be passed on to the system owner. In summary, for the DNSPs that responded to the survey, the installation cost (including the meter cost) varied from zero to \$528 for a single phase connection, and up to \$794 for a three phase connection—see Table 10.⁸ All DNSPs retained ownership of the meters regardless who paid for them.

In addition to meter installation costs, five DNSPs also have an additional fee that is charged to the system owner. The most expensive of these (\$523.60; Powercor), was charged to cover the cost of engraving, design, network connection agreement administration, GIS system update and lineworker costs to fit labels. This fee brought the total installation cost to over \$1,000. The next highest fee (\$107; Western Power Corporation) was charged to cover the time of the network engineer assessing the application. As outlined in Section 3.3, Western Power Corporation may also require a Chartered Professional Engineer to certify the connection drawings, which can add another \$500 to the connection cost. This brought the maximum installation cost to about \$1,600. The other DNSPs additional fees were much lower and were for Notification of Service Electrical works.

To put metering costs into perspective, the present retail price of a typical 1.5 kW_p PV system, without government subsidies, is around \$18,000. The government subsidy is currently \$4/W_p, but is capped at \$4,000, bringing the cost down to \$14,000. Hence a metering cost of \$500, for example, represents just over 3.5% of the total system cost. For a 0.5 kW_p system, the proportional cost rises to over 10%.

3.5.1. Jurisdictional regulation regarding payment of additional metering costs

The Jurisdictional Regulators in NSW, Victoria and South Australia have ruled that the DNSP can pass on additional metering costs of an embedded generator to that generator (see box below). The ACT, Tasmania and the Northern Territory do not have rulings specifically for embedded generators, but have ruled that additional metering costs of customers connected to the grid may be passed on to those customers. This could be interpreted as meaning that any additional metering costs of embedded generators should be paid by the system owner. In both Queensland and Western Australia it appears there is no specific ruling on additional metering costs.

3.5.2. Summary

Minimising installation costs for the system owner is important if uptake of embedded renewable-energy generators is to be encouraged. Despite most States and Territories ruling that DNSPs can pass on any additional metering costs, as can be seen from Table 10, a number of DNSPs are not doing so. This is to be commended since it reduces up-front cost barriers to deployment of renewable energy systems. It may also lead to network support for the DNSP.

Where DNSPs can both require customers to pay for metering and determine which metering scheme they shall use, there is no incentive for them to implement a least-cost metering option. Hence metering installation costs may be higher than necessary. If a DNSP does require the system owner to pay for installation, it would be much cheaper if performed by an appropriately accredited system installer; typically \$25–50 for the 0.5–1.0 hour it takes for a single person to install the meter.

⁸ Currently, single-phase detented electromechanical disk meters applicable to schemes 2a and 3a cost about \$60 (e.g. Email M3). Two-element TOU electronic meters, required for schemes 2b and 3b, cost between \$120 (e.g. Email P1) and \$270 (e.g. Email A11). Although cheaper clip-on meters, such as the Cent-A-Meter, are commercially available, they are not accumulation meters and so can not be used to calculate net energy usage. The Cent-A-Meter measures domestic electrical power usage and displays the cost per hour on a portable display located inside the home. It consists of a sensor, wireless transmitter and receiver. The sensor is a clip-on current transformer that samples the electric current on each active phase wire inside the switchboard. This information is transmitted to a graphic display that can indicate power consumption, the cost per hour of electricity, equivalent greenhouse gas generated, and in-door ambient temperature and humidity. It is available from the Australian Gas Light Company Energy Shops. For more information see <http://www.centameter.com.au/>.

Installation by the DNSP's own staff or a contractor increases costs by requiring additional personnel to travel to site.

The Victorian Essential Services Commission released an Issues Paper in July 2003 calling for input to proposed guidelines for embedded generators (VESC, 2003).⁹ One issue to be addressed was whether DNSPs should levy a standard connection charge for small generators. The consensus of respondents was that a standard charge should be applied, and it should apply only to shallow connection costs.

Since the cost of an appropriate meter is between \$60 and \$120, and labour charges would be about \$50 (assuming the system installer also installs the metering system), the total standard charge should be no more than \$200. This would also cover additional costs such as NOSE fees.

State and Territory Positions on Metering Costs

In **NSW**, according to Clause 7.1.1(d) of the *Market Operations Rule (NSW Rules for Electricity Metering) No. 3 of 2001*, if a DNSP has to install metering equipment that is different to that normally provided, either the system owner, or the retailer on behalf of the system owner, must bear any additional costs incurred by the DNSP.

In **South Australia**, according to Section 3.4.5 of the *Electricity Metering Code, July 2003*, the cost of providing and installing a new metering installation shall be borne by the party that initiates the metering change. It is not clear whether this is the system owner or the retailer.

In **Victoria**, according to Section 7.1(l) of the *DRAFT Electricity Customer Metering Code, November 2003*, the customer must bear any costs incurred installing non-market generator metering equipment.

In the **ACT**, according to Section 6.2 of the *Electricity Metering Code, August 2003*, where a customer requests the DNSP to install non-standard metering equipment, the customer must pay the difference in cost between the standard and non-standard meters. In addition, according to Clause 7.1, the metering equipment remains the property of the DNSP, and according to Clause 8.1, the DNSP may require the customer to pay the cost of installation.

In **Tasmania**, according to Section 9.12.5 of the *Tasmanian Electricity Code, September, 2003*, where a customer requests the DNSP to install non-standard metering equipment, the customer must pay the difference in cost between the standard and non-standard meters.

In the **Northern Territory**, according to Section 29(3) of the *Electricity Networks (Third Party Access) Act*, if the network provider installs metering equipment, the network user in respect of the connection point must reimburse the network provider's reasonable costs and expenses in doing so. It appears that the *Inquiry Into The NT Electricity Network Access Code, April 2003* has not changed this position.

In **Queensland**, neither the QLD Electricity ACT 1994 nor the report *Metrology Procedure for Metering Installation Types 5, 6 and 7: Explanatory Document and Amended Draft Metrology Procedure* prepared by the Queensland Competition Authority, have a stated position on this issue. However, the QLD Office of Energy indicated that if there is an existing meter that is adequate in performing the required task and a customer requires an additional meter then the customer should be required to bear the cost of that meter, while the DNSP would retain ownership of the meter.

In **Western Australia**, the WA Electricity ACT does not appear to refer to who is responsible for additional metering costs, and so it appears this is not regulated at present.

⁹ Although the discussion paper responding to input to the issues paper is yet to be released, the submissions are available on the VESC website <http://www.esc.vic.gov.au/electricity696.html>. Responses were received from AGL, Alternative Technology Association, Business Council for Sustainable Energy, CitiPower/Powercor, National Electricity Distributors Forum, Solar Charge, TGE, TXU Networks, United Energy, Wind Farmer, Wind Power Pty Ltd,

Issue 5 Metering Costs

Should DNSPs charge for installation of metering, and if they do, what can they do to minimise costs?

Assuming a standard charge should be levied, how should it be calculated?

Recommendations

- (i) If DNSPs do require the system owner to pay additional metering costs, they should allow suitably qualified system installers to perform the installation in order to reduce the installation cost component.
- (ii) A standard charge of no more than \$200 should be applied to recoup the shallow connection costs only.
- (iii) In the longer term, interval meters should be installed on all new premises, or where meters are being replaced, so as to facilitate future use of distributed generation, as well as demand management options.

3.6. Billing Arrangements

Electricity exported to the grid has economic value for the system owner, even without net export. This value is determined by the retailer according to the following criteria:

- Whether the reference price is the same as the retail price;
- If these prices are different, whether to pay the reference price only on net export or on gross export; and
- Whether to place a cap on the amount of exported electricity for which the owner will be paid.

The retailer must then decide on the length of time over which net energy usage is calculated, and how excess electricity is credited to the customer. The Goods and Services Tax (GST) will also affect the financial outcome depending on whether it is paid on the net or gross amount of electricity imported from the grid, and whether it is paid on electricity exports. The contract length and notice required for termination, while not contributing directly to the financial outcome, do impact on its long-term certainty and hence level of risk. The current billing arrangements of the retailers that responded to the survey are shown in Table 11, and are discussed below.

Although RECs, NGACs and GPRs also affect the owner's financial outcome, these may be separated from the electricity contract and so are covered in Section 3.7.

Table 11 Retailer Billing Arrangements

Company	Reference vs retail rates	Cap on export?	Time of calculation	How excess is credited	GST on net or gross imported?	Length of contract	Notice for termination ⁱ
Australian Inland Energy	reference rate 1 ¢ higher than retail rate	N	normal billing cycle	rolled into next bill	unknown	12 months ⁱⁱ	1 month
Country Energy	same ⁱⁱⁱ	N	normal billing cycle	paid for net export	net	<10 kVA, indefinite	7 days
EnergyAustralia	same	N	normal billing cycle	carried forward indefinitely ^{iv}	gross	no standard term	?
Integral Energy	same	N	normal billing cycle	rolled into next bill ^v	net	indefinite	7 days
Origin Energy	same	N	average over 3 months	rolled into next bill	net	2 years	1 month
TXU	same	N	3 month billing cycle	rolled into next bill but set to zero annually	net	no contract	na since no contract
Powerdirect AGL							
Energex	same	N	normal billing cycle	<\$50 rolled into next bill >\$50 is paid	net ^{vi}	5 years	
Ergon Energy	same	10 kWh/day	average over 3 months	rolled into next bill	net	indefinite	
Western Power Corporation	same	N	normal billing cycle	if <\$100 for >6 months, is paid	gross	5 years	
Aurora Energy	same ^{vii}	N	normal billing cycle	paid by cheque	net	5 years	NA
Actew AGL							
NT Department of Mines and Energy							

i This column is repeated in Table 14

ii A longer contract term is available on request

iii Currently only applies to systems less than 5 kW_p, and is under review and will change

iv A cheque could be provided on request if the account is in credit for a prolonged period.

v Some customers ask for, and receive, a cheque

vi Only applies to certain metering systems, see Section 3.6.5

vii If there is a net excess, it is paid at the wholesale rate, not the retail rate

3.6.1. Different reference and retail rates

All retailers except one use a reference rate (the rate paid for exported electricity) that was equal to the retail rate for small systems. The exception was Australian Inland Energy, whose reference rate was 1¢ higher than their retail rate. They also pay the reference rate on gross exports, rather than on net exports, which means that the system owner could generate a credit even if they had a net import. Aurora pay the same retail and reference rates until there is a net export. At this point the reference rate becomes the same as the wholesale rate.

Although Energex used to pay 28 ¢/kWh with a 1000 kWh per annum cap (or 6 ¢/kWh uncapped), they have now changed to net billing.

From the system owner's perspective, there are arguments both for and against identical reference and retail rates. Having a reference rate greater than the retail rate is clearly more profitable for the system owner (especially if this were to be paid on gross exports¹⁰). However, having different rates allows the reference rate to be set lower than the retail rate, reducing the system owner's financial return. This uncertainty makes calculation of pay-back time difficult and increases economic risk. Some connection agreements specifically state that the DNSP may vary the reference rate at any time, without prior notice.

The rate paid for exported electricity depends on its value to the retailer. Benefits to the retailer may include credits such as RECs and GPR, avoided NEM fees, and reduced exposure to peak electricity prices. Costs include the retail/wholesale price difference, and administration. These issues are discussed in detail in Section 4.2.

Issue 6 Retail and Reference Rates

Should the reference and retail rates be the same?

Recommendation

The report authors recommend that;

- (i) Retailers may offer reference rates that are higher than retail rates,
- (ii) Retailers should not offer reference rates that are less than retail rates, even when there is net export, unless they can demonstrate a reason for so doing.

3.6.2. Cap on net exports

Of the ten retailers that responded to this question, Ergon Energy caps the amount of net exports for which the system owner can be paid (to an average of 10 kWh/day). The other six impose no such cap. A cap on net exports reduces exposure of the retailer to high net exports from an unusually large system with an undersized load.

To date few residential renewable energy systems have been installed that are large enough to generate net exports. Annual electricity consumption of a typical Australian residence is about 7500 kWh, which would require a PV system with a capacity of at least 5 kW_p to generate annual net exports. To reach Ergon's 10 kWh/day cap, the system capacity would need to be about 7.5 kW_p—close to the 10 kVA single-phase inverter limit and well in excess of the typical system size of 1.5 kW_p. A cap on exported electricity therefore appears unnecessary. However, the existence of such a cap is unlikely to affect the majority of systems.

As is the case for the reference rate, the retailer's decision to enforce a cap depends on the value it places on exported electricity. These issues are discussed in detail in Section 4.2. In some international examples, a cap (eg. 100 MW) is placed on the total installed capacity of distributed generation which will be granted favourable access and/or tariff conditions, such as net metering. Thus no limit is placed on any individual generator, but the DNSP reserves the right to re-think strategies once significant levels of DG are installed. This approach can also reduce the risk for individual system owners, since their own tariff arrangements can be made more secure.

¹⁰ Of the metering schemes outlined in Section 3.2, a reference rate for gross exports that is different to the retail rate can only be used for schemes 2a, 2b, 5a, 5b, 6a and 6b, since for all the others the gross import and gross export cannot be calculated separately.

Issue 7 Cap on Net Exported Electricity

Should retailers place a cap on net exported electricity for which they will pay?

Recommendations

The report authors recommend that;

- (i) Retailers not place a cap on net exported electricity.
- (ii) The option of placing a cap on total distributed generation receiving the current tariffs should be considered, along with a greater certainty that tariffs for current installations will be maintained.
- (iii) The reference rate should either be fixed or pegged to the retail rate for the term of the connection agreement.

3.6.3. Length of time for net electricity calculation

All retailers performed the net electricity calculation over a standard billing period (generally three months), presumably because this simplified accounting processes. The authors see no reason why this should be altered.

3.6.4. How credit for net export is paid

Of the surveys returned, credit for net export of electricity was either carried forward indefinitely, paid immediately, carried forward but set to zero annually, carried forward until reaching at least \$50 and then paid, or paid if greater than \$100 for more than six months. Given that some systems will generate an ongoing average net export, never paying for this export seems unfair. To reduce administrative costs to the retailer, a reasonable compromise is to pay any export credit once it has reached a certain amount. It also seems reasonable that if the contract is terminated for any reason, the system owner should be paid for any remaining net export (since the retailer would be paid for any remaining net import).

Issue 8 Payment for Net Export

How should credit for net export be paid?

Recommendation

The report authors recommend that;

Credit for net export should be carried forward until reaching at least \$50 and then paid.

3.6.5. Goods and Services Tax (GST)

The goods and services tax (GST) was introduced on 1 July 2000. It is a broad-based tax of 10% on the sales or supplies of most goods, services, or other items sold or consumed in Australia. For grid-connected renewable energy systems, the type of metering and billing system can affect the amount of GST paid by the system owner.

The situation currently faced by grid-connected systems is well illustrated by the private ruling received from the Australian Tax Office (ATO) by Energex in 2001. This stated that GST should be paid by the customer (system owner) only on the net amount of electricity imported. This was because under Energex's billing arrangements at that time it was not possible to measure the gross export (usage by Energex), or gross import (usage by system owner). However, if metering systems were installed that could;

“accurately measure the flow of electricity from the network to the customer and vice versa, then Energex will have to account for its GST liability based on the actual quantity of electricity supplied to the customer. Similarly, the customers who are registered [for GST] will have to account for their GST liability based on the actual quantity of electricity supplied to the network.” (ATO, 2003).

In short, GST should be charged on gross imports or exports of electricity, but only if they can be calculated or measured. If gross imports or exports cannot be calculated or measured, GST is charged on the net import or export.. For this situation, Table 12 explains how GST would be applied to the metering schemes outlined in Section 3.2. These have not been officially confirmed by the ATO and so should be used as a guide only.

Table 12 Likely application of GST to different metering schemes

Metering Scheme	Type of Supply	Calculation of Supply where GST Paid by System Owner	Calculation of Supply where GST Paid by Retailer ⁱ
1	net	net meter	net meter
2a/2b	gross	gross import meter	gross export meter
3a/3b	net	consumption meter – generation meter	generation meter – consumption meter
4a/4b	net	net meter	net meter
5a/5b	gross	gross import meter	gross export meter
6a	gross	consumption meter – generation meter + gross export meter	on gross export meter
6b	gross	gross import meter	gross import meter + generation meter – consumption meter

ⁱ Only if owner registered for GST, and electricity production is part of their business enterprise

Although the above ATO ruling seems to imply that a system owner registered for GST will have to charge the retailer GST for electricity exported to the grid, this is only true if the supply of electricity is made in the course or furtherance of the enterprise for which the supplier is registered for GST. A system owner is not required to register unless their 'enterprise' has an annual turnover exceeding \$50,000; a limit impossible to exceed with a single renewable energy system restricted to a 30 kVA inverter limit. Hence unless a system owner operates their renewable energy system as part of a larger enterprise, they are not required to charge GST. They can, however, voluntarily register for GST regardless of their circumstances, although for most system owners the administrative burden would likely outweigh the small financial gains. Thus the majority of residential system owners will not have to charge their retailer GST.

The ATO cannot give a general ruling on interpretation of GST liability for grid-connected systems. They can give private rulings to retailers on request. At the time this Discussion Paper was released, the ATO shortly expected to include on their web site some guidelines regarding application of GST to grid-connected systems.¹¹ This information will be incorporated into the proposed grid-connection agreement template and Final Report.

All the retailers that returned surveys, bar one, applied GST to the net electricity import. However, not all DNSPs use the same metering scheme, and different metering schemes may have different GST liabilities. Thus a retailer that services more than one network area may need to have different GST regimes depending on the DNSP. Of course, this problem would be avoided if all metering schemes were the same. Table 13 shows the GST liability appropriate for each DNSPs' most likely metering scheme(s)—see Table 8 for a description of these schemes.

Retailers that are applying GST to net imports where the DNSP requires metering scheme 1 or 4a would be consistent with ATO rulings.

Retailers that are applying GST to net imports where the DNSP requires metering scheme 2a or 2b are most likely in breach of ATO rulings since they should be charging GST on gross imports.

Retailers that are applying GST to net imports where the DNSP requires metering scheme 3a or 3b must be calculating net imports by subtracting the generation meter from the consumption meter, and so would be consistent with ATO rulings.

Table 13 GST Paid by System Owner

DNSP	Type of metering scheme	How GST should be applied
Australian Inland Energy	3b	consumption meter – generation meter
Country Energy	1	net import
	3a or 3b	consumption meter – generation meter
EnergyAustralia Network	4a	net import
	2a or 2b	gross import
Integral Energy	3a	consumption meter – generation meter
TXU Networks	2b	gross import
United Energy	3a or 3b	consumption meter – generation meter
Powercor	2a or 2b	gross import
AGL		
Energex		
Ergon Energy		
ETSA	1	net import
	2b	gross import
Western Power Corporation	2a	gross import
Aurora Energy		
Actew AGL		
NT Department of Mines and Energy		

¹¹ This information will be linked to the site at http://www.ato.gov.au/businesses/pathway.asp?pc=001/003/053&mfp=001/003&mnu=3761#001_003_053

3.6.6. Length of contract, and termination / disconnection agreements

Standard contracts ranged from 12 months to five years, although two retailers had no standard term, and one retailer had no contract at all. For the system owner, long-term contracts and advance notice of termination provide certainty regarding income. For the retailer and DNSP they provide certainty regarding the various benefits and costs discussed in Section 0. Therefore it would appear that longer contracts are better, as long as no party is locked into an undesirable position. This can be achieved by either including a reasonable degree of flexibility into the contract, and ensuring it is initially fair to all parties given likely events. The length of the contract may also be affected by other aspects of the agreement. For example, Energex's five year contract was linked to payment of the system owner up-front for the deemed value of their RECs over the first five years.

Either the retailer or the system owner may wish to terminate the connection agreement before the contract has expired. In this Discussion Paper we have chosen to distinguish between "termination agreements" (between a retailer and a system owner) and "disconnection agreements" (between a DNSP and a system owner). This is because the relationship between a retailer and a system owner is essentially financial, whereas that between a DNSP and a system owner relates to a physical connection.

In all cases bar one, in the event of one or other party failing to comply with any of the contract terms and conditions, the agreement may be terminated immediately. The exception to this was Energex (Retail), who notify the system owner in writing giving them three months to comply. A number of retailers retained a right to terminate the agreement should the premises be sold or vacated, although in these cases presumably the system owner should have given notice to the retailer and DNSP anyway.

Termination agreements:

Of the retailers surveyed, the notice for termination given by the retailer to the system owner ranged from seven days to one month, as was the notice for termination given by the system owner to the retailer. There seemed to be no firm time at which a contract should be renegotiated as it neared the termination date. One month prior to termination would seem appropriate.

Disconnection agreements:

All DNSPs are obliged to provide network access for an embedded generator, however interruption to supply or longer-term disconnection from the grid may still occur for a variety of reasons. The owner may wish to disconnect for system maintenance, and the DNSP may wish to disconnect because of line maintenance, or because of an emergency owing either to the renewable energy system or to an unrelated event. Therefore some form of disconnection process should be included in any grid-connection agreement. This would be the same as that required for normal retail customers.

Termination and disconnection agreements become more complicated if the system owner wants to be rewarded for providing benefits to the retailer and DNSP. As discussed in Section 4.5, larger embedded generators that are rewarded for providing network support must enter into contractual arrangements that impose penalty payments for non-performance. Smaller systems benefiting from similar rewards would likely require a non-standard connection agreement that includes a longer notice of termination and/or disconnection, and non-performance penalties.

Table 14 Notice Required for Termination

	Retailer to Owner	Owner to Retailer
Australian Inland Energy	30 days	30 days
Country Energy	7 days	7 days
EnergyAustralia		?
Integral Energy	7 days	7 days
Origin Energy	1 month	
TXU	NA since no contract	NA since no contract
United Energy	NA	NA
Powercor	NA	NA
Powerdirect		
AGL		
Energex	3 months	?
Ergon Energy	ⁱ	3 months
ETSA	NA	NA
Western Power Corporation		3 months
Aurora Energy	NA	?
Actew AGL		
NT Department of Mines and Energy		

ⁱ Ergon may terminate the agreement at any time in the event that a Standard Customer Sale Contract for the Premises is terminated for any reason

Issue 9 Duration of Contract, Notice for Termination, and Disconnection Process

For how long should the agreement apply, how much notice should the system owner, retailer and DNSP be required to give to terminate the agreement, and what should be the process for disconnection?

Recommendations

- (i) The duration of the agreement should be at least five years.
- (ii) Early termination of an agreement by a retailer or DNSP should be allowed only under exceptional circumstances, such as an intractable safety issue arising or say, long standing non-payment of electricity bills etc. For legal reasons, where the system owner sells the system or property, the existing contract will need to be terminated and a new contract entered into with the new owners.
- (iii) Where an agreement is to be terminated by any party, one month notice should be given, and a contract should be open for negotiation one month prior to the termination date.
- (iv) The disconnection process should be clearly stated in any grid-connection agreement.

3.7. RECs, NGACs and GPRs

Because of the environmental benefits of renewable energy generation, governments have established programs that provide financial credits for generators. The schemes currently in operation are;

- the Commonwealth Mandatory Renewable Energy Target (MRET), where the credit is known as a REC (Renewable Energy Certificate)
- the NSW Greenhouse Gas Abatement Scheme, where the credit is known as an NGAC (NSW Greenhouse Gas Abatement Certificate)
- the National Green Power Accreditation Program, where the credit is known as a GPR (Green Power Right).

Eligible generation can earn either a REC (for use under either the MRET or Green Power schemes) or an NGAC (under the NSW Licence Conditions). If the electricity is sold through a Green Power scheme, it will also earn a GPR.

The ways in which these programs are treated by retailers with respect to small grid-connected customers are summarised in Table 15, and are discussed below.

Table 15 Treatment of RECs and NGACs, and GPRs

Retailer	RECs		NGACs		Green Power		
	Owned by	Separate agreement	Used to meet obligations	Owner credited?	Owner on GP paid GP rates for net export?	Paid GP rates if not on Green Power	Registration for Green Power
Australian Inland Energy	Retailer	N	N		N *	N	N
Country Energy	Retailer	N	N		N	N	N
EnergyAustralia	System owner	N	N		Y	NA	N
Integral Energy	System owner	N	N		N	N	N
Origin Energy	System owner **	Y	N		Y	N	N
TXU	System owner	N	NA		N	N	N
Powerdirect							
AGL							
Energex	Retailer ***	N	NA		N	N	N #
Ergon Energy	Retailer	N	N		N	N	N
Western Power Corporation	NA	NA	NA		N	N	N
Aurora Energy	Retailer	N	NA		NA ##	NA	NA
Actew AGL							
NT Department of Mines and Energy							

* The system owner is paid 1 ¢ above retail rate for exported electricity

** The system owner may be paid up front \$30 for their RECs according to the ORER deeming formula—see Appendix 6.4

*** RECs are integrated into the connection agreement and the system owner is paid up front \$36 for their RECs as calculated by the ORER deeming formula—see Appendix 6.4

As part of the connection agreement, the electricity can be used by Energex as Green Power

Aurora does not offer a Green Power product since their electricity is predominantly hydro

3.7.1. Mandatory Renewable Energy Target

The Mandatory Renewable Energy Target was set by the Commonwealth Government under the *Renewable Energy (Electricity) Act 2000*, and is administered by the Office of the Renewable Energy Regulator (ORER). It requires electricity retailers to source an additional 9500 GWh of electricity (compared to 1997 levels) from renewable energy generators by the year 2010.¹² However most, if not all, residential-scale renewable energy systems qualify.

Each REC represents 1,000 kWh of renewable electricity, and is currently worth about \$37 or 3.7 ¢/kWh. The penalty for not complying with the Act is 4.0 ¢/kWh, which after tax considerations (at a 30% marginal tax rate), gives a potential maximum value to the retailer of 5.7 ¢/kWh for renewable energy generation.

Small-scale renewable energy systems need not be metered in order to generate RECs, since a deeming formula can be applied as long as they were installed on or after 1st April 2001—see Appendix 6.4 for how the deeming formulas are applied. Currently five years of future generation can be claimed up front for PV. For example, a 1 kW_p PV system with an expected annual output of 1.2–1.6 MWh would typically generate 6–8 RECs over its first five years of operation, with a nominal value of \$220–300.

The maximum number of RECs that can be generated by a small system has been set at 25 per annum, representing 25 MWh of generation (the expected output of a PV system with a capacity of 15–20 kW_p). Small systems generating more than 25 MWh per annum should meter their output and will need to separately seek accreditation as a power station if they wish to participate in the MRET scheme.

System owners can choose to claim their RECs directly or assign the rights to their RECs to an agent, such as their electricity retailer, the system supplier or a government agency. The transfer of RECs and the sale of electricity are independent transactions, and so all RECs, regardless of whether they correspond to electricity used on site or exported, are treated the same way. To claim RECs directly, the system owner must register with the ORER at a cost of \$20. To assign their RECs to an agent the system owner must sign a document stating they have chosen to do so. Normally this would be in return for some benefit, such as a rebate in the case of an electricity retailer or a reduction on the price of the system in the case of a system retailer. However, the agent is under no obligation to make such offers. According to the ORER, if an agent wishes to obtain the RECs, they should inform the system owner that they may instead sell the RECs themselves directly. It would seem reasonable to expect the Agent to inform the system owner of the potential value of the RECs at time of purchase. More information can be found at <http://www.orer.gov.au/forms/>.

MRET – Current situation

There was considerable variety among electricity retailers regarding treatment of RECs. In four cases (Australian Inland Energy, Country Energy, Aurora Energy and Ergon Energy) RECs are automatically assigned to the electricity retailer as part of the connection agreement without recompense to the system owner. In one case (Origin) the system owner was given the option of selling their RECs to the electricity retailer for \$30 each, and in another (Energex), transfer to the retailer was obligatory but the system owner received \$36 per REC. In both cases the number of RECs was calculated according to the ORER five year deeming formula. In three cases (EnergyAustralia, Integral and TXU) the electricity retailer was not involved in dealing with the RECs at all.

The optimal treatment of RECs depends very much on whether the aim is to encourage embedded small-scale renewable generation by rewarding system owners or by rewarding retailers. If the aim is

¹² On the day this Discussion Paper was released, the recommendations of the MRET Review Panel were also released. These included the recommendation that the deeming period for PV systems of not more than 10 kW_p (or 25 MWh per annum) be increased from 5 to 15 years. At this stage the Federal Government has not stated how it will act on these recommendations. Should any announcements be made, the relevant details will be updated in the proposed grid connection agreement and Final Report.

to reward system owners, then the most attractive option for them is to be paid the full five year deemed RECs value up front. If the aim is to encourage retailers, they should keep the RECs themselves.

It has been argued that retailers should keep the RECs as compensation for losses incurred because of the difference between wholesale and reference prices¹³, and through administrative costs attributable to the embedded generation. However, most of the difference between wholesale and reference prices is the cost of transmission and distribution, with only about 10% of the reference price going to the retailer (to cover NEM fees, ancillary services costs and profit). The transmission costs are avoided since no transmission takes place, and the marginal costs of distributing energy from embedded generators to the nearest consumer(s) over a pre-existing system is minimal. According to the Independent Pricing and Regulatory Tribunal DNSP Review in 2002, the average electricity bill in NSW was made up of generation costs (46%), TUOS costs (8%), DUOS costs (37%), and retail costs (9%) (IPART, 2002). While these figures will vary somewhat throughout Australia, they can be applied as a general rule. Thus a retailer that sells electricity for 10 ¢/kWh, would have a margin of about 1 ¢/kWh. Higher retail prices are generally due to higher generation, transmission and distribution costs, and so the retailer's margin stays about the same. Thus the real difference for the retailer is in the order of 1 ¢/kWh.

As discussed in Section 4.2, in addition to RECs, NGACs and GPRs, retailers may benefit financially from avoided NEM fees, and through reduced exposure to summer peak prices. The combined value of GPRs (at say 0.7 ¢/kWh) and avoided NEM fees (at say 0.3 ¢/kWh) is about equal to the retailer's margin. Thus, when the financial benefits of reduced exposure to summer peak prices are also taken into consideration, it is by no means clear that the retailer also deserves to be awarded the RECs for free.

Issue 10 Treatment of Renewable Energy Certificates

How should the deemed RECs be treated in a grid connection agreement?

Recommendation

The report authors recommend that;

The system owner should be given the option of transferring the RECs to an agent (such as their electricity retailer, the system supplier or a government agency), who would compensate the system owner using the ORER deeming formula and at least the current value of RECs.

3.7.2. NSW Greenhouse Gas Abatement Scheme

The NSW Greenhouse Gas Abatement Scheme (NGGAS) aims to reduce the per capita production of greenhouse gases in NSW, and is administered by the Independent Pricing and Regulatory Tribunal (IPART). Retailers can fulfil their obligations by buying NSW Greenhouse Abatement Certificates (NGACs), which each correspond to a 1 tonne reduction in CO₂-e emissions. The number of NGACs created by a renewable energy system will depend on the amount of CO₂ that would have been released by the generator(s) it is displacing. NGACs are currently valued at \$7 to \$9 per tonne CO₂-e, and so assuming that 1kWh of electricity in NSW generates 1.0 kg CO₂, an NGAC can add about 0.7–0.9¢ of value per kWh of renewable energy.

¹³ The reference price is the price paid for electricity the retailer buys from the system owner, and with net metering is equal to the retail price.

NGACs can be created by any renewable energy generator defined according to the *Greenhouse Gas Benchmark Rule (Generation) No. 2 of 2003*, as long as the electricity generated is sold to NSW customers.

NGGAS – Current situation

Currently no retailer uses output from small-scale renewable energy generation to meet their NGGAS obligations. As retailers become more familiar with this scheme, this could change. However, given that electricity used to create RECs cannot also be used to create NGACs (unless emissions of non-CO₂ greenhouse gases such as methane are also reduced eg. landfill gas), it is unlikely the output from residential-scale renewable energy systems would be used to earn NGACs.

Issue 11 Treatment of NSW Greenhouse Gas Abatement Certificates

How should NGACs be treated in a grid connection agreement?

Recommendation

The report authors recommend that;

Since it is unlikely NGACs will be generated by residential-scale renewable energy systems, they should not be included in the agreement.

3.7.3. Green Power

Green Power schemes enable electricity customers to pay a premium for a certain percentage of their electricity to be generated from renewable sources. It is a voluntary scheme administered by the National Green Power Accreditation Steering Group, and currently managed by the NSW Sustainable Energy Development Authority (SEDA), but is expected to be managed by the Department of Energy, Utilities and Sustainability (DEUS) once it is operational. Green Power products offered by retailers must be accredited under the Green Power Accreditation Program according to the *National Green Power Accreditation Program Accreditation Document Version 3*. Renewable energy generators as defined under this document generate both RECs (that are currently surrendered to SEDA instead of the ORER), and Green Power Rights (GPRs; that are also surrendered to SEDA). GPRs can be created by most, if not all, residential-scale renewable energy systems, despite the Green Power scheme's sustainability requirements being stricter than those of the MRET scheme. GPRs are currently valued at 0.5–1.0 ¢/kWh.

Green Power – Current situation

Since electricity generated by residential grid-connected systems can be sold by retailers as Green Power, retailers were asked whether they paid system owners the Green Power tariff for net exported electricity. Two of the retailers that responded did so (EnergyAustralia and Origin), but only if the system owner was on Green Power themselves (paying the higher Green Power tariff for imported electricity). If a system owner is on Green Power they are effectively being paid the Green Power tariff on the electricity they avoid using because of their system output—although some retailers do not allow customers to both operate an embedded generator and sign up for Green Power.

It was assumed that no system owner whose imports and exports were measured separately, and who was on Green Power, was being charged the Green Power tariff for gross imported electricity but receiving the standard tariff for gross exported electricity.

Since the amount of GPRs generated is calculated according to the amount of RECs generated, it is very easy to calculate the GPRs based on the ORER REC deeming formula. All these GPRs can then be used by the retailer in their current Green Power settlement period. Although, the retailer must surrender a REC to SEDA for every GPR it claims, this REC does not have to be obtained from the system owner.

Issue 12 Treatment of Green Power Rights

How should GPRs be treated in a grid connection agreement?

Recommendations

The report authors recommend that;

- (i) Retailers should sell exported electricity as Green Power.
- (ii) Retailers should apply net billing so the system owner is effectively paid the Green Power tariff on any gross exports offset against gross imports.
- (iii) Retailers should not have to pay the system owner the Green Power tariff for net exported electricity, even if the system owner is a Green Power customer. This is based on the assumption that the system owner would benefit more from up-front payment of RECs than from an ongoing Green Power tariff. See Section 3.7.1.

3.8. Insurance

Power surges, blackouts, brownouts, or poor quality power can cause disruptions to service, and even damage to equipment connected to the grid. Under contract law it is possible that the DNSP, not the generator or retailer, is liable for any damage caused in this way (Stillman, 2002). If the DNSP is not responsible, to cover its own damages costs, it may wish to sue whoever is. Thus it is possible the DNSP may require the owner of a grid-connected renewable energy system to take out liability insurance.

However, none of the DNSPs or retailers surveyed require the system owner to take out any form of liability insurance. The consensus is that liability insurance is not necessary simply because it is very unlikely that a small scale system would have sufficient impact on a grid to cause power surges, blackouts, brownouts, or poor quality power. The only significant risk could be from islanding; however all systems conforming to Australian Standards automatically disconnect from the grid in this instance.

The connection agreements of some DNSPs require the system owner to indemnify them against any breach of relevant Guidelines, Standards and Codes, and against any loss or damage occasioned to the DNSP or third parties resulting from the connection of the installation to their distribution system. Because of this they have advised system owners to inform their insurance companies and ensure they have appropriate cover.

The consensus is that liability insurance is not required, and the authors can see no reason why this should be altered. The requirement for indemnification is also reasonable.

4. Assigning costs and benefits of embedded generation

The three main stakeholders in the connection of an embedded generator to the grid (system owner, retailer and DNSP), naturally wish to optimise their individual outcomes. A grid-connection agreement will in part determine how the benefits and costs of embedded generation are assigned. Thus, an ideal grid-connection agreement for these different stakeholders is very much influenced by their evaluation of the benefits and costs with respect to their operations. For the costs to be assigned fairly, the associated benefits for each stakeholder must first be identified. However, currently these benefits and costs are relatively poorly understood, making it difficult for each stakeholder to make a fully informed decision regarding what is in their best interest.

This process is further complicated by the fact that while all costs can readily be converted into present monetary terms, this is not the case for all benefits. Benefits that are more easily quantified include reduced peak demand, reduced system losses, and deferral of network upgrades, whereas less readily quantifiable benefits include the impact of reduced greenhouse gas emissions. Furthermore, there are other stakeholders who could benefit or incur costs as a result of connection of an embedded generator to the grid—electricity consumers and society more generally. The extent to which the consumer is affected depends on how readily benefits and costs can be transferred both through the electricity service and through pricing. Societal benefits may in part be reflected in greenhouse gas reductions, but may also be associated with infrastructure, reduced need for centralised generation, enhanced energy security, local self reliance / resilience etc.

The following highlights the various possible benefits and costs to the different stakeholders. They are provided here to help inform decisions on how to distribute costs and benefits through a standard grid-connection agreement. Section 4.4 then assigns these benefits and costs to the various stakeholders according to the recommendations in this Discussion Paper.

4.1. System Owners

4.1.1. System Owner Benefits

System owners benefit financially either through lower electricity bills or by generating income through net export to the grid. They also avoid battery purchase and maintenance costs. Both a battery bank and grid-connection maximise the output of a renewable energy system by ensuring generation in excess of immediate requirements is not wasted. However, with a grid-connected system the export price may be greater than the import price, thereby allowing the system owner to generate even greater value. System owners may also benefit from the sale of NGACs and/or GPRs depending on the agreement with their retailer (RECs can be generated regardless of grid connection, see Section 3.7).

4.1.2. System Owner Costs

System owners incur significant up-front costs for purchase and installation of a renewable energy system, which for a 1kW_p PV system are in the order of \$12,000, reduced to \$8,000 by current government rebates. As a result, their electricity costs are in the order of 20–30 ¢/kWh, which is significantly higher than current retail prices.

System owners may also pay additional costs for installing an extra electricity meter, for a Chartered Professional Engineer to certify connection drawings, and for an assessment or project fee. According to the surveys used for this Discussion paper, these additional costs ranged from zero to about \$1,600, with the average being about \$400.

4.2. Retailers

4.2.1. Retailer Benefits

Retailers may benefit from environmental credits awarded for generation of renewable energy, through avoided NEM fees, avoided Transmission Use of System (TUOS) costs, reduced exposure to summer peak prices, and possibly through reduced meter-reading costs.

Environmental credits

Retailers can potentially earn either RECs (for use under either the MRET or Green Power schemes) or NGACs (under the NSW Licence Conditions). If the electricity is sold through a Green Power scheme, it will also earn GPRs.

The current approximate values are;

REC = 3.7 ¢/kWh

NGAC = 0.7–0.9 ¢/kg CO₂-e (where 1 kg CO₂-e is roughly equivalent to 1 kWh)

GPR = 0.5–1.0 ¢/kWh

As outlined in Section 3.7, in most circumstances electricity used to earn RECs cannot also be used to create NGACs, and so would generate only RECs since they are worth more than NGACs. Thus, the most likely outcome is that electricity produced by residential-scale renewable energy systems could earn both RECs and GPRs, which currently have a combined value of about 4.2 to 4.7 ¢/kWh. The total value of a system's RECs is determined according to a deeming formula—see Appendix 6.4. This Discussion Paper recommends the full deemed RECs value be transferred to the system owner. According to the five-year deeming formula, a 1.0 kW_p system can generate 8–12 RECs (depending on location), with a corresponding value of \$220–\$300.

The total value of GPRs depends on the number of RECs generated, and so is readily calculated using the ORER deeming formula.

Avoided NEM fees

Retailers in NSW, Queensland, Victoria, SA and the ACT can source their electricity either directly from generators or from the NEM pool. Electricity sourced from the NEM pool incurs pool fees, charges and ancillary service fees. These fees amount to 0.2–0.4 ¢/kWh. In some states other charges, such as the smelter levy in Victoria (0.3 ¢/kWh), may also be applied (BCSE, 2003).

Electricity supplied directly from generators, including small scale residential systems, avoids these charges, and so their value is increased proportionately.

Avoided Transmission Use Of System (TUOS) costs

TUOS costs are charged to the DNSP in payment for use of the transmission infrastructure that delivers electricity to their distribution network. The DNSP then passes these costs on to the retailer via distribution tariffs. By generating electricity within the distribution network, that is used within that network, embedded generators reduce the amount of electricity transmitted through the transmission network, and so may reduce TUOS costs.

Reduced network losses

Embedded generation reduces the amount of electricity lost in the transmission and distribution system by reducing the transmission distance, by reducing the network load and hence temperature, and by increasing the power factor when inverters provide reactive power. The lost electricity is normally accounted for using loss factors associated with the network nodes in the vicinity of the embedded generator.¹⁴ These loss factors in turn reduce the payments generators receive from retailers. To compensate for this decrease in revenue, generators increase the wholesale prices paid

¹⁴ This assumes the embedded generator is in an area of the network with net load rather than net generation – a justifiable assumption for residential systems.

by retailers. Thus, by reducing network losses, loss factors are reduced, and wholesale prices paid by retailers are not increased as much. Therefore retailers benefit from reduced network losses.¹⁵

Reduced exposure to peak electricity prices

In recent years peaks in summer electricity demand have resulted in NEM pool prices over \$4.00/kWh. These peaks can occur anywhere from morning until late afternoon and are thought to be largely driven by increased use of air conditioners. According to a recent study, since output from PV arrays corresponds closely to these peaks it can reduce them despite decreased PV output owing to extreme heat, haze and cloud cover—see Appendix 6.5. Watt *et al.* (2003) found that north-facing PV closely matched typical commercial loads and west-facing PV closely matched typical residential loads. As a result, PV output also matched overall system load and pool price. It was also found that the energy value alone of a 1 kW_p PV array on one of the studied days would have had a spot market value of \$8.92 and on another day a value of \$22.44, or around \$31 for the two days. This compared with a net metered value currently provided to the PV system owner of \$1.60 in Adelaide (it would be less in Sydney) (Watt *et al.*, 2003). Thus although reduced exposure to peak prices would not occur throughout the year, it does add significant value to PV systems at times of greatest cost to retailers.

Reduced meter-reading costs

If electronic meters that allow remote reading are installed because of the renewable energy system, the retailer will have reduced costs because staff do not have to travel to read the meters. In the longer term, such meters would also allow the retailer and the DNSP to offer demand side management incentives to customers to reduce peak loads, to vary timing of off-peak loads etc.

4.2.2. Retailer Costs

Retailers incur costs because of the difference between the reference and wholesale electricity prices, and through administration of the connection agreement.

Difference between reference and wholesale prices

The average wholesale price of electricity in the NEM spot market in the 2002–03 financial year ranged from 2.754 ¢/kWh to 3.777 ¢/kWh (see Table 16), although it went much higher during periods of peak demand as discussed above. The long-term contract prices sometimes negotiated by most retailers are generally not published. The retail price ranged from around 8 ¢/kWh to over 20 ¢/kWh depending on the region and season (with the higher costs due to peaks in summer generation prices). Most of the difference between these prices is due to Transmission Use Of System (TUOS) and Distribution Use Of System (DUOS) costs: the remainder (around 5–10%) being the retailer's margin, made up of its own running costs (including NEM and ancillary services costs) and profit. If the system owner is paid the same price for exported electricity as for imported electricity, the retailer is effectively paying the retail price for generated electricity, leaving no margin to cover its own administrative costs or profit. However, as discussed in Section 3.7.1, the transmission costs are avoided since no transmission takes place, and the marginal cost of distributing energy from embedded generators to the nearest consumer(s) over a pre-existing system is minimal.

Table 16 Average annual spot prices for the 2002-03 financial year (¢/kWh)
From NEMMCO (2003)

Year	NSW	VIC	QLD	SA	SNOWY
2002 – 03	3.290	2.754	3.777	3.010	2.982

¹⁵ There would be an additional effect, which arises because the residual income that NEMMCO receives after billing retailers and paying generators, is paid to the relevant network service providers. This residual would be reduced if network losses were reduced, and the network service providers would be entitled to recover any deficit in their regulator-capped revenue. Although this would increase retailers' costs, its impact would be much smaller than the gains retailers made through decreased wholesale prices.

Administrative costs

These costs are incurred during initial administration of the connection agreement and subsequent billing.

4.3. Distributed Network Service Providers

Some of the benefits and costs given below as accruing to the DNSP can also be thought of as accruing to the retailer since they may be passed on via distribution tariffs.

4.3.1. DNSP Benefits

DNSPs may benefit from embedded generation through payments from the system owner and from network support.

Payments from system owner

These differ between DNSPs depending on whether they charge for grid connection, and whether they install and charge for the meter. The net benefit from such payments in turn depends on the extent to which they cover the DNSP's costs of connecting an embedded generator to their network.

Network support

Embedded generation may provide network support in a variety of ways and hence decrease associated costs. For example, it can;

- provide predictable voltage support and harmonic compensation,
- increase system capacity when transformer operating temperature is reduced both before and during the system peak, and
- defer network maintenance, replacement and upgrades.

Excluding energy savings, a year's deferral of a feeder upgrade costing \$1.5 million could result in savings of \$80,000, whereas a year's deferral of a substation upgrade costing \$8 million would save \$400,000 (Integral Energy, as cited in Watt *et al.*, 2003).

4.3.2. DNSP Costs

Costs to DNSPs can be divided into connection costs and those associated with operating a more complex system.

Connection costs

Connection of an embedded generator can incur both shallow and deep connection costs. Shallow connection costs are for installation and maintenance of the infrastructure required to connect the generator to the network connection point. Deep connection costs relate to the augmentation and amplification infrastructure that provides network protection and voltage control upstream of the network connection point. Small-scale renewable energy systems are unlikely to incur deep connection costs, and small connection costs may be met through installation charges levied on the system owner.

Complexity costs

Embedded generation can be problematic for DNSPs, for example through islanding, complication of fault detection and isolation, possible negative effects on quality of supply, and uncertainty regarding legal accountability for quality of supply (Outhred and Spooner, 2002). These incur additional day-to-day costs by increasing the complexity of line maintenance and upgrades.

4.4. Summary

Table 17 summarises the various costs and benefits that accrue to system owners, retailers and DNSPs as a result of grid-connection of a small-scale system, according to the recommendations proposed in this Discussion Paper.

Table 17 Allocation of costs and benefits according to the recommendations proposed in this Discussion Paper

	System Owner	Retailer	DNSP
Benefits	Payment for electricity export Avoided battery purchase & maintenance costs Sale of RECs ⁱ	Sale of GPRs Avoided NEM fees Avoided TUOS costs Reduced exposure to peak prices Possibly reduced meter-reading costs	Payments from system owner Network support
Costs	Purchase and installation of system Installation of an extra electricity meter Miscellaneous charges	Reference / wholesale price difference Administration costs	Connection costs Complexity costs

ⁱ Sale of RECs is included even though it does not depend on grid-connection since it is an important part of the recommendations in the Discussion Paper.

Thus, the system owner's benefits and costs are readily calculated, simplifying the connection procedure. The value of exported electricity is based on a fixed tariff, and the upfront payment for RECs is calculated using the ORER deeming formula, and should more than cover the meter installation cost and any miscellaneous charges (rolled into a single standard connection charge). Any subsequent RECs payments would provide the system owner with an additional cash reward every five years.

Assigning the avoided TUOS and DUOS (or network support) costs directly to the retailer and DNSP avoids the need for calculating their values—which, for a larger number of small generators, would be complicated and time consuming. This approach also avoids the need for individual network support contracts and calculation of associated penalty payments for non-performance (see Section 4.5). It simply acknowledges that the embedded generator provides these benefits and so deserves to be rewarded with the upfront RECs payment, and a minimal standard connection charge.

Although some of the benefits are significant only with output much greater than that provided by the average residential system, this does not mean they are valueless. It means, like costs, they are proportional to system size and to the aggregated extent of embedded generation. These benefits can be divided into two groups:

- (i) Those that carry little or no risk because they are either directly proportional to system output (retailers benefiting from environmental credits, avoided NEM fees, and avoided TUOS costs), or are up-front payments from the system owner to the DNSP; and
- (ii) Those that do involve risk because they must occur when needed (reduced exposure to summer peak prices for retailers, and network support for DNSPs).

In the first group, the retailer benefits should offset losses owing to the reference/wholesale price difference, which is also proportional to system output. The up-front standard connection charge from the system owner to the DNSP should cover the shallow connection costs.

In the second group, a key concern is that of reliability. To what degree can a retailer or DNSP rely on small-scale embedded renewable generation to provide these benefits. If they cannot be relied on,

they have little value since alternative arrangements—such as gas-fired peak plant or increased network capacity—are still required. Unfortunately, these benefits require additional study before fully informed judgements can be made. All responses by DNSPs to the VESC Issues Paper regarding payment of standard rebates to small embedded generators stated that because of reliability concerns, they were firmly opposed to such rebates (VESC, 2003).¹⁶

However, a large number of small embedded generators are likely to be more reliable than a single embedded generator since they are less likely to go off-line simultaneously. Studies in Japan have found that distributed PV systems can provide smoother output than centralised systems, and can also provide a better match to loads, thus effectively increasing their capacity value (Ohtani, 1999).

4.5. Treatment of large embedded generators

If small embedded generators wish to be rewarded for avoided TUOS and DUOS costs and for providing network support, they are effectively asking to be treated like large generators. In this case, they may have to enter into contractual arrangements similar to those applied to large generators that impose penalty payments for non-performance.

Currently Clauses 5.5(h) and 6.13.3(c) and (d) of the National Electricity Code (NEC) stipulate that large embedded generators should be appropriately rewarded for TUOS and DUOS costs that are avoided as a result of the operation of that generator. In 2000, the Victorian Office of the Regulator-General stated that “distributors would be required, pursuant to their licences, to pay a fair and reasonable share of avoided [distribution] network costs to embedded generators. The level of payments should be fair and reasonable and capped at avoided costs, to ensure that the benefits are shared between distributors and embedded generators and ultimately flow through to customers” (ORG, 2001).

To be rewarded for providing network support, large embedded generators enter into contractual arrangements called network support agreements. These document the terms and conditions of an embedded generator operating as an alternative to network augmentation, and generally require that specific future network expenditure that can be avoided or deferred be identified (BCSE, 2003). Under these agreements, large embedded generators are required to provide a level of service, reliability and information considerably greater than that currently provided by small-scale residential systems.

Such agreements are necessary because according to Clause 5.2.3 (e1) of the NEC, DNSPs are held responsible for maintaining the network. In addition, Clause 5.6 stipulates that a large embedded generator must provide the DNSP with short- and long-term electricity generation, market network service and load forecast information. According to Clause 5.8, the DNSP must also be notified at least three months in advance of any alteration to the system that could reasonably be expected to alter its performance. According to Clause 4.3.3 (e), a system operator must keep NEMMCO fully and timely informed as to the state of the security of the power system; any present or anticipated risks to power system security; and any action contemplated or initiated to address a risk to power system security or to restore or maintain the power system in a satisfactory operating state.¹⁷

¹⁶ Although the discussion paper responding to input to the issues paper is yet to be released, the submissions are available on the VESC website <http://www.esc.vic.gov.au/electricity696.html>.

¹⁷ Embedded generator/load combinations also pay standby charges since at times they need to draw electricity from the grid. These charges reflect the amount of reserve capacity built into the network needed to provide for the load depending on its frequency and extent (BCSE, 2003). However, these charges are not relevant to residential renewable energy systems since they are already accounted for in the connection component of a residential electricity supply bill.

5. References

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6. Appendices

6.1. Australian Standards Relevant to Small Grid-connected Power Systems

Standard	<u>TITLE</u>
AS 4509.1-1999	Stand-alone power systems - Safety requirements
AS 4509.1-1999/Amdt 1-2000	Stand-alone power systems - Safety requirements
AS 4509.2-2002	Stand-alone power systems - System design guidelines
AS 4509.3-1999	Stand-alone power systems - Installation and maintenance
AS 4509.3-1999/Amdt 1-2000	Stand-alone power systems - Installation and maintenance
AS 4086.1-1993	Secondary batteries for use with stand-alone power systems - General requirements
AS 4086.2-1997	Secondary batteries for use with stand-alone power systems - Installation and maintenance
AS 4777.1-2002	Grid connection of energy systems via inverters - Installation requirements
AS 4777.2-2002	Grid connection of energy systems via inverters - Inverter requirements
AS 4777.3-2002	Grid connection of energy systems via inverters - Grid protection requirements

6.2. Retailer and DNSP surveys

6.2.1. Questionnaire for Electricity Retailers – October, 2003

Name of Retailer:

State/Territory of head office:

Name of person who filled out questionnaire:

Phone:

Email:

1. Do you provide a retail service to owners of small (eg. <10kVA) renewable energy systems?
What is the upper limit (kVA) for this service?
2. In which States/Territories do you offer this service?
3. Do you offer a full connection service? Y / N
 - Panels, inverter, wiring and incidentals Y / N
 - Perform or organise installation Y / N
 - AGO Rebate Application Y / N
 - AGO Rebate final report Y / N
 - State Rebate Application Y / N
 - Network grid connect meter application Y / N
 - Network grid connect meter final contract Y / N
 - Renewable Energy Certificates Y / N
 - NSW Greenhouse Abatement Certificates Y / N
 - Electrical Chief Inspectors Office form Y / N
 - Embedded Generation contract Y / N

Metering and installation

4. Do you perform the installation and set up metering, or are these both dealt with by the network service provider? Is a separate meter required?

Billing

5. What billing system do you use? eg. net metering, reference price different to retail price, etc. Is there a cap on the amount of exported energy paid for? Please provide details.
6. To calculate the net amount of energy exported/imported do you take an average of total energy imported and exported over a 3 month billing period? If not, what system do you use?
7. How is excess energy credited to the customer? eg. Carried forward indefinitely, paid immediately, paid once over \$50, etc.
8. How long are your standard contracts? How much notice do you need to give to terminate the agreement? Are long term contracts available?

GST

9. Do customers pay GST on the net energy they use or on the full amount imported from the grid.

Green Power

10. If a customer is paying the Green Power premium for the energy they use, are they paid the same premium for any net energy export?
11. If the excess energy is sold elsewhere as Green Power, is the customer paid an increased rate even if they are not on Green Power?
12. Can the customer elect to have excess energy registered as Green Power, and if so, are there costs involved?

RECs

13. Who owns the renewable energy certificates (RECs) generated (both electricity generated on site and exported)? Is there a separate agreement for the RECs?

NGACs

14. If you have obligations under the NSW Greenhouse Gas Abatement Scheme, do you use energy generated through grid-connected PV systems to help meet these obligations? If yes, does the system owner receive any reward for this?

Insurance

15. Do you require your customers to take out additional insurance when connecting a small renewable energy system? If so, please provide details and an explanation of why you consider insurance necessary.

Disconnection

16. What procedures are in place if the system owner wants to disconnect from the grid?

Other Issues

17. Do you have any other specific issues that you think should be addressed in a connection agreement, or particular views regarding how any of the above issues should be addressed?
18. Do you have any documents that you normally supply to people wishing to connect to the grid? If so, can you provide them (or their web location) along with this questionnaire please?
19. Are there any aspects of your current agreement process that you would definitely not change?

Please provide any other comments you feel may be useful.

THANK YOU FOR YOUR TIME !

6.2.2. Questionnaire for Electricity Distributed Network Service Providers - October, 2003

Name of DNSP:

State/Territory of head office:

Name of person who filled out questionnaire:

Phone:

Email:

1. Do you allow connection of small (eg. <10kVA) renewable energy systems to your network?
What is the upper limit (kVA) for this service?
2. In which States/Territories do you offer this service?
3. Do you offer a full connection service? Y / N
 - Panels, inverter, wiring and incidentals Y / N
 - Perform or organise installation Y / N
 - AGO Rebate Application Y / N
 - AGO Rebate final report Y / N
 - State Rebate Application Y / N
 - Network grid connect meter application Y / N
 - Network grid connect meter final contract Y / N
 - Renewable Energy Certificates Y / N
 - NSW Greenhouse Abatement Certificates Y / N
 - Electrical Chief Inspectors Office form Y / N
 - Embedded Generation contract Y / N

Metering

4. What sort of metering system do you use? (choose one)
 - 1 net metering using a single bidirectional meter
 - 2a import-export metering using two unidirectional meters on the grid side of the common point between the customer's generator and loads legs
 - 2b import-export metering using a dual-element electronic meter on the grid side of the common point between the customer's generator and loads legs
 - 3a generation-consumption metering using two unidirectional meters to measure energy flows in the generator and load legs.
 - 3b generation-consumption metering using a dual-element electronic meter to measure energy flows in the generator and load legs.

Other

5. Who pays for and owns the meter? If the system owner, what does the meter cost?

Installation

6. Do you install the system yourself? If so at what cost? If not, do you require anything more than a BCSE-certified electrician to perform the installation?

7. Do you have an application fee? If so how much?
8. Do you require that small renewable energy systems being connected to your network meet any technical requirements beyond conformance with existing Australian Standards or draft Australian Standards? If so, please provide details and an explanation why you consider this to be necessary.

Insurance

9. Do you require your customers to take out additional insurance when connecting a small renewable energy system? If so, please provide details and an explanation of why you consider insurance to be necessary.

Disconnection

10. What procedures do you have in place for disconnection from the grid and notification of the system owner? For example;
 1. for line maintenance,
 2. if there is an emergency situation related to the renewable energy system
 3. if there is an emergency situation unrelated to the renewable energy system

What procedures are in place if the system owner wants to disconnect from the grid?

Other Issues

11. Are you involved in any billing, GST, Green Power, RECS, NGACs or insurance agreements with the system owner, or are these all dealt with by the retailer? If yes, please provide details.
12. Do you have any other specific issues that you think should be addressed in a connection agreement, or particular views regarding how any of the above issues should be addressed?
13. Do you have any documents or standard contracts that you normally supply to people wishing to connect to the grid? If so, can you provide them (or their web location) along with this questionnaire please?
14. Are there any aspects of your current agreement process that you would definitely not change?

Comments

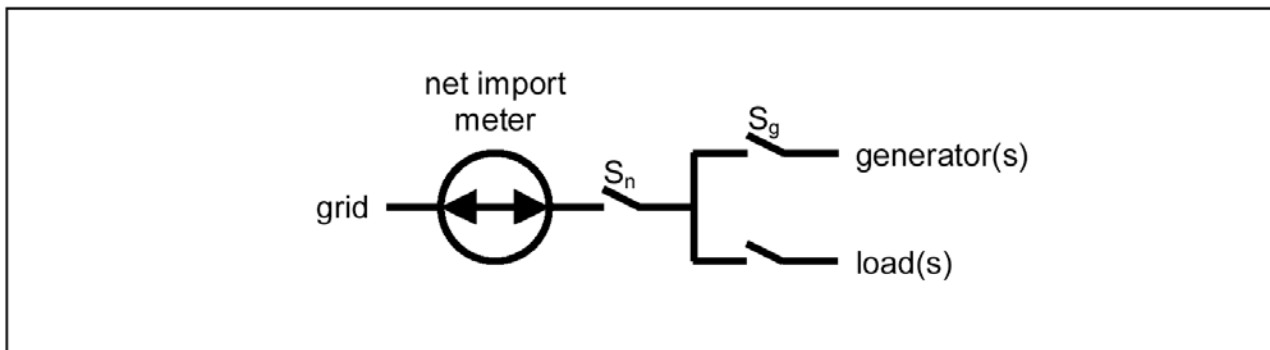
Please provide any other comments you feel may be useful.

THANK YOU FOR YOUR TIME !

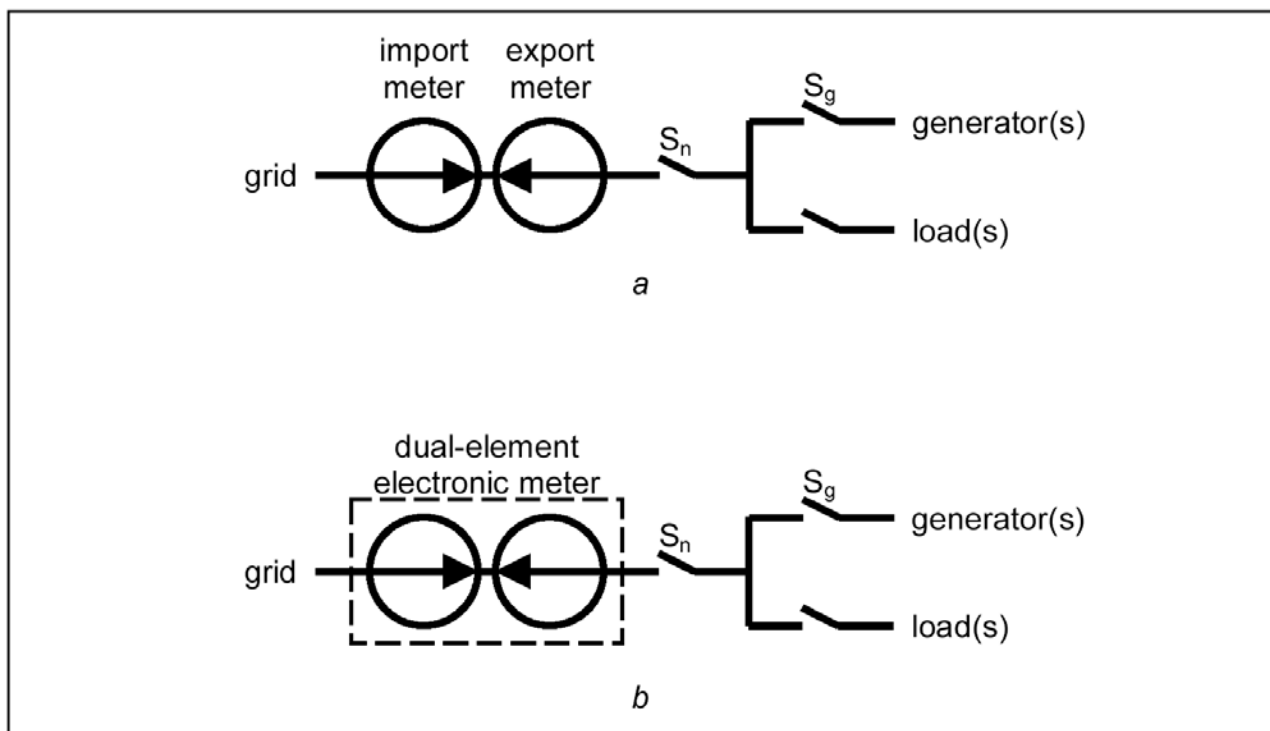
6.3. Metering schemes

From Roche (2001): S_n , normal supply main switch; S_g , embedded generator main switch.

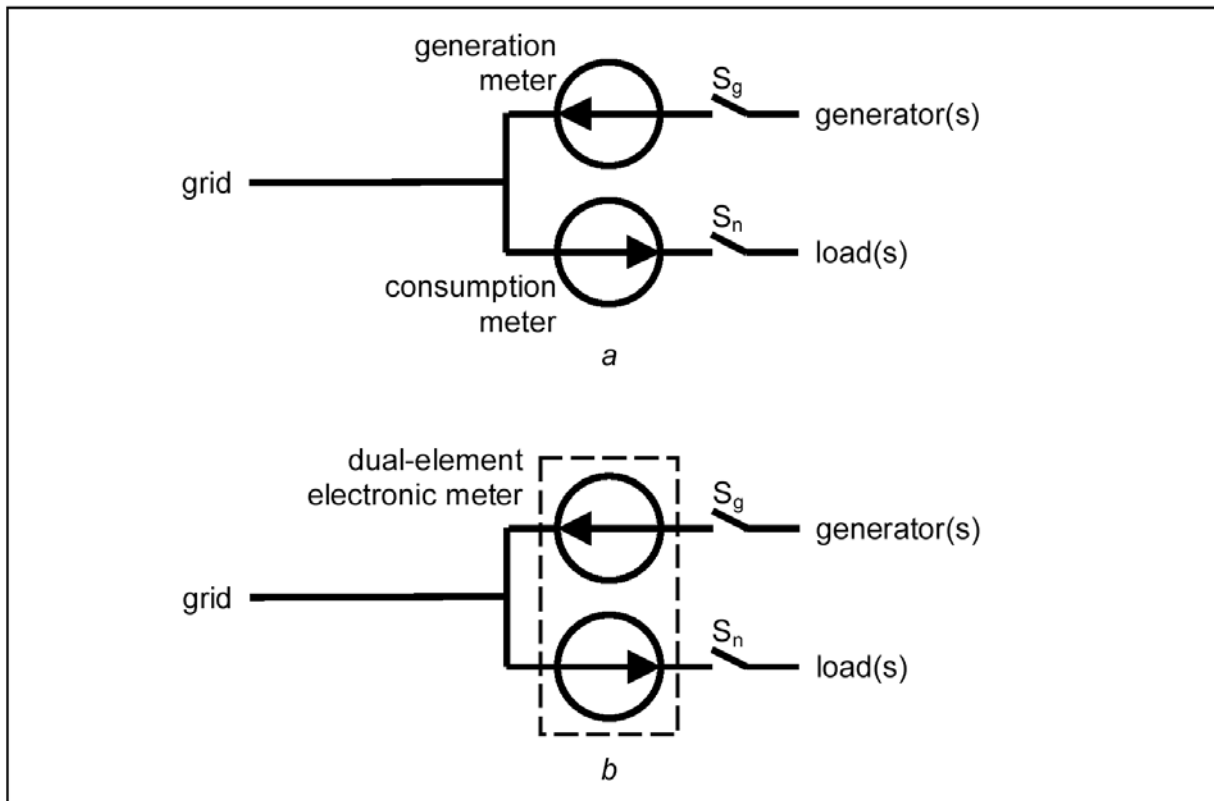
Metering scheme 1



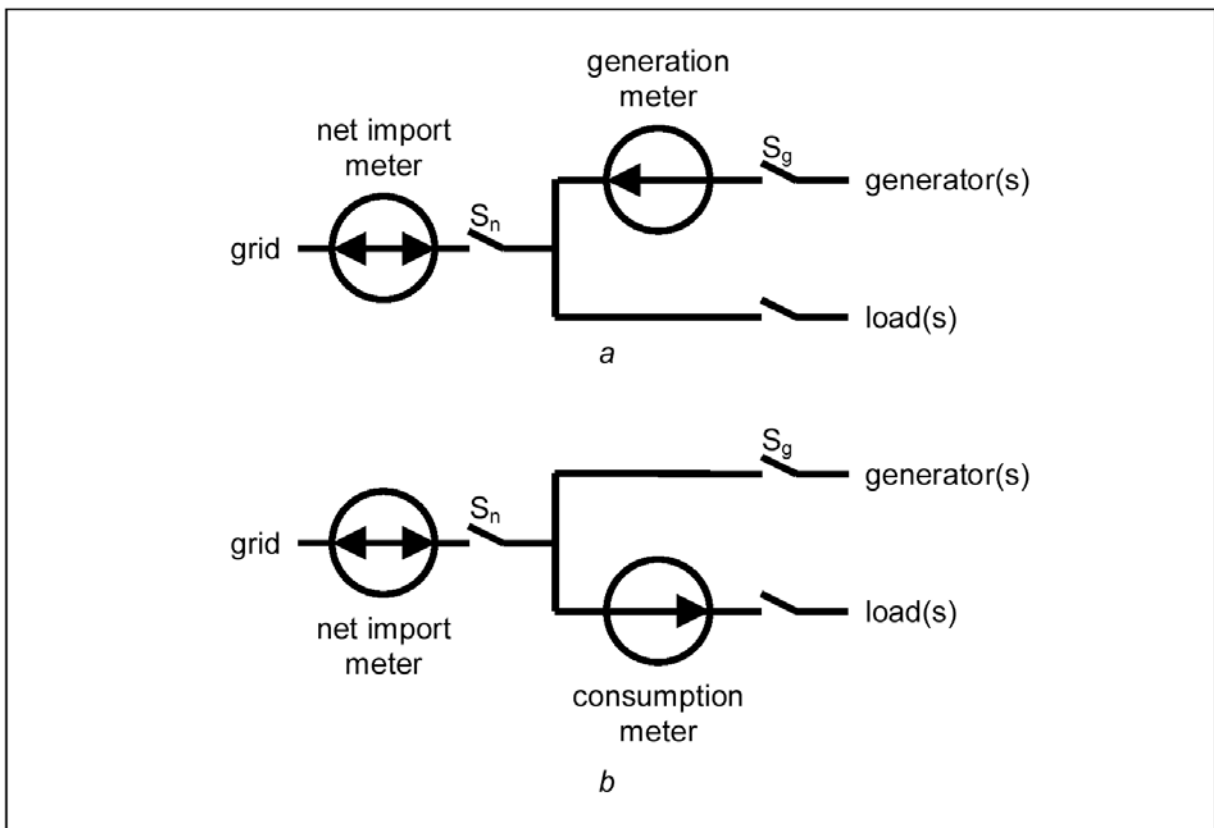
Metering schemes 2a and 2b



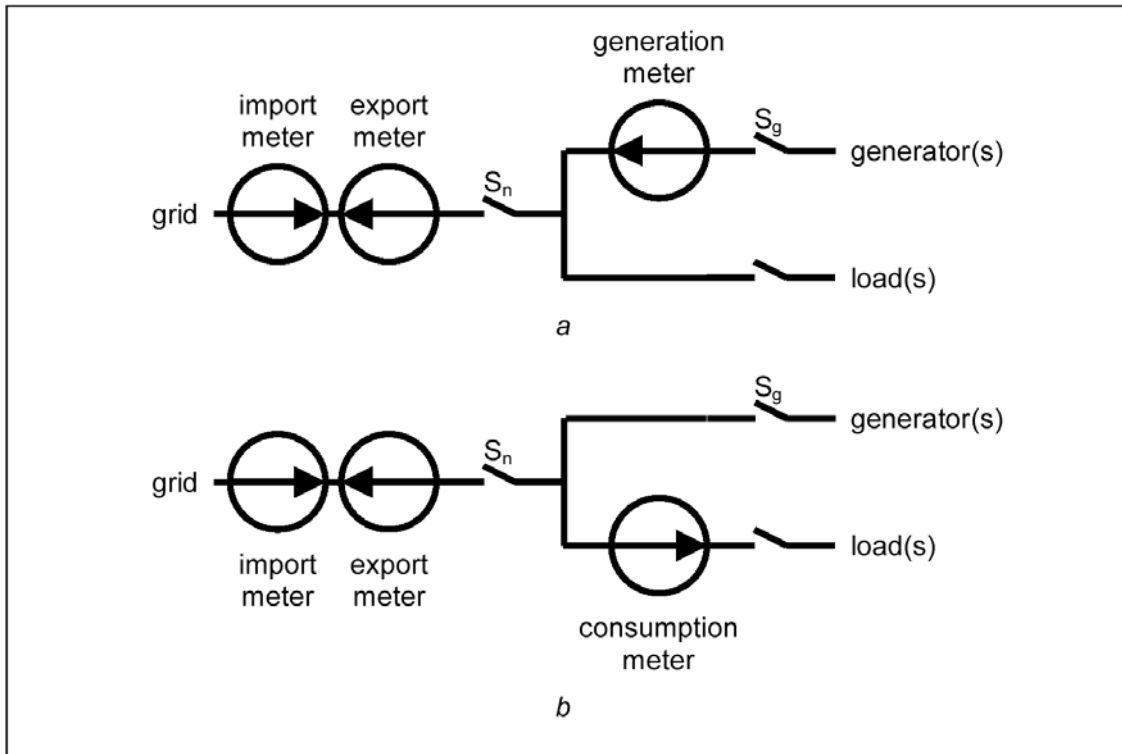
Metering schemes 3a and 3b



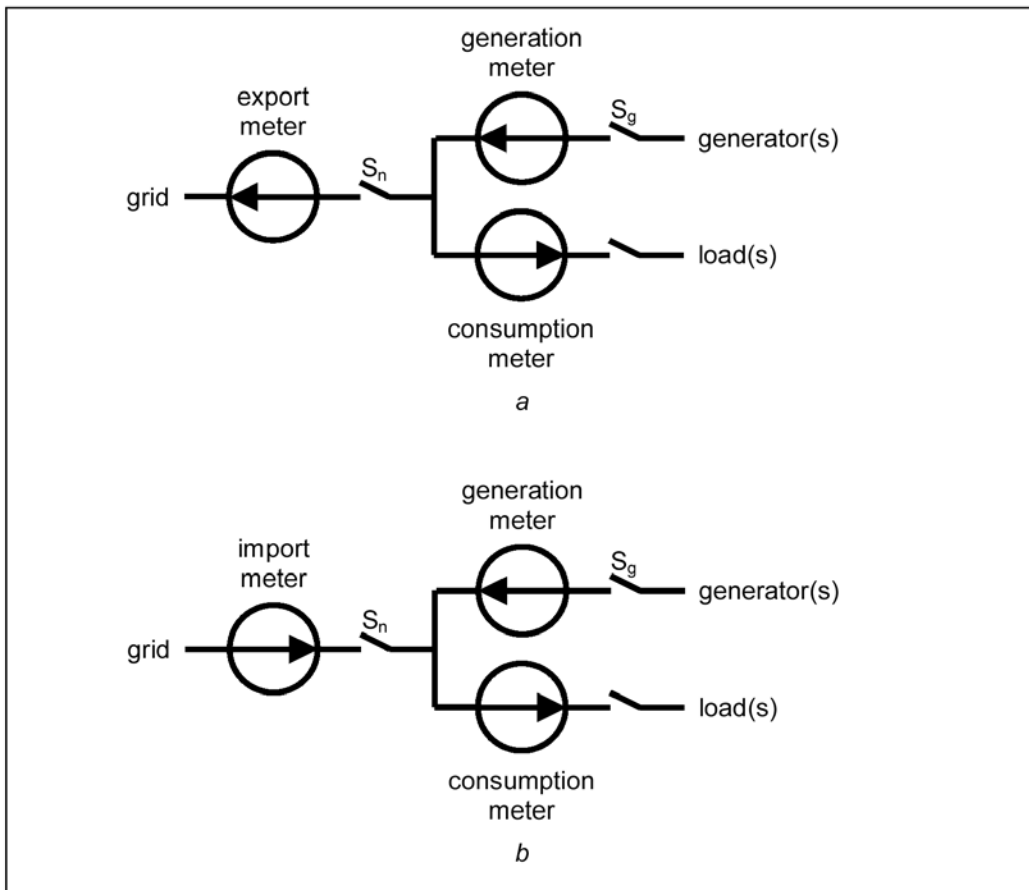
Metering schemes 4a and 4b



Metering schemes 5a and 5b



Metering schemes 6a and 6b



6.4.1 Photovoltaic Deeming Formula

Renewable Energy Certificates for Small Generation Units: Photovoltaic

In order to create RECs from your small generation unit using the deeming formula, the unit must be installed on or after 1 April 2001. If the unit was installed before 1 April 2001 you may still be eligible for RECs from the unit but you must apply to ORER to become a registered person intending to accredit a power station and for the generation unit to become an accredited power station. Application forms are available from <http://www.orer.gov.au/forms/index.html#renewable>. RECs from such units can not be assigned to agents.

To establish how many certificates you may be eligible to create from your photovoltaic unit you should refer to the Zone Rating table and Postcode Zone table listed below.

1. Establish your postcode zone by using the 'Postcode Zones for Photovoltaic systems' (Table 1).
2. Once you have established your postcode zone you will be able to establish your zone rating for your photovoltaic zone by referring to Table 2.
3. To calculate the annual number of RECs your system is eligible for you multiple the zone rating by the rated power output (in kWp) of your unit. You can find the rated power output of your unit in the specifications provided by the unit manufacturer. Please ensure that you use the exact figure that applies to your particular model.

$$\text{zone rating} \quad \times \quad \text{rated power output in kWp} \quad = \quad \text{annual number of eligible RECs}$$

or

$$\text{zone rating} \quad \times \quad \text{the kW capacity of your PV system} \quad = \quad \text{annual number of eligible RECs}$$

4. Multiply the annual number of eligible RECs by one year or five years depending on the period over which you wish to create RECs.
5. You must round down the final number of eligible RECs to the nearest whole number.

Note: If you calculate that you are entitled to more than 25 RECs per year, in step 3, your system does not qualify to be a deemed unit under the Act. However, you may be eligible to create RECs for the unit by applying to ORER to become a registered person intending to accredit a power station and for the generation unit to become an accredited power station. Application forms are available from <http://www.orer.gov.au/forms/index.html#renewable>. RECs from such units can not be assigned to agents.

Example 1.

If you wished to create RECs on a 5 year basis for a photovoltaic unit that has a rated output or kW capacity of 5.7 kW in the postcode area of 2315, you must:

1. Establish your postcode zone; **Zone 3**
2. Establish your Zone rating; **The zone rating for zone 3 is 1.382**
3. Multiply your zone rating by the kW capacity.

$$1.382 \times 5.7\text{kW} = 7.8774 \text{ MWh}$$
4. Then multiple by 5 years.

$$7.8774 \times 5 \text{ years} = 39.387\text{MWh}$$
5. Then round down the total amount of electricity taken to be generated to the nearest MWh to determine the number of RECs you are eligible to create.

$$39.387 \text{ MWh is rounded down to } \mathbf{39 \text{ MWh}}$$

Example 2.

If you wished to create RECs on an annual basis for a photovoltaic unit that has a rated output or kW capacity of 5.7 kW in the postcode area of 2315, you must:

1. Establish your postcode zone; **Zone 3**
2. Establish your Zone rating; **The zone rating for zone 3 is 1.382**
3. Multiply your zone rating by the kW capacity.

$$1.382 \times 5.7\text{kW} = 7.8774 \text{ MWh}$$

4. Then multiple by 1 year.

$$7.8774 \times 1 \text{ year} = 7.8774 \text{ MWh}$$

5. Then round down the total amount of electricity taken to be generated to the nearest MWh to determine the number of RECs you are eligible to create.

$$7.8774 \text{ MWh is rounded down to } 7 \text{ MWh}$$

Table 1 – Postcode zones for Photovoltaic systems

postcode range			postcode range			postcode range			postcode range		
from	to	zone	from	To	Zone	from	to	zone	from	to	zone
0	799	3	2900	2999	3	4474	4476	1	6251	6254	3
800	869	2	3000	3390	4	4477	4478	2	6255	6270	4
870	879	1	3391	3398	3	4479	4485	1	6271	6315	3
880	1000	2	3399	3413	4	4486	4490	2	6316	6357	4
1001	2356	3	3414	3426	3	4491	4492	1	6358	6393	3
2357	2357	2	3427	3474	4	4493	4499	2	6394	6400	4
2358	2384	3	3475	3514	3	4500	4721	3	6401	6430	3
2385	2393	2	3515	3516	4	4722	4722	2	6431	6431	2
2394	2395	3	3517	3520	3	4723	4723	3	6432	6433	3
2396	2398	2	3521	3524	4	4724	4735	2	6434	6439	2
2399	2399	3	3525	3538	3	4736	4736	1	6440	6441	1
2400	2400	2	3539	3539	4	4737	4824	3	6442	6444	3
2401	2404	3	3540	3549	3	4825	4827	2	6445	6459	4
2405	2407	2	3550	3560	4	4828	4828	3	6460	6467	3
2408	2410	3	3561	3569	3	4829	4829	2	6468	6469	2
2411	2414	2	3570	3570	4	4830	5261	3	6470	6471	3
2415	2536	3	3571	3606	3	5262	5263	4	6472	6474	2
2537	2537	4	3607	3617	4	5264	5270	3	6475	6506	3
2538	2544	3	3618	3622	3	5271	5300	4	6507	6555	2
2545	2557	4	3623	3628	4	5301	5429	3	6556	6573	3
2558	2626	3	3629	3657	3	5430	5450	2	6574	6602	2
2627	2629	4	3658	3684	4	5451	5653	3	6603	6607	3
2630	2630	3	3685	3687	3	5654	5669	2	6608	6641	2
2631	2639	4	3688	3724	4	5670	5679	3	6642	6724	1
2640	2820	3	3725	3731	3	5680	5699	2	6725	6750	2
2821	2842	2	3732	3999	4	5700	5709	3	6751	6797	1
2843	2872	3	4000	4416	3	5710	5722	2	6798	6799	2
2873	2874	2	4417	4417	2	5723	5724	1	6800	6999	3
2875	2876	3	4418	4422	3	5725	5733	2	7000	8999	4
2877	2889	2	4423	4423	2	5734	5799	1	9000	9999	3
2890	2897	3	4424	4426	3	5800	6243	3			
2898	2899	4	4427	4473	2	6244	6250	4			

Table 2 – Zone ratings for Photovoltaic systems

zone	Rating (MWh/kW _p)
1	1.622
2	1.536
3	1.382
4	1.185

Please note that the information provided in this document may be subject to change with amendments to the Renewable Energy (Electricity) Act, the Regulations and the administrative processes adopted by the Office of the Renewable Energy Regulator.

4 October 2002

6.4.2 Wind Deeming Formula

Renewable Energy Certificates for Small Generation Units: Wind

In order to use the deeming tables provided your small generation unit must be installed on or after 1 April 2001. If the unit was installed before 1 April 2001 it may still be eligible for RECs but the unit owner must apply to ORER to become a registered person intending to accredit a power station and for the generation unit to become an accredited power station. Application forms are available from <http://www.orer.gov.au/forms/index.html#renewable>. RECs from such units can not be assigned to agents.

The number of RECs that you are eligible to create is also determined by the rated capacity of the unit and the number of hours the generator can operate based on actual resource availability.

To establish how many certificates you may be eligible to create from your wind unit you should refer to the attached table of deemed RECs for wind units and:

1. Look up your unit's rated capacity (kWh/year). If the exact capacity rating of your unit is not listed in the table, you must round down to the nearest capacity rating listed. If your system's capacity is larger than listed in the table then your system does not qualify to be a deemed unit under the Act. It may be eligible to create RECs, however you must apply to ORER to become a registered person intending to accredit a power station and for the generation unit to become an accredited power station. Application forms are available from <http://www.orer.gov.au/forms/index.html#renewable>. RECs from such units can not be assigned to agents.
2. Refer to the number of RECs deemed for your system based on the resource availability. If you do not know the actual resource availability, then you may claim for the default amount which is 2000hours/year. If you claim for resource availability above these default amounts, then you must provide and retain copies of site-specific audit reports and advise ORER of the name and contact details of the person or company that conducted the audit;
3. Multiply the amount of RECs listed in the table by one year or five years depending on the period over which you wish to create RECs.

Example 1.

If you wished to create RECs on a 5 year basis for a system that has a rating of 2.9 kW and a resource availability of 3,600 hours, you must:

1. Round down the capacity rating to 2.8kW (as this is the nearest capacity listed in the table);
2. Multiply the listed annual amount of electricity taken to be generated (9.58MWh) by 5 years.

$$5 \text{ years} \times 9.58\text{MWh/year} = 47.9\text{MWh}$$

3. Then round down the total amount of electricity taken to be generated to the nearest MWh to determine the number of RECs you are eligible to create.

$$47.9\text{MWh equates to } 47\text{RECs}$$

4. As you have claimed a resource availability in excess of the default amount (2,000 hours/year) you must provide and retain copies of a site-specific audit report to support your claim. If you cannot provide such a report then you may only claim for the default amount. The default amount of RECs that you could create for five years, for a 2.8 kW unit is 26 RECs

Example 2.

If you wished to create RECs on an annual basis for a system that has a rating of 2.9 kW and a resource availability of 3,600 hours, you must:

1. Round down the capacity rating to 2.8kW (as this is the nearest capacity listed in the table);
2. Multiply the listed annual amount of electricity taken to be generated (9.58MWh) by 1 year.

$$1 \text{ year} \times 9.58\text{MWh/year} = 9.58\text{MWh}$$

3. Then round down the total amount of electricity taken to be generated to the nearest MWh to determine the number of RECs you are eligible to create.

$$9.58\text{MWh} \text{ equates to } 9\text{RECs}$$

4. As you have claimed a resource availability in excess of the default amount (2,000 hours/year) you must provide and retain copies of a site-specific audit report to support your claim. If you cannot provide such a report then you may only claim for the default amount. The default amount of RECs that you could create, for a 2.8 kW unit is 5 RECs

Schedule 6**Wind turbines**

(paragraph 20 (1) (c))

Rating (kW)	Hours each year of wind resource availability								
	2 000	2 200	2 400	2 600	2 800	3 000	3 200	3 400	3 600
0.2	0.38	0.42	0.46	0.49	0.53	0.57	0.61	0.65	0.68
0.3	0.57	0.63	0.68	0.74	0.80	0.86	0.91	0.97	1.03
0.4	0.76	0.84	0.91	0.99	1.06	1.14	1.22	1.29	1.37
0.5	0.95	1.05	1.14	1.24	1.33	1.43	1.52	1.62	1.71
0.6	1.14	1.25	1.37	1.48	1.60	1.71	1.82	1.94	2.05
0.8	1.52	1.67	1.82	1.98	2.13	2.28	2.43	2.58	2.74
1	1.90	2.09	2.28	2.47	2.66	2.85	3.04	3.23	3.42
1.2	2.28	2.51	2.74	2.96	3.19	3.42	3.65	3.88	4.10
1.4	2.66	2.93	3.19	3.46	3.72	3.99	4.26	4.52	4.79
1.5	2.85	3.14	3.42	3.71	3.99	4.28	4.56	4.85	5.13
1.6	3.04	3.34	3.65	3.95	4.26	4.56	4.86	5.17	5.47
1.8	3.42	3.76	4.10	4.45	4.79	5.13	5.47	5.81	6.16
2	3.80	4.18	4.56	4.94	5.32	5.70	6.08	6.46	6.84
2.2	4.18	4.60	5.02	5.43	5.85	6.27	6.69	7.11	7.52
2.4	4.56	5.02	5.47	5.93	6.38	6.84	7.30	7.75	8.21
2.5	4.75	5.23	5.70	6.18	6.65	7.13	7.60	8.08	8.55
2.6	4.94	5.43	5.93	6.42	6.92	7.41	7.90	8.40	8.89
2.8	5.32	5.85	6.38	6.92	7.45	7.98	8.51	9.04	9.58
3	5.70	6.27	6.84	7.41	7.98	8.55	9.12	9.69	10.26
3.2	6.08	6.69	7.30	7.90	8.51	9.12	9.73	10.34	10.94
3.4	6.46	7.11	7.75	8.40	9.04	9.69	10.34	10.98	11.63
3.6	6.84	7.52	8.21	8.89	9.58	10.26	10.94	11.63	12.31
3.8	7.22	7.94	8.66	9.39	10.11	10.83	11.55	12.27	13.00
4	7.60	8.36	9.12	9.88	10.64	11.40	12.16	12.92	13.68
4.2	7.98	8.78	9.58	10.37	11.17	11.97	12.77	13.57	14.36

Rating (kW)	Hours each year of wind resource availability								
	2 000	2 200	2 400	2 600	2 800	3 000	3 200	3 400	3 600
4.4	8.36	9.20	10.03	10.87	11.70	12.54	13.38	14.21	15.05
4.6	8.74	9.61	10.49	11.36	12.24	13.11	13.98	14.86	15.73
4.8	9.12	10.03	10.94	11.86	12.77	13.68	14.59	15.50	16.42
5	9.50	10.45	11.40	12.35	13.30	14.25	15.20	16.15	17.10
5.2	9.88	10.87	11.86	12.84	13.83	14.82	15.81	16.80	17.78
5.4	10.26	11.29	12.31	13.34	14.36	15.39	16.42	17.44	18.47
5.6	10.64	11.70	12.77	13.83	14.90	15.96	17.02	18.09	19.15
5.8	11.02	12.12	13.22	14.33	15.43	16.53	17.63	18.73	19.84
6	11.40	12.54	13.68	14.82	15.96	17.10	18.24	19.38	20.52
6.2	11.78	12.96	14.14	15.31	16.49	17.67	18.85	20.03	21.20
6.4	12.16	13.38	14.59	15.81	17.02	18.24	19.46	20.67	21.89
6.6	12.54	13.79	15.05	16.30	17.56	18.81	20.06	21.32	22.57
6.8	12.92	14.21	15.50	16.80	18.09	19.38	20.67	21.96	23.26
7	13.30	14.63	15.96	17.29	18.62	19.95	21.28	22.61	23.94
7.2	13.68	15.05	16.42	17.78	19.15	20.52	21.89	23.26	24.62
7.4	14.06	15.47	16.87	18.28	19.68	21.09	22.50	23.90	
7.6	14.44	15.88	17.33	18.77	20.22	21.66	23.10	24.55	
7.8	14.82	16.30	17.78	19.27	20.75	22.23	23.71		
8	15.20	16.72	18.24	19.76	21.28	22.80	24.32		
8.2	15.58	17.14	18.70	20.25	21.81	23.37	24.93		
8.4	15.96	17.56	19.15	20.75	22.34	23.94			
8.6	16.34	17.97	19.61	21.24	22.88	24.51			
8.8	16.72	18.39	20.06	21.74	23.41				
9	17.10	18.81	20.52	22.23	23.94				
9.2	17.48	19.23	20.98	22.72	24.47				
9.4	17.86	19.65	21.43	23.22	25.00				
9.6	18.24	20.06	21.89	23.71					
9.8	18.62	20.48	22.34	24.21					
10	19.00	20.90	22.80	24.70					

Please note that the information provided in this document may be subject to change with amendments to the Renewable Energy (Electricity) Act, the Regulations and the administrative processes adopted by the Office of the Renewable Energy Regulator.

6.4.3 Small Hydro Deeming Formula

Renewable Energy Certificates for Small Generation Units: Hydro

In order to use the deeming tables provided your small generation unit must be installed on or after 1 April 2001. If the unit was installed before 1 April 2001 it may still be eligible for RECs but the unit owner must apply to ORER to become a registered person intending to accredit a power station and for the generation unit to become an accredited power station. Application forms are available from <http://www.orer.gov.au/forms/index.html#renewable>. RECs from such units can not be assigned to agents.

The number of RECs that you are eligible to create is also determined by the rated capacity of the unit and the number of hours the generator can operate based on actual resource availability.

To establish how many certificates you may be eligible to create from your hydro electric unit you should refer to the attached table of deemed RECs for hydro electric units and:

1. Look up your unit's rated capacity (kWh/year). If the exact capacity rating of your unit is not listed in the table, you must round down to the nearest capacity rating listed. If your system's capacity is larger than listed in the table then your system does not qualify to be a deemed unit under the Act. It may be eligible to create RECs, however you must apply to ORER to become a registered person intending to accredit a power station and for the generation unit to become an accredited power station. Application forms are available from <http://www.orer.gov.au/forms/index.html#renewable>. RECs from such units can not be assigned to agents.
2. Refer to the number of RECs deemed for your system based on the resource availability. If you do not know the actual resource availability, then you must claim for the default amount which is 4000 hours/year. If you claim for resource availability above these default amounts, then you must provide and retain copies of site-specific audit reports and advise ORER of the name and contact details of the person or company that conducted the audit;
3. Multiply the amount of RECs listed in the table by one year or five years depending on the period over which you wish to create RECs.

Example 1.

If you wished to create RECs on a 5 year basis for a system that has a rating of 2.3 kW and a resource availability of 5000 hours, you must:

1. Round down the capacity rating to 2.2kW (as this is the nearest capacity listed in the table);
2. Multiply the listed annual amount of electricity taken to be generated (10.45MWh) by 5 years.

$$5 \text{ years} \times 10.45\text{MWh/year} = 52.25\text{MWh}$$

3. then round down the total amount of electricity taken to be generated to the nearest MWh to determine the number of RECs you are eligible to create.

52.52MWh equates to 52RECs

4. As you have claimed a resource availability in excess of the default amount (4,000 hours/year) you must provide and retain copies of a site-specific audit report to support your claim. If you cannot provide such a report then you may only claim for the default amount. The default amount of RECs that you could create for five years, for a 2.2 kW unit is 41 RECs.

Rating (kW)	Hours each year of hydro resource availability										
	4 000	4 500	5 000	5 500	6 000	6 500	7 000	7 500	8 000	8 500	8 760
Amount of electricity taken to be generated (MWh/year)											
5	19.00	21.38	23.75								
5.2	19.76	22.23	24.70								
5.4	20.52	23.09									
5.6	21.28	23.94									
5.8	22.04	24.80									
6	22.80										
6.2	23.56										
6.4	24.32										

Please note that the information provided in this document may be subject to change with amendments to the Renewable Energy (Electricity) Act, the Regulations and the administrative processes adopted by the Office of the Renewable Energy Regulator.

26/11/2001

6.5. Correlation of PV output with peak loads

The following charts are taken from Watt *et al.* (2003).

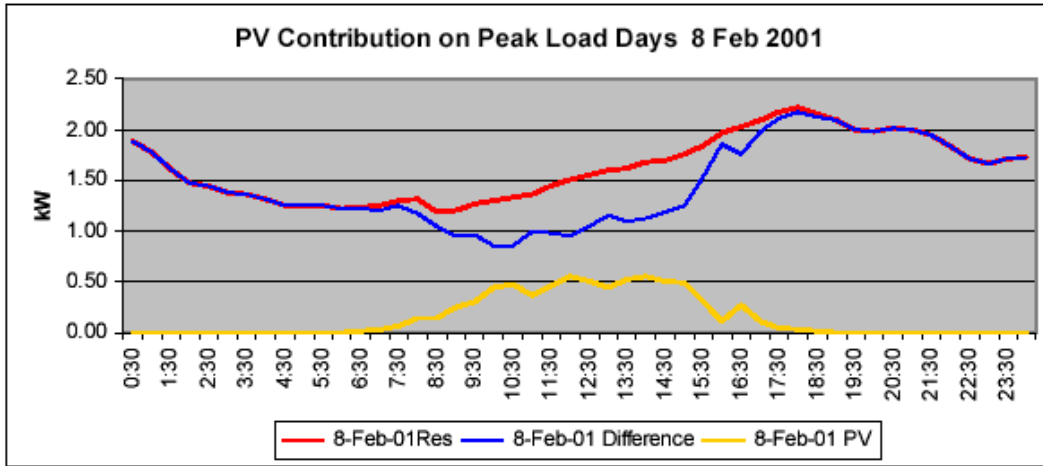


Figure 1 Typical Adelaide Residential Load against PV Output on a Peak Summer Day.

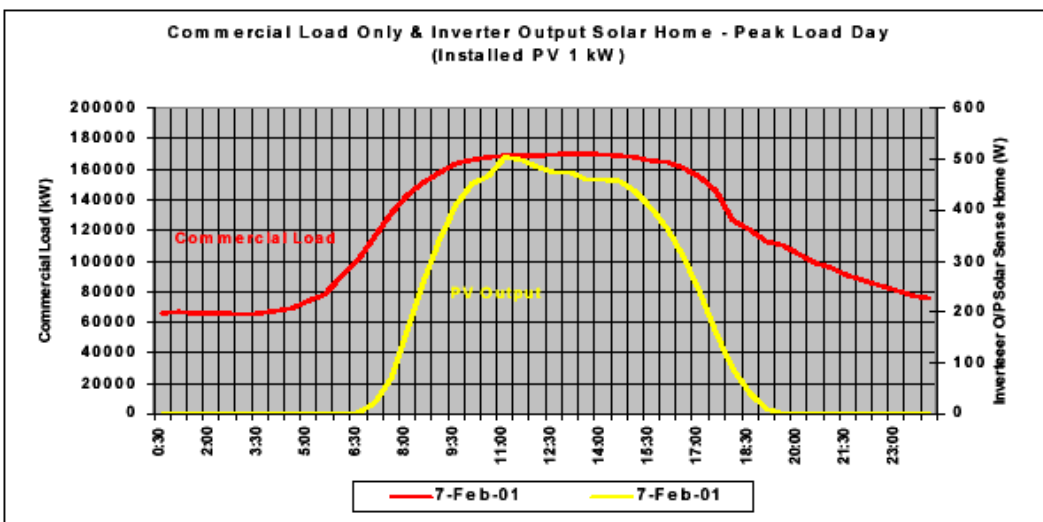


Figure 2 Typical Adelaide Commercial Load against PV Output on a Peak Summer Day.

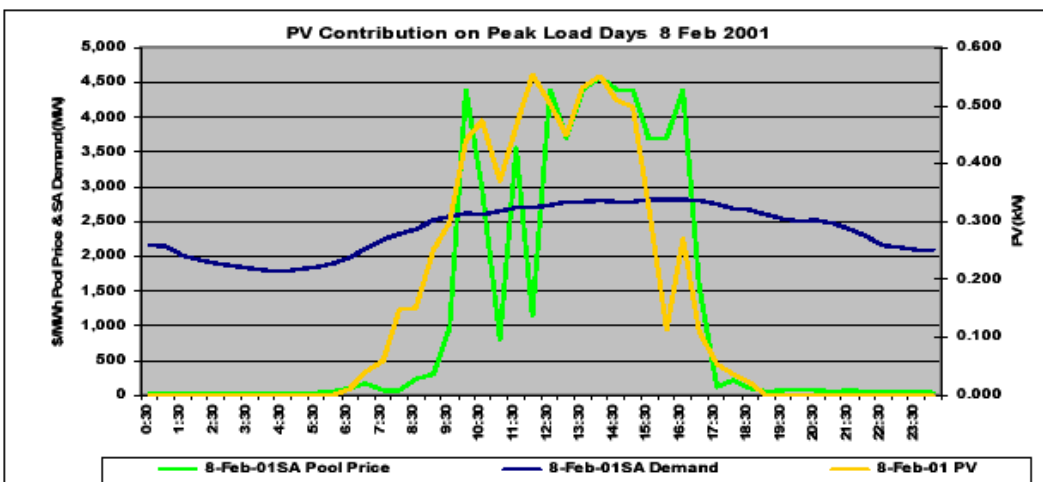


Figure 3 PV Output against Adelaide System Load and Pool Price on a Peak Summer Day.

7. Glossary of Acronyms and Units

AC	Alternating Current.
ACCC	Australian Competition and Consumer Commission
ACRE	Australian CRC for Renewable Energy
AEPG	ACRE Energy Policy Group
AGO	Australian Greenhouse Office
ANZSES	Australian and New Zealand Solar Energy Society
AS	Australian Standard
ASP	Accredited Service Provider
ATO	Australian Taxation Office
BCSE	Business Council for Sustainable Energy
CO ₂ -e	carbon dioxide equivalent
DC	Direct Current
DEUS	Department of Energy Utilities and Sustainability
DITR	Department of Industry, Tourism and Resources
DNSP	Distributed Network Service Provider
DUOS	Distribution Use Of System
ESAA	Electricity Supply Association of Australia
ESCOSA	Essential Services Commission of South Australia
GIS	Geographical Information System
GPR	Green Power Right
GST	Goods and Services Tax
GWh	gigawatt-hour
ICRC	Independent Competition and Regulatory Commission
IPART	Independent Pricing and Regulatory Tribunal
kVA	kilovolt-ampere
kWh	kilowatt-hour
kW _p	kilowatt-peak
MEU	Ministry of Energy and Utilities
MRET	Mandatory Renewable Energy Target
MWh	megawatt-hour
NEC	National Electricity Code
NEM	National Electricity Market
NGAC	NSW Greenhouse Abatement Certificate
NGGAS	New South Wales Greenhouse Gas Abatement Scheme
NPER	National Professional Engineers Register
NT	Northern Territory.
ORER	Office of the Renewable Energy Regulator
OTER	Office of the Tasmanian Energy Regulator
PV	Photovoltaic.
PVRP	Photovoltaic Rebate Program
QCA	Queensland Competition Authority
REC	Renewable Energy Certificate
SAIIR	South Australian Independent Industry Regulator
SEA	Sustainable Energy Authority (Victoria)
SEDA	Sustainable Energy Development Authority
SEDO	Sustainable Energy Development Organisation
SEI	Sustainable Energy Industry
TOU	Time-Of-Use
TUOS	Transmission Use Of System
UE	United Energy
UNSW	University of New South Wales
USA	United States of America
VESC	Victorian Essential Services Commission

8. Glossary of terms

Accumulation meter: A meter capable of measuring only the total energy flow: see interval meter.

Bidirectional meter: A meter capable of recording net energy flow by monitoring flows in both a forward and reverse direction.

Detented meter: A (unidirectional) meter, which is prevented from operating in a reverse direction by some mechanical or electronic means.

Embedded generator: A small electricity generator installed within an electricity distribution network.

Generation: The total flow of electrical energy out of a customer's embedded generator.

Grid: An alternative term for an electricity distribution network.

Gross consumption: The total flow of electrical energy into a customer's load(s).

Gross export: The total unidirectional flow of electrical energy from a customer's electrical system (loads & generator) into a grid.

Gross imports: The total unidirectional flow of electrical energy from a grid into a customer's electrical system (loads & generator).

Interval meter: A meter capable of measuring how the energy flow changes with time: see accumulation meter.

Inverter: A device that can transfer power from a DC source to an AC sink. It may also operate in the reverse direction and transfer power from an AC source to a DC sink.

kVA (kilovolt-ampere): A unit of (both real and reactive) power.

kWp (kilowatt-peak): A unit of power used in the rating of photovoltaic arrays, corresponding to a DC output of 1000 watts under a set of standard test conditions.

Load: Any device that draws electrical energy from a grid.

Main switch: A switch located on a main switchboard used to isolate an electrical circuit, as defined in AS/NZS 3000.

MWh (megawatt-hour): A unit of energy equal to 10^6 watt-hours or 3.6×10^9 joules.

Net export: Gross exports less imports. This equals net production.

Net imports: Gross imports less exports. This equals net consumption.

Non-tariff meter: A meter not used for billing purposes.

Photovoltaic: A term describing devices that convert light energy into electrical energy via a particular quantum-mechanical process.