Value of Generation from Small Scale Residential PV Systems

REPORT TO THE CLEAN ENERGY COUNCIL

- Final Report
- 14 July 2011

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Executive Summary

The NSW Solar Bonus Scheme provided strong support for the uptake of small scale PV systems through a gross feed-in tariff of around 60 c/kWh, reduced to 20 c/kWh in October 2010. Rapid uptake of small scale rooftop PV systems under the scheme has led to the level of installations breaching the scheme cap of 300 MW, resulting in the closure of the scheme in May 2011. A key issue going forward is to develop support mechanisms to support the industry until such time as it becomes economically self sufficient. However, the NSW government is concerned that any support does not increase costs faced by electricity consumers.

Framing ongoing support is likely to be based on the two key issues.

- First, what is the value of net exports (that is, electricity generated but not consumed within the residence) from roof-top systems? For electricity consumed internally, the value is equivalent to the avoidable component of the retail tariff. One view is that the value of net exports should also equal the retail tariff as any electricity generated is likely to be consumed by nearby residences. The alternative view is that the tariff on exports is the value of generation on the wholesale market.
- Second, what level of support in the form of a premium tariff rate on net exports, is required to allow the industry to continue to develop to the point where it becomes economically sustainable. Based on conservative estimates of the level of future cost reductions, it is likely that the cost of generation from small scale systems will be equivalent to the cost of grid supplied electricity sometime towards the end of this decade. But in order to achieve these cost reductions some level of support may be required.

This report contains the findings of an assessment of these issues.

Value of net exports

Net exports provide value in terms of the costs avoided if that electricity was supplied from distant generation sources. The value from roof-top systems comes about because of the close proximity to loads. The value provided to a retailer or other buyer could comprise:

- Energy value, comprising the value that the net exports would earn if it was traded on the wholesale market or if the equivalent amount of electricity had to be purchased from the wholesale market. This value comprises not only the spot value on the wholesale market but, at low levels of installation within a region, the avoided losses from central supply sources and any costs incurred by retailers in contracting for wholesale energy.

- Network savings mainly in the form of deferred investment in fixed cost assets. The magnitude of this value depends on the correlation between PV generation and peak demand at the regional level.
- Ancillary savings, such as avoided market fees.

Other benefits are also possible such as a reduction in the wholesale price to other customers during peak periods, reduced network losses faced by customers in regions with a high level of uptake, and environmental benefits through reduced emissions and reduced water use. These benefits have not been considered in the calculation of the value of net exports either because they require a high level of uptake to be realised, may not be able to be realised under current market arrangements or because there is a lack of data to make robust estimates of the value of the benefits.

The principle value of net exports is likely to come from the energy value. Net exports from PV systems depend on the size of the system relative to load, with estimates of typical net exports of around 26% for a 1.5 kW system to 33% for a 2 kW system. Based on limited data it is apparent that most of the exports occur in mid morning to mid afternoon, when wholesale market prices are typically higher than average.

Current energy market arrangements make it difficult to capture this value. An analysis of the spot prices weighted to the level of net exports reveals that value can vary from 50% to 100% higher than the time-weighted average price. The level of add-on to the time-weighted price depends on the level of exports occurring in the high price periods.

An estimate of the typical export value for 2011/12 has been constructed as follows:

- The volume-weighted price for 2011/12 in NSW is estimated to be around 7.9 c/kWh based on a volume-weighted margin (using 2010 data) of around 57% and the long run marginal cost of NSW generation of around 5 c/kWh[1].
- Network losses on avoided electricity purchases of about 8%.
- Avoided market fees and market costs of around 0.1 c/kWh.
- No value for network deferral as published evidence suggest a near zero contribution of PV generation during the evening peak at distribution nodes largely connecting residential nodes. This is conservative as although distribution investments are unlikely to be avoided, some deferral of transmission asset upgrades is possible if there is large scale uptake of small scale systems.

[1] Note we use the long run marginal cost of base load plant - representative of the time weighted average price - as a basis for calculating the premium for export generation. IPART uses an alternative price in constructing retail tariffs called the energy purchase cost allowance which is the long run marginal cost required to meet the regulated load of the retailers. Because we do not have information of the hourly load pattern implicit in the regulated load calculation, we have used the time weighted average as the comparator.

- No value for retail margins as retail costs are still incurred in metering and billing on sales of exported PV generation. Further, other scheme costs (SRES, RET) are also not included as these costs may still be incurred by the retailer.
- Giving a total value of around 8.6 c/kWh or around 50% of the estimated value of the usage charge component of the regulated retail tariff.

The value is likely to increase over time due to higher electricity prices as a result of higher fuel prices and the imposition of the carbon pricing. The proportion of the retail tariff is likely to increase to around 60% once carbon pricing is implemented.

However, this approach does not necessarily capture the full value of net exports. There are considerable regional variations in the value of net exports. Network losses vary widely by region and can be as high as 20% in some nodes considerably increasing the value of net exports at those nodes, resulting in a value as high as 70% of the time weighted average. Secondly, marginal network losses are averaged over the whole year under current market arrangements, and may not reflect the real loss value at times when PV generation is occurring when network elements are heavily loaded. Furthermore, a high level of penetration of PV systems in a region could result in all customers in that region from benefiting from lower network loss factors. These considerations could favour a higher value for the net export component, which should be examined further.

Applying a fair and reasonable rate to net exports should not of itself lead to higher costs to other customers.

Premium rates

SKM MMA was asked to calculate a premium on the fair and reasonable rate that could be applied on net exports to lead to payback periods of less than 10 years, considered by the industry the minimum level of payback required by purchasers. SKM MMA developed a discounted cash flow model to determine the premium required for typical systems to achieve this payback.

The analysis assumes the following key assumptions:

- Capital costs starting in 2012 at around $6,000/kW for a 2 kW system. This cost reduces by 30% by 2020.
- Avoided retail tariffs starting at 18 c/kWh in 2011 (time of use basis, weighted to the profile of PV generation), increasing in line with recent decisions on network tariff escalators and with the introduction of a carbon price.
- Fair and reasonable rate on exports of around 7.8 c/kWh, again increasing in line with carbon price and a gradual increase in fuel prices.
- Subsidy in the form of payments under the SRES scheme.

- Discount rate of 5% in real terms.
- 16% capacity factor for the PV system (translating into generation levels of 1,400 kWh per annum), with a 1% per annum deterioration in this factor.

The model predicts that for a system installed in 2012, a simple payback of 18 years without the subsidy from the SRES scheme and around 11 years after the subsidy. These paybacks are driven by the high present value of energy savings due to projected rising energy costs.

The analysis found that the premium (above the fair and reasonable rate) on net exports for 2.0 kW systems installed in 2011/12 needed to be around 20 c/kWh for a simple payback of 10 years to 60 c/kWh for a simple payback of 7 years. The premium required increases in 2012/13 due to the lower multiplier applying reducing the discount from the SRES scheme. Around 30 c/kWh is required for a 10 year payback and about 70 c/kWh for 7 year payback. Thereafter the premium required reduces and by 2018 no premium is required.

Lower premium rates are required for large system sizes and higher export amounts (although the impact of higher export amounts is complicated for premium rates less than 20 c/kWh). For system sizes greater than 3kW, the premium required is less than 20 c/kWh for payback periods of 10 years.

Imposing a premium rate of 20 c/kWh lead to annual payments of around $18 million per year (for 10 years) for every 100,000 units installed. A premium rate of 30 c/kWh would lead to annual payments of $27 million for every 100,000 units installed. These payments translate into $6/dwelling per annum (for 10 years) for a 20 c/kWh premium to $10/dwelling per annum for a 30 c/kWh premium.

The premiums required to achieve these short payback periods may be justified on the grounds of consumer unfamiliarity of the benefits of PV systems, or on the uncertainties faced over capturing additional market benefits generated by PV systems, or capital market constraints. As the level of premium required increases sharply with quicker payback periods, increasing the cost to government and/or electricity consumers, it is prudent that longer payback periods should be aimed for, just sufficient to overcome any perceived market failure. Another possibility is to confine payment to regions areas where wider market benefits of embedded generation systems are likely to be greatest.

Recommendations

The key recommendations from the qualitative analysis are summarised as follows:

- As a minimum, the value of the tariff on exported electricity is represented by the wholesale value, network losses, avoided greenhouse gas emissions (as expressed in higher electricity prices), avoided market fees and avoided regulatory fees. This value is likely to range between 50% to 70% of the equivalent retail tariff.

- Small scale PV systems could provide other benefits to the market, but these have not been quantified due either to difficulty in estimating these benefits, or they may not be easily captured under the current regulatory environment or require high levels of uptake to realise the benefits.
- The real value of electricity exports should be paid by retailers to system owners. The tariff on electricity exports should be designed as a volume weighted average which is fixed over time to avoid confusion for consumers and complexity in forecasting returns. The actual rates could be calculated by IPART on a three year basis using the same process undertaken for determining regulated retail tariffs.
- Regional export tariff rates should be applied to more accurately capture the benefits of installed systems where the costs of supplying electricity may differ by region.
- A premium to be paid on top of the real value of exports should be examined but this would be assessed on other grounds (e.g. degree to which it led to industry development or overcame other market failures). The government should consider upfront subsidisation of installation costs in areas where PV systems are likely to provide the most benefits as an incentive for installation. The premium could represent an unfair burden on consumers if subsidised through higher electricity prices, so there is a need to cap these liabilities. The liabilities could be capped say through a declining premium rate with declines occurring at various threshold uptake levels. Any premium on new installations should cease to apply when grid parity is reached, which is likely to occur from mid to the end of this decade[2].

[2] Any system installed prior to the cessation time should still receive the premium for a time related to the payback period used to calculate the premium.

1. Introduction

SKM has been engaged by the Clean Energy Council (CEC) to provide advice on the most appropriate net metering tariffs for residential solar photovoltaic (PV) systems. Although the principles examined are applicable in all state jurisdictions, the focus is on NSW as there are ongoing inquires into the value of PV generation.

A net metering tariff refers to a scheme where the owners of installed PV systems are paid for the 'net exports' of electricity to the grid that their system generates. System owners are not compensated by way of a special tariff for the proportion of electricity that is consumed (this type of tariff would represent a gross-metering scheme) within the residence.

SKM was asked to consider the following points in its analysis:

- What is the real value of electricity exported to the grid under the current regulatory regime?
- How much should the tariff be and who should make the payments to the household?
- What impact would the tariff have on overall electricity prices?
- What are the conditions in which PV systems enhance the grid and are there any policy measures that could encourage uptake in these areas?

The first section of this report comprises a qualitative analysis of the considerations above. The second section of this report is a quantitative analysis of the value of a potential tariff rate. The tariff will comprise the components as recommended in the qualitative analysis and will be forecast to represent NSW. Sensitivity analysis was conducted for uncertain variables to determine the variability in the real value of net exports and the tariff premiums required to achieve payback periods required by system owners. Potential costs to electricity consumers of paying premium rates on net exports were also estimated. Finally, policy levers are suggested to realise the legitimate value that PV generation brings to energy markets under current market arrangements.

2. Principles for Supporting Small Scale Generation

Recent support measures in the form of upfront subsidies and ongoing tariff payments under a feed-in tariff arrangement have seen an explosion in the uptake of roof-top PV systems in NSW. Under the NSW Solar Bonus Scheme, around 300 MW of roof-top systems were installed or on order to be installed by May 2011, when the scheme was closed. Because of the rapid uptake, the costs of the scheme were high, at around $1.44 billion at the end of the payments under the scheme in 2017[3]. The cost is to be funded by payments by Government under the climate change fund and additional payments by retail customers. IPART has estimated that the impact of the Solar Bonus Scheme could have added 5% to 10% to the increase in retail prices in 2011/12 (on top of the 17% increase already approved)[4]. Other estimates have a lower impact, with one study indicating a maximum cost impact of $41 per annum.

With the scheme closing, the rate of installations has dropped, threatening the continued development of the industry if not its imminent collapse. The intent now is to develop support policies that can secure the steady but ongoing development of the industry but at a reasonable cost to the community. The NSW Government's policy objective is for a small scale PV policy that has no net cost impact to electricity consumers.

The principle of the analysis in this report is that any support policy should be based on the need to address market failures or barriers that inhibit the uptake of small scale roof-top systems to an optimal extent. Market failures, caused by the externalities of environmental benefits and benefits to network providers and retailers not being realised by owners of small scale systems, may reduce the uptake of small scale distributed systems below the optimal level. Solar PV micro-generation may be more competitive if the full value of externalities is taken into account in the design of tariffs for electricity exported to the grid. Other market failures such as uncertainties over the future benefits of PV systems and capturing the economies of scale and learning by doing may also justify some form of policy intervention.

2.1. Energy market failures

Under current energy market arrangements small scale distributed generators may not get all the benefits they accrue to the market. The system owner gets the benefits of energy used on their premises, but without a tariff, receives no benefit for exported energy. The generation and

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[3] M. Duffy (2011), *Solar Summit Stage One: Opportunities for Containing Solar Bonus Scheme Costs*, paper presented at the NSW Solar Summit Stage 1, May 6.
[4] R. Sims (2011), *Regulated retail electricity prices from 1 July 2011*, paper presented at the Electricity Price and Market Dynamics Review, April 29.

transmission system gets the capacity and (net) network benefits of all energy production regardless of whether it is used on the premises or exported. Retailers also benefit, because embedded generation supplies energy during high price periods. These considerations suggest that the tariff should be set at a rate that is equivalent to the value of the foregone benefits. However, it is difficult to determine the value of these benefits, especially since energy, capacity, and network savings vary depending on the proportion of energy that is exported.

2.1.1. Pricing arrangements

Under current pricing arrangements, a number of factors may limit the benefits of small scale generation:

- Retail price caps may limit the benefits of internal consumption during high price periods.
- Lack of time of use metering may limit the benefits of consumption and export during high price periods. Time of use meters are gradually being rolled out to residential customers, but the full roll out will take time. However, even these meters may not allow the exports to be valued at the avoided wholesale energy cost.
- Lack of arrangements for owners of small scale systems to trade excess energy generation in to the market.

If the buy-back tariff is simply the equivalent of the general use retail tariff, then the benefits of generating during times of peak system demand are not reflected, because the average retail prices on which general use tariffs are based do not accurately reflect the value of PV to the market during these peak periods. More innovative retail tariffs are not offered for several reasons, including lack of adoption of interval metering (not necessarily a market failure) and the imposition of retail price caps for some customer classes.

Widespread adoption of small scale systems may also act as a demand management option, reducing demand during peak price periods and acting to minimise any price increases. The impact on peak prices depends on the coincidence of generation with peak demand periods. To the extent that peak demand is reduced and prices fall as a result, this will lead to benefits to other customers. However, any ancillary benefits are not realised by system owners under current pricing arrangements.

2.1.2. Network losses

Transmission of electricity from a generation centre to residential loads will incur line losses. Distributed on-site generation avoids these losses for the owner of the system and reduces losses to the systems for electricity generated and consumed on-site.

Exports to nearby loads could also benefit from reduced losses to those loads. The export tariff should capture the benefits of these avoided losses.

Another benefit of generating during high demand periods is that the loadings on network elements are reduced leading to lower losses for all customers at a distribution node. Since rooftop PV systems typically service the local grid, transmission and distribution network losses will be reduced due to the proximity of installed systems with the grid (reduced losses that occur when electricity is transferred longer distances through the network). Under current market arrangements, it is difficult for system owners to capture part of this benefit.

This latter benefit is only likely to be material through widespread adoption in a region.

Reduced losses only occur to the extent that exports from PV systems supply other local loads and are not exported to other distant load centres, thus incurring losses.

2.1.3. Realising network benefits

There are some conditions under which installation of rooftop PV systems will augment the local grid. In particular these benefits are likely to occur in regional areas where the cost of supplying electricity is high from increased provision of ancillary services, as well as significant planned infrastructure which is required to meet future peak demand.

There is currently no incentive to connect PV systems where the benefits are the greatest since network operators tend to smear the cost of providing network services across regions and voltage levels so that the location effects become invisible (MMA, 2008). This also occurs through policies that aim to increase equity by equalising tariffs across each customer class regardless of location (MMA, 2008).

Where PV generation profiles are coincident with peak demand periods, there may be benefits from avoided infrastructure upgrade costs.

The value of PV systems in regional areas is also increased through the avoided cost of electricity consumed (which may be higher than in other regions).

2.1.4. Implications

In order to capitalise on these benefits, which may not be accurately captured by the assumed “average tariff rate” which would apply to all system owners in NSW, policy makers should consider implementing tariff rates that vary across regions in NSW. A regional tariff would not result in the complications associated with forecasting returns [5]and would not be difficult to implement, since consumers would simply be allocated a tariff rate based on region.

This type of scheme is similar to the manner in which consumers are allocated regulated electricity tariffs.

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[5] Except (as previously discussed) where generation is difficult to accurately forecast.

Where there are additional regional benefits from PV generated electricity (such as lower electricity losses to all consumers in that region), this could be reflected through a premium on the real value of net exports. PV output profiles and electricity demand should be analysed to determine the potential regional benefits. SKM has provided an estimate of various regional tariff rates as part of the quantitative analysis, however this analysis is indicative only and should be further refined.

Some energy market barriers that might slow the take up of small scale systems are not market failures. While they may be barriers to installation of rooftop systems, they may represent rational or efficient economic behaviour. Impediments of this type include:

- Uncertainty about future energy prices and hence the potential returns from an investment in small scale systems, resulting in proponents applying a high discount rate in evaluating small scale systems.
- Constraints on the availability of capital to the extent that renewable energy investments are constrained by the scarcity of capital experienced in other areas of the economy.

2.2. Other market failures

Other benefits provided by small scale distributed generation that may not be fully incorporated into the calculation whether or not to install small scale PV include:

- Diversification of energy resources to enhance energy security, principally through diversification in fuel, technology type and geographic spread of generation. For example, failure of one distributed generator will have minimal impact on supply reliability.
- Widespread adoption of small scale distributed technologies could limit the exercise of market power in the wholesale market.
- Improved power quality and reliability in areas where load growth is rapid and network capacity may become severely constrained during extreme peak periods.
- According to a CSIRO (2009), an increase in distributed generation would lead to less variable spot prices. In particular, there would be fewer occurrences of very high prices, which may mean that some new peaking plant capacity could be delayed.

There are other market failures in relation to research, development and innovation. First, there may be positive spillovers from the public good aspects of knowledge accumulation, the value of which cannot be captured by innovators. Many investments produce spillovers but have sufficient private returns for firms to invest without that support. Policy should be crafted to elicit private investments that would not otherwise have been made, but for which the collective private and spillover returns are still positive. Second, there may be uncertainty relating to future market developments. This could lead to suboptimal decision-making by public and private agents about investments in assets with long lives. The danger is that agents may misjudge future developments. This may then lead to more costly provision of the economic services provided by that infrastructure over its lifetime and to lock in of existing technology options.

The market failures that affect technology diffusion can be summarised as follows[6]:

- Learning by doing and knowledge spillovers. Uptake of new technologies typically involves the adopter learning by doing. That is, an early adopter itself improves the characteristics and operation of the technology through learning by doing. The adopting firm creates benefits for other firms through knowledge spillovers, while incurring most of the costs of adoption. This is because an adopting firm cannot typically keep other firms from also exploiting some of the knowledge gained from adoption, even where a patent or other protection exists. Firms therefore do not have the incentive to increase those benefits by investing in technological development and diffusion.
- Adoption externalities. The cost of a new technology to a user may depend on the number of other people who adopt the technology. Further, the initial adopters of a new technology typically aid the diffusion process by making available to other parties information on the new technology. Early adopters generate knowledge on the existence, characteristics and applicability of the new technology. This knowledge is likely to become available to other firms who can use this knowledge even though they did not incur the cost of its generation.
- Network externalities. These externalities occur where costs of a technology may reduce or its benefits increase, as adoption becomes more widespread.
- Incomplete information. There is a great deal of uncertainty around the potential outcomes of adopting new technologies. Further information about these prospects is typically asymmetric, in that developers of technologies have better information about these prospects than other investors who may wish to adopt them. Early investors may be sceptical about the prospects of a technology and demand a premium on return in order to cover the risks of the investment.

The result of these market failures is that investment in and deployment of relatively novel small scale technologies may be at a lower level than is optimal from society's point of view.

2.3. Assessing options to overcome market barriers

Whatever policy is recommended to support the PV industry should be assessed on the following criteria:

[6] A. B. Jaffe, R. G. Newell and R. N. Stavins, (2001), "Technological change and the environment", *Discussion Paper 00-47 REV*, Resources for the Future, Washington DC

- Efficiency. Does the approach lead to net benefits to society or achieve a given benefit at least cost? Will the policy resolves market failures not covered by other measures at a net benefit to society?
- Effectiveness. Does the policy measure achieve the stated goals? For example, would a policy measure achieve more than what is achieved already under the SRES scheme benefits?
- Equity. Do the costs of the scheme fall unfairly on some groups in the community? The NSW Government has already stated a desire that any support measure would not increase the electricity prices faced by other electricity customers. Costs of the Gross Feed-in Tariff were believed to have fallen unfairly on low income consumers at a time when energy costs were already increasing for a host of other reasons.
- Administration and compliance costs. Any scheme should be simple so that administration and compliance costs are minimised. The Clean Energy Council has recognised this in its desire to develop a minimalist policy approach.
- Fit within current institutional arrangements affecting energy markets. This includes not unnecessarily discriminating against other technologies or leading to impacts which undermine current market arrangements.

The key is to specify an objective for further policy support. We adopt an infant industry argument in that we assumed the objective of the support policy is to rapidly reduce system costs through learning by doing in the installation of systems (including balance of systems) and in realising system benefits until such time as the costs are low enough that the industry is self sufficient. This objective has built in an objective that any policy measure is temporary and targeted to overcoming barriers to sustainable uptake of small scale systems.

3. Market Value for PV Generation

In the absence of a tariff scheme, system owners get the benefit of energy consumption generated through their systems, but may only receive limited benefits for the value of the electricity exported to the grid.

There is some contention as to the value of the energy produced by PV systems that is exported to the grid, and the resulting tariff rate that should apply to capture the value. The real value of the electricity generated by PV systems is partly accrued through avoided payments for on-site consumption plus reimbursements for exports to the grid.

3.1. Avoided cost of electricity consumed

PV electricity generation which is consumed locally (not exported to the grid) for each half hour interval represents a benefit to system owners through the avoided cost of electricity (the retail tariff which would have been paid for consumption). The value of the avoided cost of electricity consumed is captured by the retail cost of electricity which would have been paid by consumers if obtained through conventional mechanisms (through the NEM) as opposed to being produced internally by PV systems. The total value of the avoided cost of electricity consumed is represented by the output consumed, multiplied by the appropriate retail tariff. This avoided cost represents a benefit to consumers through reduced electricity bills, and therefore contributes to the total real value of electricity produced by the PV system. Since consumers would automatically receive this benefit, the avoided cost of electricity consumed does not comprise part of the tariff rate.

However, even here there are some complicating factors. First, there can a high degree of fixed costs in supplying electricity to a home. Under current tariff arrangements, these fixed costs can be spread across all consumption under usage charges. A high level of uptake may require these fixed costs to be recouped in some other way, since owners would pay less to electricity retailers if a proportion of electricity consumed is produced by PV systems.

Second, the average tariff rates may only reflect the average prices across all time periods. Time of day tariffs are now available for customers with the appropriate meters. For other customers, the average price avoided may not reflect the real value of the avoided purchases of electricity from the grid. A comparison of the existing regulated tariffs in Table 1 indicates the highest avoided cost occurs during 2.00 pm to 8.00 pm on weekdays when electricity generation from PV systems is likely to be greatest.

The volume weighted average of the avoided cost of electricity consumed is forecast based on the PV generation consumption at half hour intervals as a proportion of total PV generation consumed, multiplied by the relevant retail tariff. In calculating the avoided cost of electricity, the consumption for periods where there are no net exports is equal to the PV generation, while

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consumption during periods of net exports is calculated as the difference between PV generation and net exports. Only variable components of the tariff were considered (usage charges only).

The results indicate a benefit of approximately $189/MWh based on data for the 2011 regulated time of use tariff rates. There are a number of limitations associated with this forecast, namely that the regulated retail tariffs are not necessarily representative of what consumers are being charged, nor does the time of use pricing structure necessarily represent the real avoided cost. The PV generation profiles are based on average annual generation and are not regional or seasonal, therefore average PV generation consumed may differ for households.

The value of the avoided cost of electricity consumed accrues to customers through reduced electricity bills, and hence 'pays-off' some of the installation investment.

- **Table 1: Regulated retail tariffs for residential customers, NSW, 2011/12**

Tariff	Usage charge, c/kWh	Service availability charge, c/day
Domestic all time	20.6 for consumption up to 1,750 kWh per quarter, 29.1 c/kWh for remaining consumption	40.8
Power smart	Peak (2.00 pm to 8.00 weekdays): 40.6; Off peak (10.00 pm to 7.00 am): 9.6; Shoulder period (all other times): 16.4	59.0

Sources: Energy Australia; IPART (2011)

3.2. Value of net exports

A fixed tariff rate which represents a volume weighted average of the real value of exports to the grid maximises the benefits of net exports. While solar PV systems generate output when demand is high and an average price may not capture the benefits of reducing system demand during peak periods (since electricity is higher in this period), flexible tariffs can become complicated.

The real value of exports is comprised of:

- The wholesale value of net exports to the grid
- Avoided transmission and distribution losses,
- Avoided market and regulatory fees, and
- Avoided future infrastructure upgrades (network benefits).

Other components of the tariff relate to the value of avoided greenhouse gas emissions (which apply to both consumed and exported electricity) and forms part of the real value of all electricity generated, as well as a risk premium to compensate investors for the option value associated with

PV systems in terms of protecting against future cost increases in alternative sources of generation through fuel price increases and higher carbon prices than anticipated.

3.2.1. Wholesale value of net exports

3.2.1.1. Wholesale price margin

Net exports to the grid are calculated as the difference between hourly energy produced by PV systems and energy consumed. The initial value of these exports (i.e. the value which excludes any additional benefits of PV generated electricity) is represented by the wholesale cost of electricity. The wholesale cost (and not the retail cost) represents the value of the exports since owners are effectively supplying the retailer with electricity. Since the retailer would still incur costs to provide the exported electricity to other consumers (metering, recording and billing costs), the retail margin is not incorporated in the value of net exports when determining the tariff rate.

The electricity produced by PV systems which is exported to the grid may supply energy during high price peak periods. Therefore there may be some additional benefits to retailers if volume weighted average tariffs are paid to PV owners for net exports. However, since small systems that are active during the day may not export much net energy to the grid during peak periods, the benefits to retailers are likely to be minimal.

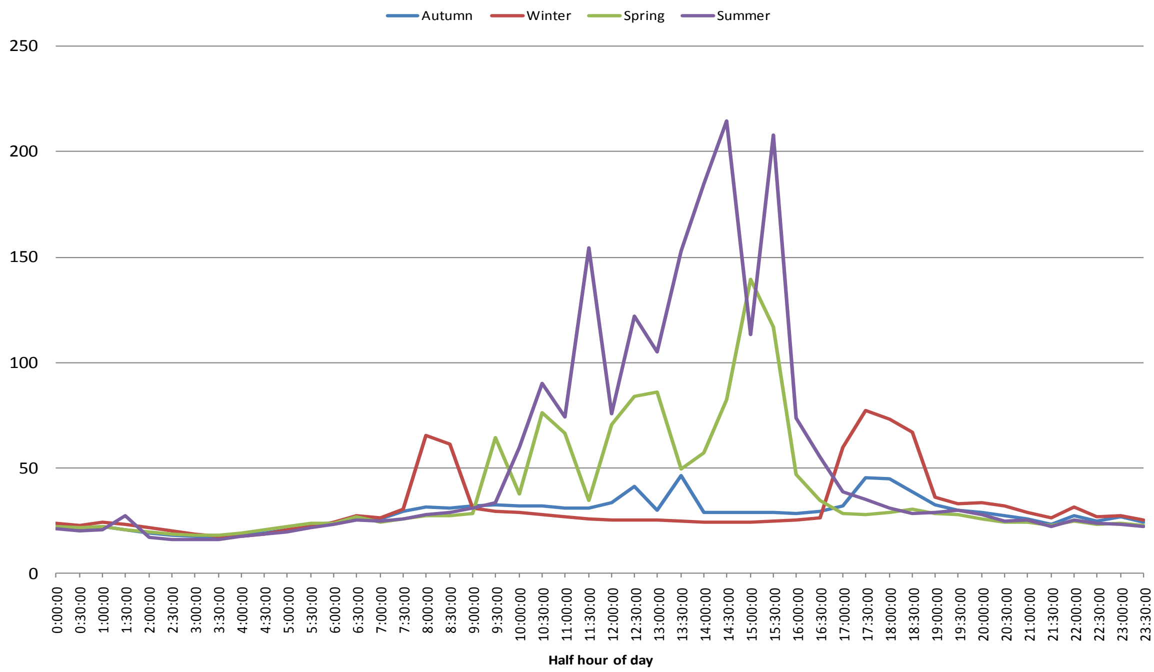
The concept is illustrated in the following charts. Average weekly prices for each season over the period of March 2010 to February 2011 are shown in Figure 1. For the whole year, the average price was around $37.50/MWh. However, the prices were substantially higher in the summer and spring months than in other months. Prices were also higher in the middle of the day in those two seasons, when the level of PV generation is likely to be highest.

Thus, the price earned on exports should reflect the fact that exports from a PV system are likely to be greater when prices are highest. Three factors are combined to estimate the margin earnt by net exports (in NSW). These are: the time profile for electricity prices in a typical week (by season), the volume weighted wholesale prices for PV output and the assumed net export (surplus electricity generated) patterns by season. Weighting the price to the level of exports, using the hourly price data shown in Figure 2 and Figure 3, and the hourly proportion of exports as shown in Figure 4, to derive the volume weighted price[7] for PV exports, the margins on the simple time weighted average price are shown in Figure 5. The analysis of the historical price data indicates that the margin over the time weighted price is likely to range from around 57% based on 2010 data (see

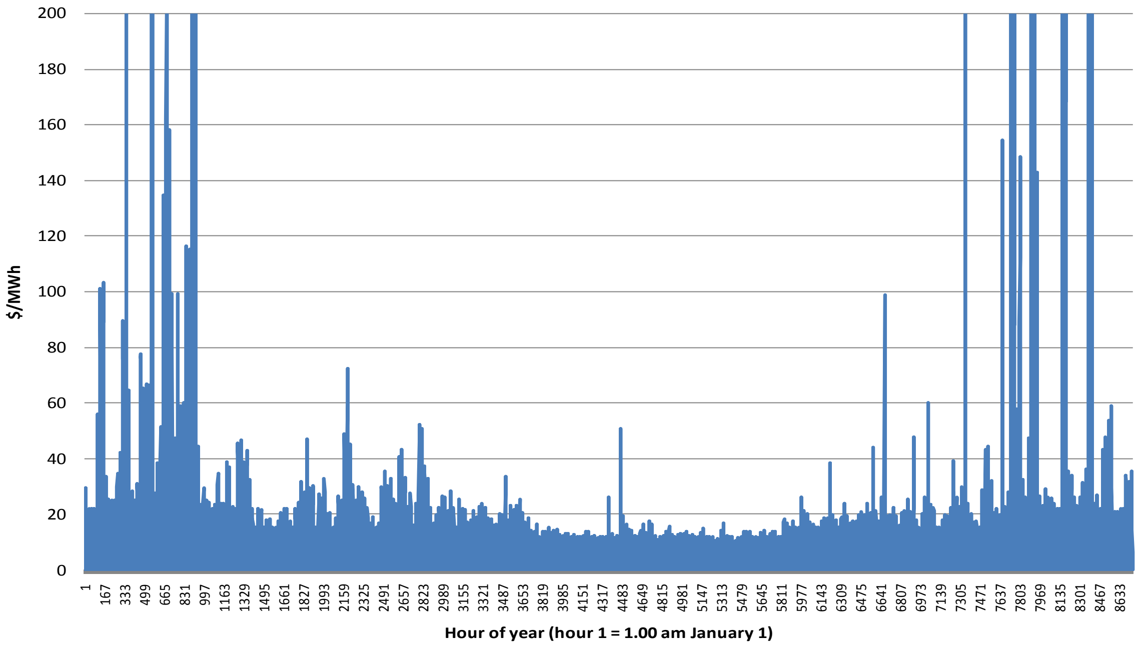
[7] Note this definition of the load weighted price is different to the definition used by IPART. The IPART definition refers to the average price as weighted by electricity demand in each hour of the year. The reference to load weighted price in this report refers to the average price as weighted by the level of net exports from a typical PV system.

Figure 5) to around 100% based on 2009 data. The high margin comes about due to the presence of a high level of PV generation during the few periods with very high prices.

- **Figure 1: Average hourly prices for a typical week in each season, NSW, 2010**



- **Figure 2: Volume weighted wholesale prices for PV output, 2009**



Note: Prices in each hour weighted by the proportion of PV generation in each hour.

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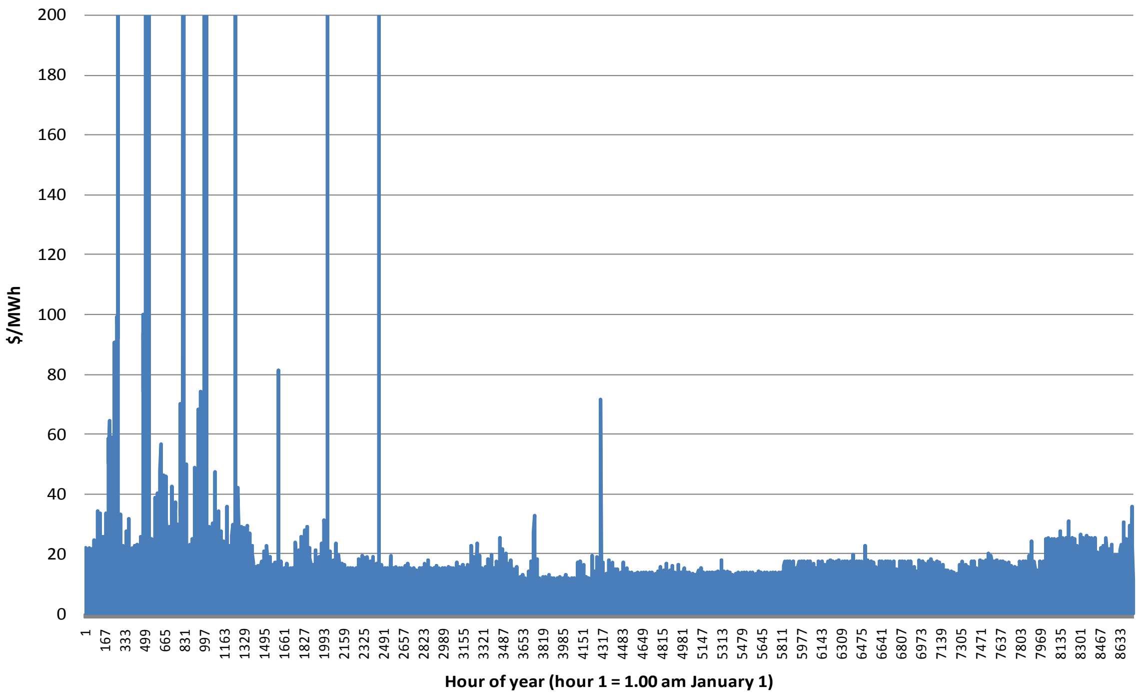
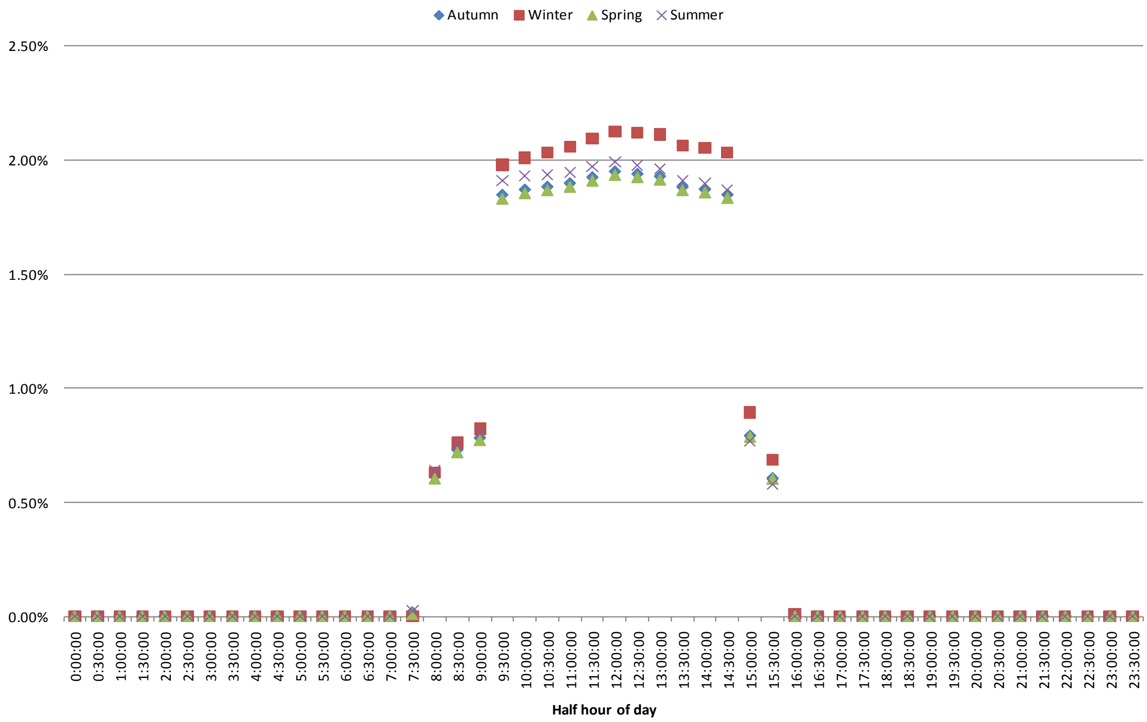
Figure 3: Volume weighted wholesale prices for PV output, 2010

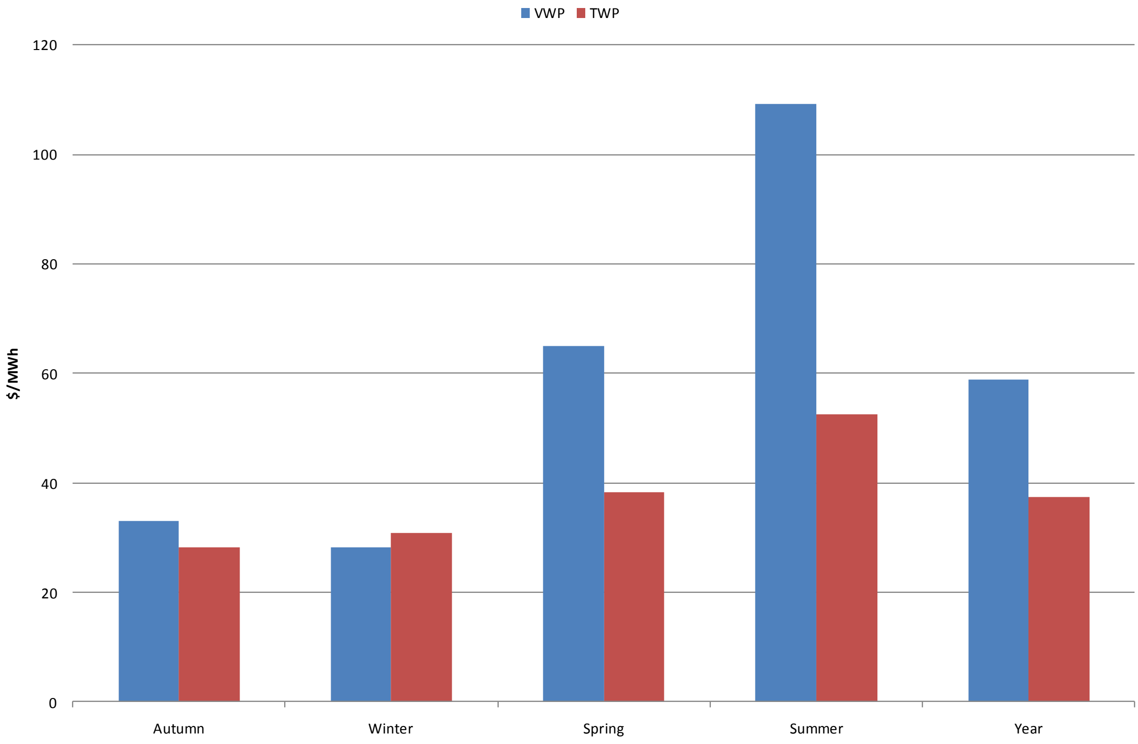


Note: Prices in each hour weighted by the proportion of PV generation in each hour.

Figure 4: Assumed net export pattern, % of total annual output



- **Figure 5: Time weighted and volume weighted prices for net exports**



The margins calculated in Figure 5 refer to that earned by a typical system size (of 2 kW) and typical residential load. This premium is likely to differ depending on both the size of the system and the size of the residential load. The greater the system size (for the same load) the higher the net exports are likely to be in high price periods. The lower the residential load, the greater the levels of net exports are likely to be.

3.2.1.2. Estimates of wholesale value

The average wholesale price for net exports from a roof top system is estimated below. The weighting is based on published PV generation data. Average daily residential demand (wholesale) was sourced for summer, autumn, winter and spring over a 24-hour period in half hour intervals. The data is assumed to represent residential demand and consumption in the half hour intervals. AECOM (2010) estimated that on average, approximately 34 per cent of total residential PV generation in NSW is exported to the grid. This average was used to forecast total PV exports per hour in a typical week in each season based on the typical hourly pattern of residential demand for electricity.

Data from a study on the output of residential PV systems in the Newington Olympic Village was used to derive the PV generation profile for NSW. The data indicate that on average, PV generation peaks between 10am to 2pm daily, with net exports occurring in the hours between approximately 8am to 4pm on average. Demand for electricity peaks on average at different intervals in the day depending on season. These data highlight the need for seasonal data in estimating an appropriate tariff rate for net exports for NSW.

There are a number of limitations associated with this data. First, the PV generation profiles are based on one suburb in NSW (Newington Village) which is assumed to be representative of the NSW region. There are likely to be a number of regional differences occurring in PV systems potential to generate electricity, particularly in regions where exposure to solar radiation is more prevalent. Second, the generation data is based on average annual exports, not average annual daily exports and therefore may not be reflective of daily exports when compared to average annual daily demand for electricity.

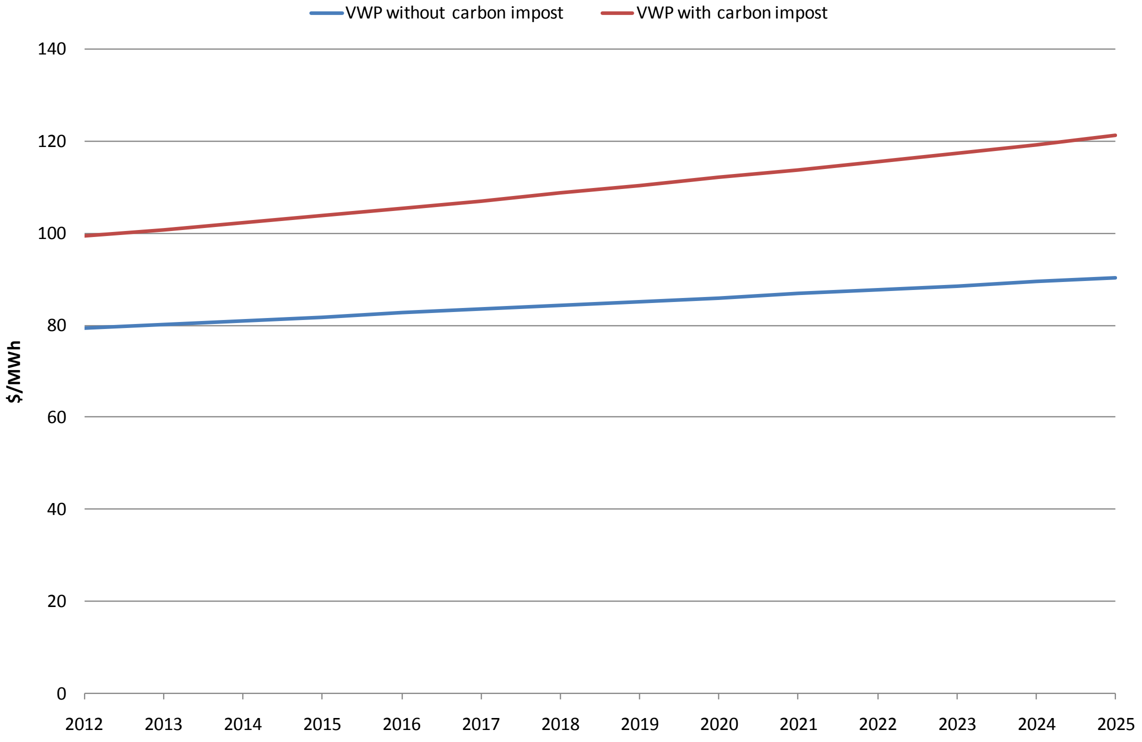
Net exports were estimated for each day (by season) as the difference between PV generation and electricity consumption. As previously indicated, the results suggest that net exports occur in all seasons in the middle of the day. The exports occurring at each half hour interval as a proportion of total exports was used to forecast the volume weighted average of the wholesale value of exports based on the half-hour interval wholesale spot prices. The results indicated an average value per MWh exported of $79/MWh in 2012. The value of exports is representative of the high proportion of net exports during periods with high electricity wholesale spot prices in summer.

This estimate was constructed as follows:

- Long run marginal cost of new generation at $50/MWh (time weighted average basis).
- Margin applied to obtain volume weighted value for PV exports set at 57% (see Section 3.2.1).

The value of exports is expected to grow for two reasons: as fuel prices continue to increase on the back of tightening supply on world energy markets (we have assumed underlying electricity prices increase by 1% per annum to reflect the long term trend increase in fuel prices); and as carbon taxes are imposed (we assume a carbon price of $23/t CO_2e staring in mid 2012 escalating by 2.5% per annum for two years and then 5% per annum in real terms). The impact of these assumptions on future electricity prices are shown in the following chart.

- **Figure 6: Projections of the volume weighted price for net exports**



Seasonal fluctuations in PV output will have a significant impact on the average value net exports per MWh, since PV is likely to generate more output in summer, when spot prices are higher. Similarly, it is expected that winter weather conditions will result in reduced PV electricity generation, which will also alter the value of net exports.

3.2.2. Avoided transmission and distribution losses (network benefits)

Solar PV systems may result in reduced transmission and distribution losses since the source of production would be closer to the final point of use. This occurs since having a generator closer to the load would reduce the amount of electricity imported from the network (Access Economics, 2008). Garnaut suggests that the non-linear relationship between load and loss would mean that all customers would benefit from reductions in system losses (Garnaut, 2011).

Some of the benefits from avoided line losses can be captured through 'marginal loss factors' which are applied to wholesale prices of electricity that retailers pay. Relying on marginal loss factors may understate benefits since loss is accounted for on an average annual basis and more loss occurs during peak demand periods. Therefore the non-linear relationship described by Garnaut is not captured through marginal loss factors. In the case where PV systems generate more power during peak demand periods, a significant loss saving would be unaccounted for.

The value of avoided transmission and distribution losses are forecast by multiplying the wholesale value of exports by marginal loss factor (MLF) provided by the Australian Energy Market Operator (AEMO). The wholesale value of net exports estimated was multiplied by the marginal loss factors for the transmission and distribution networks for NSW, assumed at 5% and 3% respectively. These marginal loss factors were summed to represent a total loss of 8%, and applied to the wholesale value of net exports. The results indicated that PV generation would result in savings of approximately $4 per MWh from avoided transmission line losses, and $2 per MWh for avoided distribution line losses. When summed, the value of the net exports per MWh when accounting for transmission and distribution line losses is estimated at approximately $86/MWh in 2012.

The limitations associated with forecasting the value of avoided transmission and distribution losses stem from the use of average MLFs for the whole year. Therefore, this approach does not take into account daily and seasonal fluctuations, which may bias against PV systems with generation concentrated in periods where losses are high.

Using a state wide average may also limit the value of PV exports in some regions. There are likely to be increased benefits from net exports in remote regions where losses are likely to be higher. Hence, the installation of PV systems in remote regions is likely to generate value above the average annual average for NSW. Regional analysis should be undertaken to determine these benefits, based on regional MLF, regional PV generation and regional household demand profiles.

3.2.3. Avoided network infrastructure costs

Network benefits occur when there is a deferred cost of upgrading transmission and distribution infrastructure to service future demand for electricity. There is potential leverage for network benefits through avoided infrastructure upgrades where:

- The network demand profile is coincident with the PV generation profile.
- The network loading is nearing capacity.
- The rate of demand growth is small.
- The cost of network augmentation is large.

Assuming PV systems will provide additional capacity to service future peak demand (through net exports), the value of any export tariff should consider the avoided cost of future upgrades to service the growing demand. The generally accepted benchmark for the value of deferred infrastructure spending is that 50 per cent of benefits should accrue to PV owners with 50 per cent retained by network service providers. Any avoided infrastructure costs would be based on simulated PV output profiles compared to peak demand profiles.

However, there is some contention in the potential benefits through avoided upgrade costs for a number of reasons including:

- Net export output may not necessary correlate with peak demand in some regions. To the extent that infrastructure is required to service the future peak demand for even one household, the avoided cost of infrastructure is eliminated (and any resulting benefits). While PV may provide some relief for peak demand in some regions, infrastructure that services these regions may require upgrades to service other regions and the benefits may be minimal.
- There is an incentive to electricity providers to undertake network augmentation as network tariffs in the NEM are regulated through a structure of 'maximum allowable revenue' which is based on the value of assets.
- There is a certain degree of uncertainty regarding PV electricity output since the systems are affected by weather conditions. While PV systems have an increased capacity to generate electricity under cloudy conditions than some other sources of renewable energy systems, the capacity would be decreased when compared with optimal weather conditions. Since utility providers are required to ensure that infrastructure exists to service peak demand at all times, the potential benefits through avoided upgrades may be eliminated through the need to provide certainty in supply.

An analysis of potential network augmentation benefits would require taking into account the likely location of solar PV systems, whether there are current capacity constraints in the system and the likely planned transmission and distribution network investment (AECOM, 2010).

The available evidence suggests a very low correlation between the output of PV systems and the peak load in regions dominated by residential customer loads. A study by URS (2006) examining loads and PV output in a village community at Newington showed no correlation of PV output to peak demand, which typically occurred at the evening peak period when solar insolation in low. A study by Watt et. al. (2006) also found low correlation between PV output and demand on feeders servicing primarily residential areas in major regional centres, although the same study found better correlation at feeders serving regional areas including those serving residential loads (and almost perfect correlation at feeders serving predominantly commercial loads).

Hence, other studies indicate that the benefits of potential avoided future network augmentation are likely to be minimal since PV generation would not reduce peak demand. Since infrastructure is required to service peak demand whenever it occurs, the analysis in this study assumes no benefits are accrued.

Further analysis should be conducted to determine potential regional benefits from avoided infrastructure upgrades where peak PV output may more closely correlate with peak demand for electricity.

3.2.4. Avoided greenhouse gas emissions

Where a carbon trading scheme is prevalent, the cost associated with greenhouse gas emissions (the externality costs of electricity production and consumption) would be captured through higher electricity prices (both wholesale and retail). Therefore, the value of the avoided greenhouse gas emissions would be captured in the avoided retail cost of consumption, as well as the wholesale energy price paid for net exports. This assumption relies on a carbon tax that fully captures the social costs of the externality and that the full cost of compliance is passed to the end user through changes in wholesale and retail electricity prices.

The current value of wholesale and retail electricity prices do not reflect the cost of greenhouse gas emissions. Therefore these values must be estimated as part of the determination for an export tariff rate and should apply to all electricity generated by PV systems, regardless of whether it is consumed locally or exported to the grid. SKM recommends that the tariff rate should be revised in light of the carbon trading scheme when prices adjust to reflect the cost of carbon emissions[8], as the prices are more likely to accurately reflect the price of carbon.

Avoided greenhouse gas emissions occur for all PV generation, whether consumed locally or exported to the grid for distribution to other households. The savings/environmental benefits occur since electricity is produced by renewable sources, rather than by conventional mechanisms.

In the absence of a carbon trading scheme, the spot and retail prices obtained from 2012 data do not include a price on carbon. For the purpose of calculating the value of net exports, a price of $23 a tonne has been assumed, escalating at 5 per cent per annum. The price per tonne is multiplied by 0.86 to represent a price per MWh, and has been included in the final modelling to represent the value of greenhouse gas emissions avoided. The wholesale value of net exports based on these assumptions for carbon pricing is shown in Figure 6.

3.3. Other market benefits

Other potential benefits which are not considered as part of this analysis include:

- Security of supply: This refers to the ability for solar PV to provide electricity when conventional networks may be experience power outages. The dispersed nature of small scale PV systems would enhance security of supply since a reduction in output in any one system will not have a marked impact on reliability of supply. However, the extent of additional security is difficult to forecast since solar PV systems are reliant on favourable weather conditions to generate electricity and output cannot be guaranteed. Also it cannot be guaranteed that PV systems will be able to service all demand during outages.
- Limit the market power of providers: At a large scale level of adoption, PV systems can provide some protection against exercise of monopoly powers in the wholesale market due to the greater uncertainty over their contribution during peak demand periods.

[8]The majority of electricity production relies on fossil fuels which generate carbon emissions.

3.4. Summary

A tariff on net exports from PV systems can comprise two components. First, there is a component to reflect the value to the market of the net exports. Setting a tariff to cover this value is justified on the grounds that current market arrangements do not allow for this value to be captured in trading transactions. Second, there may be a premium component to allow for other objectives to be met such as development of the industry or achieving scale economies and learning by doing through widespread adoption.

In this section, there was an attempt to determine the value to the market of net exports. The value was found to comprise the projected wholesale price (weighted to the time profile of net exports) plus the marginal losses avoided and avoided market and regulatory fees. A component for deferring network investments was not justified in general as net export from small scale systems on household roofs do not occur in the peak demand period for local feeders.

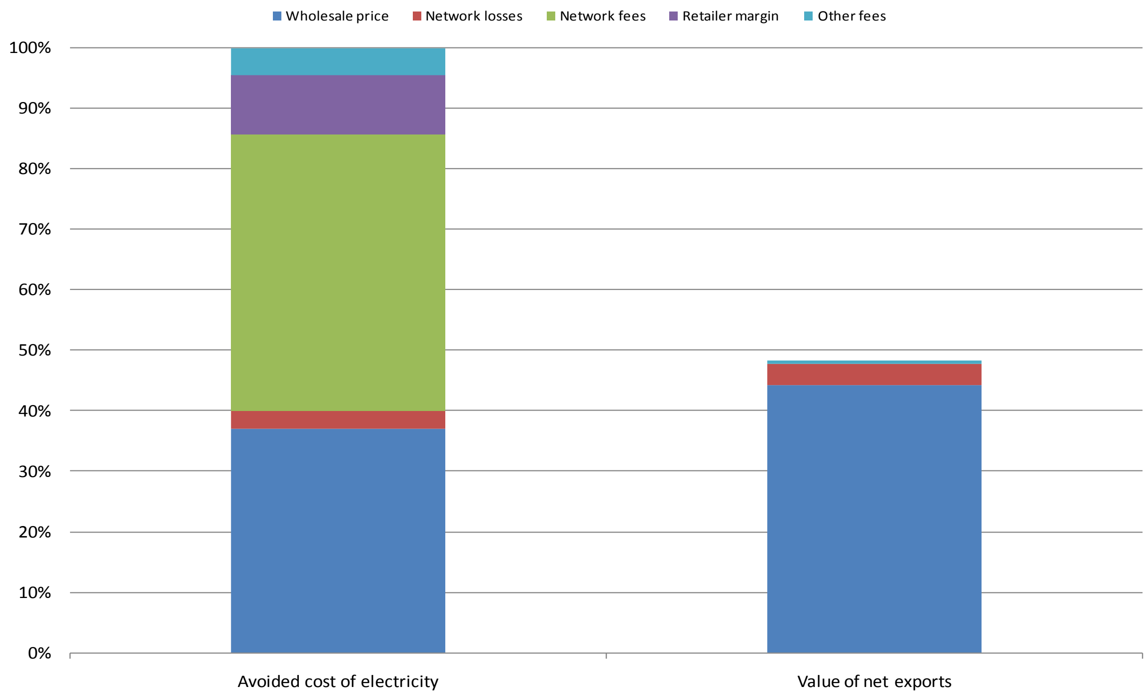
The value of net exports is compared to the average retail tariff (which is the reward to PV generation used within the house) are compared in Figure 7. The value of net exports as a proportion of the retail tariffs is calculated to be around 50% to 70%, depending on assumptions on location, household consumption levels and system size. This ratio can be used as a simple mechanism to base the returns to net exports under a feed-in tariff arrangement.

The analysis also indicates there is some merit in considering regional variations on the net export value. As marginal losses are likely to be higher in some regions, a higher tariff could be paid. There is also some merit to adding a component to reflect the marginal losses during periods when the PV system is supplying to the grid (as opposed to the published marginal losses which reflect an average across all time periods). Although this is justified in principle, there are some issues to be considered with regional variations. The inclusion of marginal losses as part of the value stream is contingent on the assumption that the electricity generation supplies nearby other loads. Whilst this is likely to be a valid assumption at low penetration level, high penetration levels may results in high losses being occurred as the electricity is transmitted further from the point of generation. One way around this is to put a cap on the regional capacity that can receive the higher tariff.

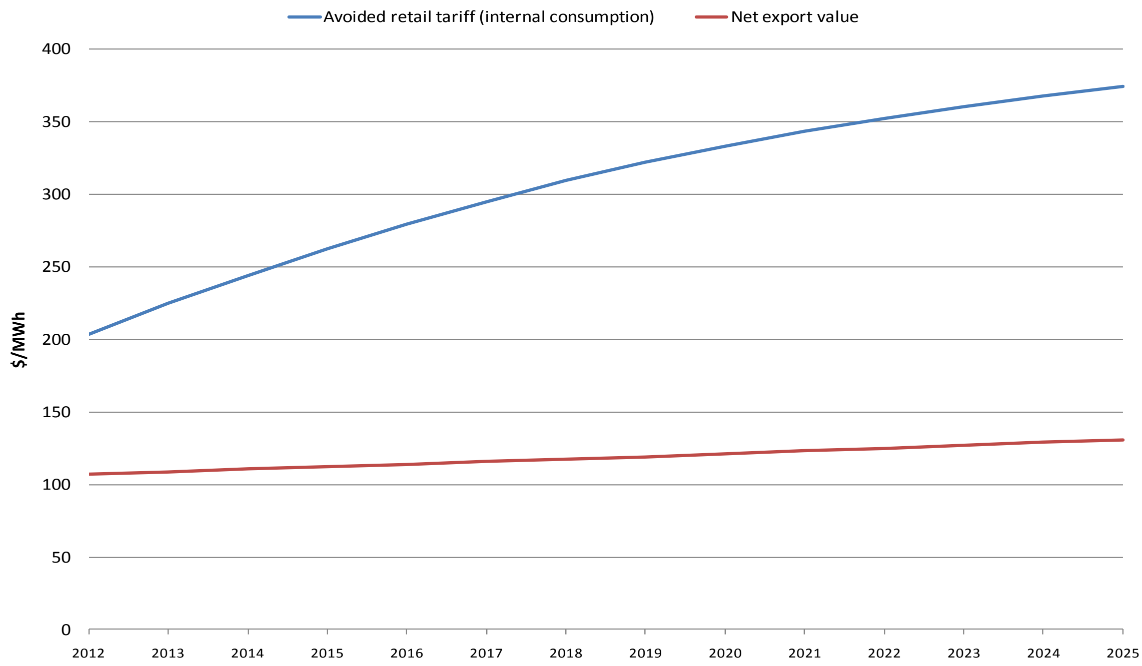
To the extent that net exports from roof top systems reduce imports of electricity into a region, other customers (without PV systems) may also benefit through transmission losses. Including a value for this benefit should be investigated further.

Based the assumptions listed in this section, projections of the avoided retail tariff for internal consumption of PV output and the value of net exports can be derived (see Figure 8). The projections indicate the value is likely to rise on the back on continuing cost increases and the implementation of a carbon pricing scheme. The projections are for the value of output on average. There are likely to be marked regional variations with higher values than shown for some regions.

- **Figure 7: Components of the avoided cost of electricity and value of net exports, 2011/12**



- **Figure 8: Projection of the value of PV output**



4. Estimates of the Premium Rate

This section will demonstrate the methodology for calculating an appropriate premium rate for the *average* NSW residential system. The premium is calculated for payback period of up to 10 years after installation, a rate deemed by the industry sufficient to overcome market barriers to uptake. It should be noted that the results of this report are *not* a suitable estimate for a final premium rate, but rather a representation of a potential structure. The analysis has been based on a number of assumptions which are outlined below. These assumptions and particularly regional differences should be taken into account for any policy planning.

The analysis is focussed on calculating the premium above the fair and reasonable market value required to overcome other barriers to uptake (apart from energy market barriers).

The value of the premium would not be affected by who incurs the cost of the premium (i.e. the electricity consumers or the government), but rather by the desired duration for the payback period. The premium required to compensate investors will increase in line with shorter payback periods. A payback period which is shorter than the life of the asset will also allow owners to continue to earn benefits to the end of the life of the system. While premium tariff schemes are likely to terminate close to the payback period, beyond the payback period the owner will still accrue the benefits associated with avoided costs of electricity consumption and the electricity retailer would accrue the benefits of net exports to the grid.

4.1. Approach

Discount cash flow analysis has been undertaken in order to forecast the premium value for a tariff which would apply for payback periods of 7 to 10 years. The following parameters (Table 2) are assumed in the model.

The impact of the assumptions on capital costs is illustrated in Figure 9. The capital cost is expected to fall over time but at a diminishing rate reflecting cost reductions through learning by doing and continuing reductions in manufacturing costs through larger scale production systems. Capital costs per unit of output is lower the larger the system size, reflecting economies of scale in installation costs. For example, a 3kW system installed in 2010/11 is expected to cost around $6,300/kW but the same system installed in 2015 is expected to cost $5,000/kW. A 5 kW in 2010/11 is expected to cost $6,000/kW.

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Table 2 Modelling Parameters/Assumptions

Currency	AUD 2011
Installation cost	$6,500/kW[9] for a 1.5 kW system in 2011 to $5,000/kW for a 10 kW system
Average retail electricity tariff in 2010	19 cents per KWh
REC Rebate Zone	3
SRES Multiplier	3 in 2012/13, 2 in 2013/14, 1 thereafter to 2030
REC Price (real terms) $/MWh	38
Assumed PV Life	25 years
Module Efficiency Deterioration	0.5 per cent per annum
Discount rate	5.0 per cent (real rate)
CPI	2.5 per cent
PV Size	1.5 kW to 10 kW
Net export proportion	Varies by system size. For residential system, mean is 26% for 1.5 kW system to 42% for systems greater than 5 kW
Wholesale value of exports (inc line losses but excluding emissions savings	60% margin on time weighted price plus 8% loss factor (distribution and transmission loss savings)
Carbon price $/tonne	$23
Carbon price escalation	2.5% per annum for 3 years then5% per annum thereafter
Starting year for carbon price	2012
Marginal emission intensity in 2011	0.95
Marginal emission intensity de-escalator	-2 per cent

[9] Based on quotes of net installed costs published in July 2011 in daily newspapers after removing the contribution of the SRES subsidy. The cost may be lower if other discounts are offered through, for example, bulk orders for a region.

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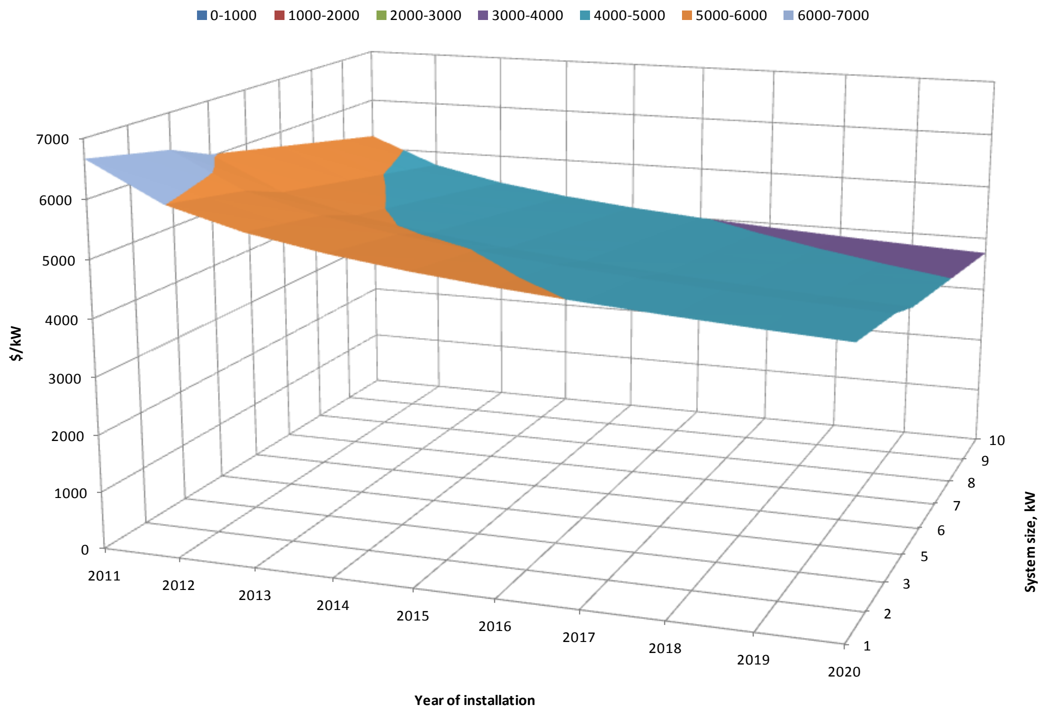
- **Figure 9: Capital cost as a function of system size and year of installation**



4.2. Long run marginal cost

The long run marginal cost is the upfront and ongoing costs of the system spread over the output produced over the life of the system. The long run marginal cost will vary by system, being lower for larger systems due to some modest economies of scale with large systems. The long run marginal cost is also sensitive to the projected decrease in capital costs over time and to the discount rate used.

For a 1.5 kW system installed in 2012, the long run marginal cost is calculated as 32 c/kWh for a 5% discount rate and 49 c/kWh for a 10% discount rate. For a 10 kW system, the long run marginal cost varies from 23 c/kWh for a 5% discount rate to 39 c/kWh for a 10% discount rate.

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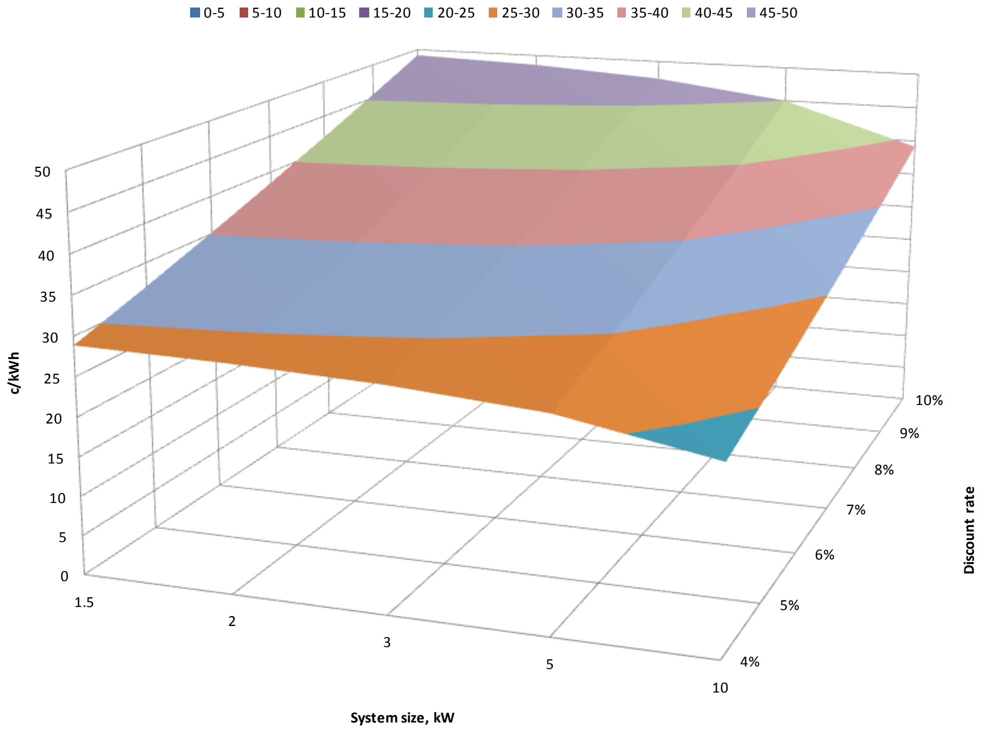
- **Figure 10: Long run marginal cost of small scale PV generation as a function of discount rate and system size**



4.3. Grid parity

Grid parity refers to the situation where the long run marginal cost of PV generation is equivalent to the average retail tariff (averaged over customer load). Retail tariffs are expected to rise on the back of rising fuel prices, rising capital costs for all electricity supply infrastructure and the implementation of carbon pricing. Assuming that underlying retail prices for residential loads increase in line with recent IPART determinations for the next three years and then gradually at a lower rate to a 1% per annum from 2015 onwards plus the impact of a carbon tax regime with a \$20/t start price in 2012 escalating at 5% per annum in real terms, the retail tariff is projected to increase from around 22 c/kWh in 2012 to around 28 c/kWh in 2025.

Based on this retail tariff regime, the long run marginal cost of supply for a 1.5 kW system is expected to reach grid parity by the end of the decade (and thereafter be lower than the retail tariff). A 10 kW system will reach grid parity over the next few years.

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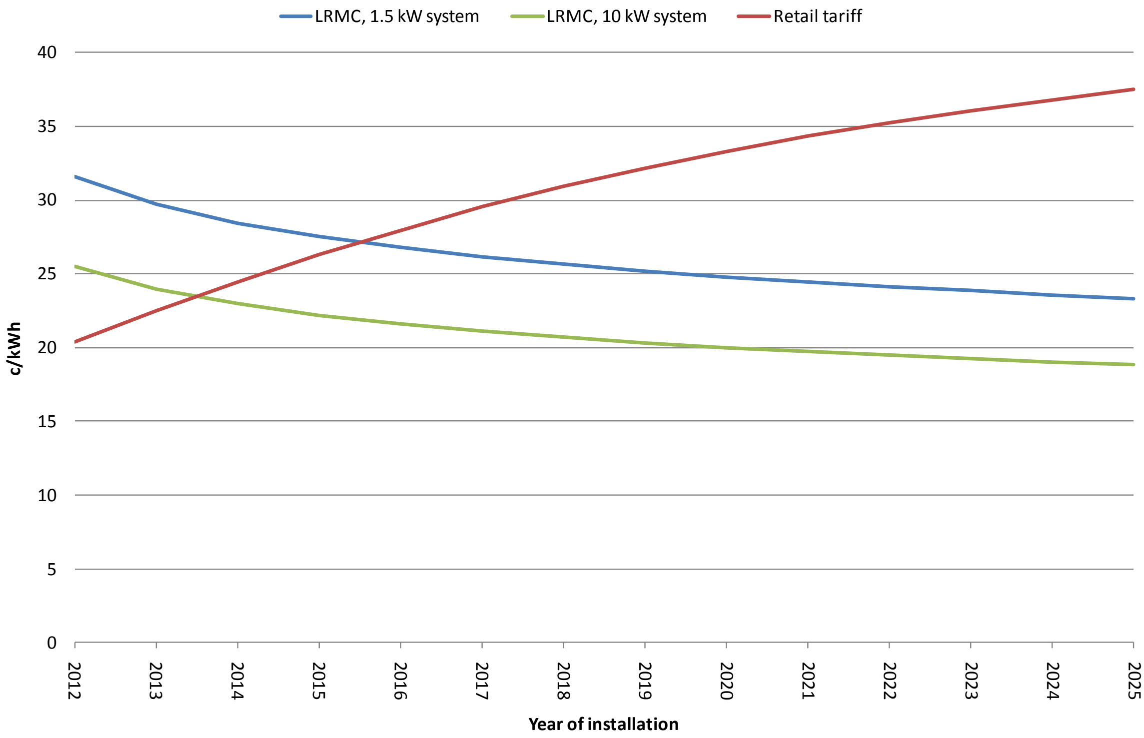
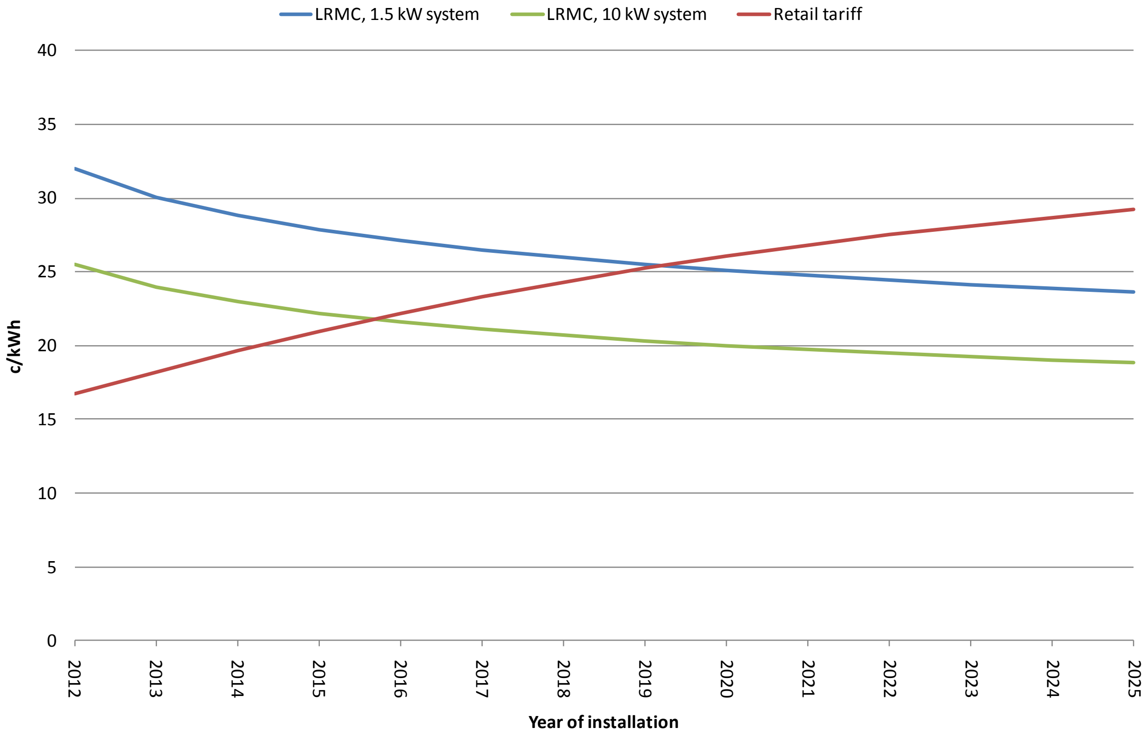
- **Figure 11: Long run marginal costs of generation in comparison with the average retail tariff**



Grid parity is typically interpreted as the time at which small scale PV generation becomes economic relative to alternative supply sources. However, the results should be interpreted with care when used for this purpose. First, the idea behind the concept of grid parity is that customers would avoid paying the retail tariff. But the retail tariff could include a fixed component, which is paid regardless of how much electricity is purchased. Fixed components typically cover part of the network fees. Thus, the avoided component of retail tariffs is likely to be smaller than indicated by the average tariff level. Second, some of the output of a PV system would be exported rather than offset host load. The assumption is that the value of this exported electricity is similar to the average retail tariff, which may not be the case.

A better measure of competitiveness is against the weighted average return, where the average return is weighted according to retail price for internal use and the export price for net exports. This comparison is shown in the following chart. Using the weighted average unit, the point of breakeven with long run marginal cost is pushed out by 2 to 5 years to mid to late this decade.

▪ **Figure 12: Long run marginal costs of generation in comparison with the weighted average return**



Source: SKM analysis. Weighted average return is calculated as: Average retail price * (1-export proportion) + Export price * (export proportion). The export proportion is assumed to be 26% for a 1.5 kW system and 42% for a 10 kW system.

4.4. Payback period analysis

A number of scenarios have been tested to determine the value of a premium tariff, with results presented in Table 3. The results indicate the premium rate required to be paid over the assumed payback period to achieve the target payback rate.

The results indicate that to achieve payback period of 7 years, with payments occurring for the 7 years, would require significantly higher premiums compared to longer payback periods and compared with previous feed-in tariff schemes in Australia. The premium required to achieve a 7 year payback would represent an increased burden for funding of the scheme (whether through taxpayer funding or with costs passed onto electricity consumers)[10].

[10] The premium will be declining over the life of the payments as the real value of electricity increases.

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- **Table 3 Required premium rate, 2 kW system installed in 2011/12**

Payback Period	Total tariff c/kWh ($)	Premium rate (1st Year) ($)
7	71	60
8	54	43
9	40	29
10	29	18

Source: SKM analysis. Assumes the value for net exports with average export amount of around 33% for a 2 kW system. Premium rate refers to the total tariff minus the value of exports to the market, calculated to be around 10 c/kWh in 2012.

As long as the wholesale value of exports has been calculated correctly, the impost to electricity consumers is not the level of the total tariff but the net level (i.e. the premium rate after the export value deducted from the total tariff) referred to the premium rate in Table 3. For a 10 year payback period, this rate is around 20 c/kWh.

The level of the premium required is also a function of the level of other Government rebates particularly the upfront income earned under the multiplier arrangements of the SRES scheme. The earning falls sharply over the next three years as the multiplier reduces. Thus, this means that a higher premium will be required to achieve a specified payback period unless an equivalent cost reduction in PV systems can be achieved. From 1 July 2011, the multiplier falls from 5 to 3, and then reduces to 2 from 1 July 2012. The latter means a reduction in the upfront rebate of $1,200 for a 2 kW system requiring a reduction in unit system costs of 20% to compensate.

The payback period achieved as a function of year installed and premium rate is shown in Table 4. The analysis indicates that premiums of at least 30 c/kWh is required for system sizes of 2 kW for a 10 year payback period to be achieved for systems installed from 2013 onwards. The rate required to achieve a 10 year payback decreases over time.

The analysis is complicated by the fact that the results are highly sensitive to a number of key factors. For systems installed from 2013, the degree of sensitivity is indicated by:

- The premium rate required for a 10 year payback is not very sensitive to the level of exports. For a 2 kW system installed in 2013, the level of tariff fall by around 5 c/kWh (to 25 c/kWh) if net exports increase to 40%. The analysis is complicated because the premium rate at a lower level than 30 c/kWh increases the payback period when the rate is applied on a net basis, since the overall payment on exports is lower than the rate of internal electricity usage (which is equivalent to the retail tariff).

- If installed costs fall by 40% over the period to 2020 (instead of 30% as assumed in the analysis above), the level of premium required falls to around 20 c/kWh for systems installed in 2013 to 10 c/kWh for systems installed in 2016.
- **Table 4: Pack period (years) for 2 kW system achieved as a function year of installation and premium rate**

Year installed	Premium rate, c/kWh					
	10	20	30	40	50	60
2012	12	11	10	9	8	8
2013	12	11	10	9	9	8
2014	13	12	11	10	9	8
2015	12	11	10	9	9	8
2016	11	11	10	9	8	8
2017	11	10	9	9	8	8
2018	10	10	9	8	8	7
2019	10	10	9	8	8	7
2020	9	9	9	8	8	7

Calculated for a 1.5 kW system, with average capital cost reductions averaging 30% in real terms in the period to 2020.

Assuming a premium rate of 20 c/kWh to 30 c/kWh would lead higher costs to either the Government or to other customers. Based on an uptake rate of between 50,000 to 100,000 units of around 2 kW in size and 30% net exports leads to estimate of the costs ranging from:

- $9 million to $18 million per annum respectively at a 20 c/kWh premium rate.
- $14 million to $ 27 million per annum respectively at a 30c/kWh premium.

5. Policy Levers

5.1. Tariff Design

Based on analysis of potential implications of various tariff schemes, as well as international experience, SKM recommends a constant, fixed rate tariff over the duration of the scheme based on a volume weighted average of the real value of electricity exported to the grid plus a premium for installation where the government will not subsidise the cost upfront. This type of tariff would provide[11]:

- Decreased difficulty for consumers in forecasting returns[12].
- Harmonisation with other states and territories.

System costs are expected to decrease during the duration of the scheme. Indeed, an objective for paying the premium is to allow the industry to learn by doing and to achieve economies of scale so costs reduce over time to the point that the industry becomes sustainable. This creates issues of the incentives to pass cost reductions onto consumers. Since the duration of the scheme will be set in advance then a 'tapering off' of the scheme through reducing tariffs is relevant. The tapering of the tariff would apply to new installations in the year the tariff applies. The duration of payment should be equivalent to the payback period required.

We suggest a tariff arrangement as follows:

- A tariff to apply to net exports equal to the calculated value of the net exports to the market. This value would be reappraised periodically by IPART following a predetermined formula of the components of the value.
- Consideration be given to having different values on a regional basis to reflect the higher value of net exports in some regions. Although this would provide a greater coincidence of market value by region, it comes at a cost of increased complexity.
- If the Government desires to develop the industry, then a premium rate is applied to net exports. The premiums would only be paid over the appropriate payback period, which is probably 10 years to minimise the cost and to optimise uptake rates. The premium would fall over time based on the year of installation.

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[11] When compared with variable tariff schemes.
[12] Under a feed-in tariff scheme the majority of uncertainty in forecasting returns results from the inability to accurately predict output from the PV system. This uncertainty is further enhanced under a net-metering scheme since consumers would be required to forecast output as well as consumption. A feed-in tariff scheme which fluctuates based on the price of electricity would increase the difficulty in forecasting returns as well as be difficult and expensive to administer.

Under this type of scheme, consumers are paid a fixed tariff regardless of time of generation or time of use, therefore there is still an incentive to reduce consumption during peak periods since owners will be paid for next exports to the grid and it is likely that a significant proportion of generation will occur during some peak periods.

5.2. Cost impacts of the scheme

5.2.1. Who should pay the tariff?

The Council of Australian Governments (GOAG) have established a number of agreed principles regarding the implementation of a premium on energy generated which state that any jurisdictional or cooperative decisions must:

- Be a transitional measure with clearly defined limits;
- Undertake analysis to establish benefits and costs of any subsidy against the objectives of that subsidy (taking into account other complementary measures in place to support small renewable consumers);
- Give explicit consideration to compensation from public funds or specified levies rather than cross subsidisation by energy distributors or retailers; and
- Not impose a disproportionate burden on energy consumers without small renewable generation.

SKM has been engaged by the Clean Energy Council to provide information on the potential cost impacts of a net metering scheme with a premium that would ensure a payback period of between 7 and 10 years after installation. The duration of the scheme will be clearly defined, and hence will meet the COAG agreed requirement for subsidies to ‘be a transitional measure with clearly defined limits’.

There are a number of options as to who should subsidise/pay for the cost of a tariff rate, as outlined below:

- A subsidy paid by the electricity retailers or distributors;
- A levy on all consumers of conventional electricity; or
- Government budget allocation (NSW Government, 2009).

The real value of electricity should be paid for by the retailer since PV systems supply energy in a similar manner as through conventional mechanisms, with these costs passed on to consumers through retail margins. If calculated correctly to the real market value, this should not add to the cost paid by electricity consumers.

The issue of contention is who should subsidise the value of the tariff premium. The merits of each option are further discussed below. It should be noted that a subsidy paid by electricity retailers or distributors would impose unfair costs on the shareholders of these businesses (NSW Government, 2009).

5.2.2. A levy on all consumers of conventional electricity

The total cost of a premium rate depends on the scheme design, tariff rate and level of uptake. In South Australia, the cost of premium tariffs is estimated to have comprised approximately 0.5 per cent of an average household electricity bill (Garnaut, 2011). In NSW, previous more generous tariff rates[13] were forecast to add between 5 to 10 per cent to retail electricity prices in 2011/2012 if the scheme had continued, which led to the decision for subsidy of the scheme from the state budget in order to avoid an unfair burden on electricity consumers (Garnaut, 2011).

Consumers of electricity which is derived from conventional sources are in effect generating negative environmental externalities. Therefore it may be argued that higher retail electricity tariffs from any premium scheme would represent the social cost of electricity consumed, since producers of PV generated electricity are generating electricity from renewable sources. However, assuming a carbon trading scheme is applied with costs incurred through higher electricity prices, then consumers would already be paying the social cost of electricity. The tariff premiums would therefore, place an unfair burden and on these consumers.

The decision between a socially optimal level of consumption and access to electricity represents a trade-off between efficiency and equity, which must be considered by the NSW government when deciding how the tariff premium is subsidised.

5.2.3. Government budget allocation

According to the NSW Government (2009), government subsidisation is unachievable due to the state’s narrow revenue base and cyclical and structural budgetary imperatives. However, the issues of equity raised may provide some merit for re-consideration of funding of the tariff premium. Furthermore, there are issues of access which should be considered, further discussed below.

5.2.4. Access to the scheme

Assuming a scheme where a premium is applied over 7 to 10 years to cover the cost of installation for consumers, there arises some issues of access to the scheme for consumers who will not be able to provide the upfront funds required for installation. If the government’s objective is to ensure full access to the scheme, then a more appropriate approach would be to consider subsidising the cost of installation upfront (similar to previous government rebates). Consumers would only receive compensation from retailers for the real value of exports (i.e. the tariff premium would be

[13] When compared with South Australia.

removed). This type of scheme may be ongoing with no end-date, since consumers would continue to supply electricity to the grid and subsequently to retailers. However, there would need to be regulatory measures to ensure that retailers continue to pay consumers for the value of electricity to the grid as opposed to 'free-riding' off owners of PV systems.

Our analysis indicates that an initial subsidy for installation would be most appropriate in terms of equity and access to the scheme. Failing this, a tariff premium which is government subsidised is favourable when compared to installation which is subsidised by electricity consumers. It should be noted that the tariff premium will not change regardless of how it is funded. Any rebates should be set to a maximum allowable amount based on current prices, but vary where costs of installation may be lower. Since the tariff would represent only the real value of exports and not a fixed premium to cover installation, this would provide incentive for producers of PV systems to pass on any cost savings for installation.

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