Assessing the impacts of Feed in Tariffs and metering configuration (gross or net), on the payback period for an average Solar PV system in Metropolitan Melbourne

Author Darren Bailey B.Sc. (Hons)
Student 30235339
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Declaration

This study is the authors own assessment of the impacts of feed in tariffs and metering configuration on the payback period for an average solar PV system in metropolitan Melbourne. Where the author has relied on information or work of others this has been appropriately acknowledged.
Abstract

With an increasing customer focus on renewable energy and the perceived benefits from widespread solar photovoltaic (PV) generation there has been a rapid increase in the number of solar PV system installed across Australia during 2008 and 2009.

Debate has continued regarding the most effective configuration of a Feed in Tariff with both gross and net metering identified as the most effective depending on the goals of the scheme. The Victorian Government have proposed a net Feed in Tariff set at $0.60 per kWh to meet the goals outlined by the Premier, John Brumby.

In this dissertation, the metering data obtained from over 125 existing Solar PV customers is analysed and the payback periods for a PV system is calculated at a range of Feed in Tariffs based on the modelling developed for the Victorian Government.

The existing models are extended to include a range of Feed in Tariffs and, secondly, data assumptions from the models are tested using actual customer data from PV sites to calculate a range of payback periods at different tariff and metering configurations.

The results show that the proposed $0.60 per kWh net Feed in Tariff will be the most effective to meet the goals defined for the scheme, but this result is achieved despite inaccurate data assumptions.

The metering configuration and Feed in Tariff value have significant impacts on the payback periods and variations in a customer’s energy usage profile will have large impacts on the payback periods.

It is also identified from the customer data that solar PV will have a minimal impact on reducing peak load demands across the energy network.
Acknowledgments

As author, I would like to acknowledge the support provided from the project sponsors Dr Trevor Pryor and Dr Martina Calais from Murdoch University as well as Dr Muriel Watt from UNSW whose discussions at the start of the project helped clarify and shape the direction as well as helping limit the wide scope to a manageable level.

I would also acknowledge the support from my employers Jemena and the United Energy Distribution network whose data was used for the analysis.

Finally, I would like to thank my partner Lucy King for her support throughout the project and weekends and evenings will no longer be spent reviewing spreadsheets and data and we might now have opportunity to get some more renovations completed.
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1 Introduction

1.1 Background

Victorian customers have long benefited from a readily available cheap electricity supply delivered from the large, brown coal fired, base load generators located in the Latrobe Valley, 60km to Melbourne’s east. With this plentiful supply, Victoria has had little incentive to invest in other energy supply sources and the higher cost of renewable energy has long been referenced against the existing cheap and reliable supply.

To meet increasing energy supply needs, smaller gas powered peak generation plants have been developed over the last 10 years. With a higher fuel cost, the gas powered generation plants are only operated during periods of high wholesale electricity prices coinciding with high demand on the network.

Network investment has connected the South Australian, New South Wales and Tasmanian energy networks enabling power to be transferred across the National Energy Market to meet end user supply needs in multiple states.¹

With the Federal Governments ‘Solar Homes and Communities Plan’² a rebate of up to $8,000 has been available for the purchase and installation of a household Solar PV system. With an original aim to install 3,000 PV systems over a 5 year period, the rate of installation remained low between 2000 and 2007 (refer to Figure 1).

With the change in Federal Government in 2007, the rebate was increased from the original $4,000 to $8,000 and Figure 1 shows the number of applications for the rebate increased significantly\(^3\). This $8,000 rebate was unexpectedly withdrawn in June 2008 and replaced with the Solar Credits program offering a grant up to $5,000. The calculations used in this study are based on the $8,000 rebate available at the time of installation.

This increase has occurred with Federal and State Government policy still debating the tariff value in price terms, of the electricity being fed back into the grid and the possible

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\(^3\) Australian Government, Department of Environment Water Heritage and the Arts, 2009, Solar Homes and Communities Plan ‘applications grew to...approximately 6,043 per week in May 2009’ and the scheme closed with 63,000 applications to be processed.


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implementation of a defined Feed in Tariff, but without confirmed dates for implementation of a Feed in Tariff scheme.

Providing clarity in relation to the value and configuration of a Feed in Tariff will provide customers the certainty required to assess the environmental and financial impacts from an investment in a Solar PV system.

The Victorian Government through its Department of Primary Industries (DPI) have regulated since 2008 that customers received a ‘fair price’ for the power they exported back to the grid. This price has remained the same as the retail tariff the customers pay for their electricity, effectively providing a net overall outcome and an extended payback period taking into account GST which is applicable on both the energy consumed and fed back to the grid as the customer receives a net outcome.

In 2008, the Premier of Victoria, John Brumby outlined the principles required for the introduction of a new Feed in Tariff in Victoria which would have to meet the goals shown below in Figure 2, and which would define the price a customer would receive for their exported electricity.

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4The Department of Primary Industries is responsible for agriculture, fisheries, earth resources, energy and forestry in Victoria, Summary of DPI’s Feed in Tariff forum which discussed the fair price and values for a Feed in Tariff is found at, http://www.dpi.vic.gov.au/dpi/dpinenergy.nsf/LinkView/51D88B7390CE8683CA257457000CDFF74CAC723B1D53BD66CA25740C000D2004/$file/Stakeholder%20Forum%2028%20Sept%202007%20Summary.pdf

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Figure 2

Government goals for a Feed in Tariff

- Stimulate the use of renewable energy
- Create jobs
- Help Victorians reduce their carbon footprint
- Safeguards to ensure the schemes cost to Victorian’s does not exceed $10 per year
- Promote renewable energy and ensuring vulnerable Victorians would not be hit by high electricity prices

The calculation of the payback period for the PV system was also factored into the goals to ensure it would be financially worthwhile to install a PV system. Extensive modelling was then undertaken to review the options available and to determine a preferred approach.

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1.2 Research Focus

This study will use customer metering data obtained from existing solar PV sites to assess the impacts on the payback period of variable Feed in Tariffs as well as the impacts due to the metering configuration at the site.

The payback periods will be assessed by extending the existing Feed in Tariff modelling and then through the use of the customer data in place of the modelling assumptions. The study will then review the accuracy of the data assumptions used for the modelling.

The data obtained from existing gross and net metered sites for the 2008 year, will then be used to assess the effectiveness of solar PV as a demand management tool in reducing peak energy load on the electricity network.

Specifically this study will address the following questions:

1. What are the impacts on the payback period from variations in the tariff rate of a Feed in Tariff and in variations in the metering configuration, based on both the existing modelling assumptions and then using actual customer data?
2. What is the most effective Feed in Tariff configuration to meet the goals outlined for the implementation of a Feed in Tariff scheme in Victoria?
3. Is solar PV an effective demand management tool to assist the electricity network to meet its peak load periods?

This study will also review the potential impacts to customers’ usage profile from installing a solar PV system and recommend further areas of research to fully assess the impacts from the introduction of the proposed Feed in Tariff.
1.3 Document Outline

An overview of Feed in Tariffs and metering configuration is provided in Section 2, with the models used for the study described in Section 3. Section 4 (Pricewaterhouse Coopers (PWC) model) and Section 5 (Department of Primary Industries (DPI) model) are the key sections where the original models are extended with additional Feed in Tariff values and then the model data is replaced with the actual customer data and remodelled. The outcomes at this point enable the analysis of both the accuracy of the models as well as the realistic timeframe a customer should expect to payback their system. Section 6 analyses and summarises these outcomes and uses the data obtained to review consumption levels in the previous year, as well as the effectiveness of PV as a demand management tool. Section 7 identifies whether the aims for the study have been achieved before finally Section 8 outlines the conclusions as well as recommendations for further study.
1.4 Limitations

To enable the study to use data obtained from existing solar PV customers, the metering data was analysed and then summarised into average hourly, daily, monthly and annual consumption and export. In excess of 4.5 million half hour meter reads were used in calculating the usage profile of an average PV customer.

For the study, the customer data has been de-identified so the site specific customer circumstances and energy usage profile have not been able to be explored.

The metering data has been obtained for the year 2008 and any seasonal or climate variations during that year could have a disproportionate impact on the outcomes of this study. Data obtained over a longer timeframe will remove this risk however it is generally not available due to the recent installation of the PV systems.

The access to some of the Government modelling detail remains confidential and is restricted, however as this assessment uses only the payback periods and customer metering data, it is not expected that this restriction will have caused any significant influence to the final results.
2 Overview of Feed in Tariffs and Metering Configuration

2.1 Current Status

The Victorian State Government through its Victorian Greenhouse Strategy\(^6\) implemented legislation from which a Feed in Tariff will provide a guaranteed rate for any solar PV generated electricity exported back to the grid. The development of the Feed in Tariff has its origin at the stakeholder forum hosted by the Department of Primary Industries (DPI) in 2007 to principally discuss Feed in Tariffs.

With an increasing level of small scale distributed generation being installed, the DPI wanted to ensure there was a clear understanding across the energy industry as to how these sites would be managed in a fair and consistent manner in regards to the electricity exported.

The ‘fair and reasonable’ criterion developed at the forum enabled customers and retailers to have some certainty regarding tariff rates and processes. However these outcomes did not lead to a major increase in the take up of solar PV, possibly due to the tariffs agreed simply matching the retail tariffs, with a credit applied at the value as the customer’s retail tariff for any electricity exported.

The outcomes from the forum (see Figure 3) provided the DPI with the basis to develop a Feed in Tariff that would meet both the stakeholders’ requirements as well as meeting the yet to be defined Government policy.

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Figure 3  Summary of key outcomes from DPI’s Feed in Tariff Forum

- Gross metering gives the necessary payback certainty
- Net metering disadvantages smaller systems and users who are home during the day
- A premium Feed in Tariff is necessary to promote such uptake of small scale renewable technology such as PV.
- A payback period of not more than 15 years is necessary

The DPI were therefore tasked with developing a Feed in Tariff taking into account the goals outlined by the Premier (refer Figure 2) as well as from the earlier Stakeholder forum (refer Figure 3).

To balance these outcomes and to determine the preferred approach, a range of modelling was commissioned by the DPI including from McLennan Magasanik Associates (2008)\(^9\), Pricewaterhouse Coopers (2008)\(^10\) as well as detailed report from Firecone Ventures Pty Ltd (2008)\(^11\) regarding options to increase the take up rate of solar PV.

\(^7\) Outcomes of DPI forum were that a ‘fair and reasonable’ rate was paid for the exported electricity. In effect the customer would receive the same value as the energy they bought from their retailer, with the credit and debit calculations on the customer’s electricity bill.


\(^8\) McLennan Magasanik Associates, August 2008, Final Report to Victorian Department of Primary Industries - Benefits and Costs of the Victorian FIT Scheme, Department of Primary Industries


\(^9\) McLennan Magasanik Associates, November 2008, Final Report to Victorian Department of Primary Industries - Benefits and Costs of the Victorian FIT Scheme, Department of Primary Industries


\(^10\) Pricewaterhouse Coopers, 2008, Net Metering Analysis


\(^11\) Firecone Ventures Pty Ltd, 2008, Options to increase the update of small-scale solar power by Victorian households, Firecone
Payback period calculations were provided in both the PWC as well as the DPI modelling\(^\text{12}\) which also assessed the financial impacts to all customers.

The model outcomes led to a proposed net metered, Feed in Tariff at $0.60 per kWh. With the aim to deliver the goals outlined by the Premier of limiting the impacts to other Victorian customers as well as with a payback period of less than 15 years.

The payback period was calculated to ensure the system had been paid back within the 15 year life cycle of the proposed Feed in Tariff scheme and is calculated based on the customers financial outlay for the system after rebates, and then the timeframe required to payback this balance from the gains of their solar PV system.

The modelling assumptions provide the basis for this study, and the impacts on the payback period for an average solar PV system can be determined at variable Feed in Tariff values and with different metering configurations.

The assumptions are based on available industry data and the limited previous solar PV payback period analysis including work from Watt, Passey, Barker and Rivier (2006)\(^\text{13}\) which did not explore such customer numbers to understand the usage profiles across a range of solar PV customers.

Solar PV has also been identified as a possible option to help reduce the peak load during the hot summer afternoons when the network is at its most constrained and this study

\textbf{References:}


\(^{13}\) Watt, M., Passey, R. Barker, F. and Rivier, J., 2006, Newington Village – An Analysis of Photovoltaic Output, Residential Load and PV’s ability to Reduce Peak Demand, Report for the NSW Department of Planning, Centre for Energy & Environmental Markets, UNSW Sydney
expands on previous works from Borenstein (2005)\textsuperscript{14} and Pop (2005)\textsuperscript{15} to examine the peak load and export timeframes to assess the effectiveness of PV as a demand management tool in reducing demand on the network at peak times.

\section*{2.2 Metering Configuration Overview}

A residential roof top solar PV system has its optimal placement on a north facing sloping roof, angled perpendicular towards the maximum sunlight.

The installation and wiring of the PV system by the registered installer and its connection to the electricity network will determine whether it will be gross or net metered. In both cases the electricity exported back to the grid is measured with an interval based electricity meter installed to record data every 30 minutes.

The electricity meter also records the customers’ household consumption from the network and it is this usage data that is extracted and provided to the customer’s retailer for tariff billing purposes.

The volume of generated electricity exported and receiving the value of the Feed in Tariff will depend on whether the site is net or gross metered as seen in Figure 4 and Figure 5. The value received for the exported electricity will directly impact the payback period for the installation.

The gross metering configuration shown in section 2.2.1 exports all the generated electricity directly to the grid, with the meter measuring the export and consumption data

\textsuperscript{14} Borenstein, S, 2005, \textit{Valuing the Time varying Electricity Production of Solar Photovoltaic Cells}, Centre for the Study of Energy Markets, University of California

\textsuperscript{15} Pop, M., 2005, \textit{The Value of Distributed Urban Residential PV Electricity in the Australian NEM}, Practicum report, Centre for Energy & Environmental Markets, UNSW Sydney

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at the two measuring elements within the meter. The separate elements ensure that the 30 minute meter reading data is measured independently and it is the exported electricity that receives the value of the Feed in Tariff.

A net metered configuration (section 2.2.2) has the PV system connected directly to the customers’ switchboard and the PV generated electricity first supplies the internal consumption needs. It is only when the system is generating more than is being consumed internally that the excess electricity is exported to the grid. As with a gross metered site the separate measuring elements ensure the data is clearly separated into export and import.

With an average PV system generating the same amount of electricity regardless of its metering, the gross metered site will export more power directly to the grid and will have a greater benefit from a Feed in Tariff and a lower payback period than in a net site where it is only the excess power exported back to the grid and hence receives less overall value.

The impact on the payback period will be impacted by both the value of the tariff as well as the metering configuration.
2.2.1 Gross Metering

The rooftop generation system is connected directly to the Co-Generation meter, which measures both the import and export electricity through the meter on a separate measuring element.

All generated electricity is exported directly to the grid and the internal household consumption is supplied directly from network via the meter and the customers’ switchboard.

Figure 4  Diagram of a Gross metering configuration

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Item A: Measurement Element 1, measures the customers normal consumption main. Interval Channel 1 is assigned to measurement element 1 that records the customers total consumption (export energy).

Item B: Measurement Element 2, measures the energy generated by the customers generation system. Energy is measured via the generation system’s output cable that is directly connected to a separate terminal within the meter. Interval Channel 2 is assigned to measurement element 2 to record the total energy generated by the customers generation system (import energy).

Item C: Generation System output cable that is connected directly to a meter for the purpose of measuring and the energy generated by the generation system.

Item D: Customer normal consumption main that is connected directly to the meter to measure and record energy consumed by the customers load.

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16 Perez, F. 2009, Internal Jemena document, not available externally

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2.2.2 Net Metering

The net metered system connects the rooftop generation firstly to the customers’ switchboard, which provides electricity supply to the house.

Any excess electricity that is not used internally is exported to the grid and measured at the meter. When the PV system is not generating the household load requirements are met with the electricity supplied directly from the grid.

Figure 5 Diagram of a Net metering configuration

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Legend

Item A:
Measurement Element 1, measures the customer’s net import and export energy and is recorded in separate interval channels. Interval Channel 1 is assigned to record net export energy while interval channel 2 records net import energy (excess generation to distribution network).

Item B:
Generation System output cable is connected directly to the customers switchboard.

Item C:
Customer normal consumption main is connected directly to the meter to allow a circuit path for net export and net import energy.

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17 Perez, F. 2009, Internal Jemena document, not available externally

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2.2.3 Summary

With the existing value for the Feed in Tariff at the same level as the retail tariff with GST being paid on both, the overall financial impact from both metering configurations is the same. At this level the energy used internally and not exported is valued at the same rate as the exported energy and there is no impact on the payback period from either metering configuration and the payback period is based on how much is generated.

In 2008 the average Victorian energy tariff valued this exported power at $0.158 per kWh\(^{18}\) with this rate applied to both the exported electricity as well as the electricity used to offset consumption from the grid. The introduction of an increased value for a Feed in Tariff will provide a value differential between the retail tariff and the exported electricity with the exported electricity becoming more valuable.

Setting an appropriate value for the Feed in Tariff will be critical to deliver the goals of the scheme highlighted in Figure 2, as well as providing a price differential as an incentive to export more electricity to the grid.

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2.3 Data Collection Process

With the installation of a solar PV system connected to the grid, the electricity network is required to install an Interval electricity meter to measure the imported and exported electricity in 30 minute intervals. This ‘interval’ data is then downloaded from the meter quarterly by the meter reader and provided in the agreed industry format to the retailer for the calculation of the customer’s retail bill.

With multiple network businesses and retailers across Australia, a consistent data delivery format is required to enable the automated processing of this data. The data formats are outlined by the Australian Energy Market Operator (AEMO) in the ‘MDM File Format and Load Process document19. It is from this agreed format that the data for each site has been extracted and converted into a usable MS Excel format. The data was extracted from network billing data files used to provide the interval data to the electricity retailers for billing purposes.

With every PV customer having an interval meter installed ensuring that the full data set is available for the 2008 period is critical in providing the required level of data for this study.

2.4 **Methodology**

2.4.1 Sites

The electricity distribution business United Energy Distribution\(^{20}\) (UED) supplies electricity to approx 600,000 customers across the South East / Mornington Peninsula areas of Melbourne.

The Solar PV installer on behalf of the customer will have requested the type of meter to be installed to meet the wiring requirements for the site and a gross or net meter will be installed as per this request. This decision is at the request of the customer’s electrician or installer with the network company installing the meter to fit this request.

Whether a site is net or gross metered is then tracked via the customer’s meter number and it is this meter identifier that has been used to identify the sites used for this study.

To enable the data to be available for 2008, the customers must have had an interval meter installed prior to December 2007.

From 2007, the majority of new PV installations have been net metered and the volume of gross metered sites available for review were significantly lower than net metered sites.

A random selection of 75 gross and 75 net metered sites meeting the pre December 2007 installation criterion were obtained and the metering data files for the 2008 period were extracted from the data already provided to the customer’s retailer.

As this data is sent quarterly to the retailers, the existing quarterly files were extracted and formatted into a single file showing the full data for 2008.

Unexpected gaps in the data where no consumption or export was recorded as well as meters being changed, reduced the number of sites with full data for 2008 to 65 net and 64 gross metered sites. As only sites with a clear data history on both the consumption and export data streams were selected.

### 2.4.2 Data

The data is originally in a comma separated value or ‘csv’ format and was extracted into a Microsoft Excel spreadsheet enabling the easier analysis of the customer’s consumption and export.

This file results in two data streams (one for import and one for export) each day with 48 half hour individual meter readings for each stream. This is replicated across all 366 days of 2008 (Leap Year) and across all 129 meters used in this analysis.

With the data separated into half hourly readings the spreadsheets are used to do multiple calculations to determine the average customer data used for this study.

This includes

1. Total electricity consumption and total exported electricity from each site for the full period of 2008.

2. The daily average electricity import and export for each month at the 30 minute interval level.

3. Daily export and consumption profiles focussing on summer afternoon peak consumption between 2pm and 8 pm.
4. Identification of peak export periods for both net and gross metered sites.

An example of the ‘csv’ data format can be seen in Figure 6 where data is shown for the period 1 Jan 2008 through to 10 Jan 2008 for the 00.00 to 15.00 timeframes.

**Figure 6** Data extract from customer metering file – de-identified

<table>
<thead>
<tr>
<th>TransactionID</th>
<th>UNITEDDP-TXN-2635896</th>
</tr>
</thead>
<tbody>
<tr>
<td>File Contents</td>
<td></td>
</tr>
<tr>
<td>100.NEM16.20090501427.UNITEDDP.PULSE</td>
<td></td>
</tr>
<tr>
<td>300.2008D101,0,0,0,0,0,0,0,0,0,0,0,0,0,1,20,58,78,212,316,410,406,560,623,661,698,716,737,694,692,672,640,688,66</td>
<td></td>
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<tr>
<td>300.2008D102,0,0,0,0,0,0,0,0,0,0,0,0,0,1,12,46,96,200,330,403,507,550,625,577,715,742,750,750,749,720,692,649,592</td>
<td></td>
</tr>
<tr>
<td>300.2008D103,0,0,0,0,0,0,0,0,0,0,0,0,0,1,14,38,107,209,315,419,466,564,620,656,691,708,716,718,704,692,695,620,56</td>
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</tr>
<tr>
<td>300.2008D104,0,0,0,0,0,0,0,0,0,0,0,0,0,1,13,36,102,202,307,407,460,562,616,669,688,712,718,709,695,675,638,599,66</td>
<td></td>
</tr>
<tr>
<td>300.2008D105,0,0,0,0,0,0,0,0,0,0,0,0,0,0,10,32,95,203,311,410,497,567,626,669,697,716,724,721,710,680,644,601,548</td>
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<td>300.2008D108,0,0,0,0,0,0,0,0,0,0,0,0,0,1,41,90,140,138,176,354,356,371,544,547,576,709,774,753,726,696,653,600,5</td>
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<td>300.2008D110,0,0,0,0,0,0,0,0,0,0,0,0,0,0,10,34,95,198,307,409,491,467,571,656,691,713,724,720,710,687,654,617,559</td>
<td></td>
</tr>
</tbody>
</table>

Figure 6 shows a single data stream with the date followed by the ‘0’ values for the first 12 half hour readings before increasing in value. This is a typical profile of a PV site with no export over night and with the gradually increasing value of electricity exported towards the middle of the day this would indicate a gross metered site. The full daily data file can be seen in Appendix 4.

The electricity is measured in watts (W) over a 30 minute period and converted into kWh for the purpose of billing or crediting the customer.
2.5 Data Limitations

There are some key aspects which need to be taken into account regarding the data obtained for the 2008 period and the limitations it places on the accuracy of this analysis.

1. Firstly, the data has been assumed to be accurate and where estimated or substituted (calculated data where actual data is not available) data has been used within a data file, it is assumed to be an accurate representation of the consumption or generation at the site. Industry standards\textsuperscript{21} regulate the calculation methodology of this data and the data has been assumed to be accurate.

2. It is assumed that each solar PV installation has been installed by an accredited installer and has been located to maximise the effectiveness of the PV panels for the purpose of generating electricity.

3. For the purpose of this study the household consumption for net metered sites has been calculated as it is not directly measured by the network’s electricity meter.

   It is assumed that the average PV system whether gross or net metered will generate the same amount of electricity each year on average. The difference between the average amount exported from a gross site and amount exported from a net site has been calculated as the amount consumed internally.

   Some customers have installed their own meter on the inverter side of their PV system to measure the system output and enable them to calculate the internal consumption.

However as this study uses de-identified customer data this has not been further investigated.

Without network metering to record the levels of electricity generated from the PV systems at the net metered sites the chosen calculation method is the most reliable method where the actual data is unavailable; however it is also a limitation when trying to measure the effectiveness of the metering configuration and pay back periods and will become more of a problem when there are less gross metered sites to calculate the true output levels from the PV system.

4. For the purpose of this study, the installation configuration requested by the installer has not been audited and it is assumed that the metering is correct for the installed PV system.
3 Payback period and metering configuration review

3.1 Introduction

The purpose of this study is to assess the impacts on the payback period for an average Solar PV system installed in metropolitan Melbourne using variable tariffs for a Feed in Tariff and with either a net or gross metering configuration. This impact on the payback period has been assessed using existing modelling and then with actual customer data.

The development and configuration options for a possible Feed in Tariff in Victoria were outlined in the report by Firecone Ventures (2008)\textsuperscript{22} prepared for the Department of Premier and Cabinet. The report outlined opportunities to increase the uptake of solar PV as well assessing the impacts to a variety of stakeholders from the proposed changes. This study was followed with additional work by McLennan Magasanik and Associates (2008)\textsuperscript{23} and Pricewaterhouse Coopers (2008)\textsuperscript{24} to determine the most suitable Feed in Tariff for Victoria based on all the goals outlined by the Government and Stakeholders.

\textsuperscript{22} Firecone Ventures Pty Ltd, 2008, Options to increase the update of small-scale solar power by Victorian households, Firecone Ventures,

\textsuperscript{23} McLennan Magasanik Associates, November 2008, Final Report to Victorian Department of Primary Industries - Benefits and Costs of the Victorian FIT Scheme, Department of Primary Industries

\textsuperscript{24} Pricewaterhouse Coopers, 2008, Net Metering Analysis, Pricewaterhouse Coopers

Assessing the impacts of Feed in Tariffs and metering configuration (gross or net), on the payback period for an average solar PV system in metropolitan Melbourne
In their report Firecone Venture concluded that there was ‘no single correct answer to the case for a FiT (Feed in Tariff) or the detailed design of a Feed in Tariff’ as well as confirming that ‘the preferred approach depends on the weight placed on different policy objectives, and on the assessment of likely impact.’

The Firecone analysis had identified that the different policy objectives would determine the effectiveness of any proposed scheme and a single preferred option was not applicable in every case. As policy goals changed so would the preferred version of the tariff.

This study investigates the impacts on payback periods in respect of the Government goals and the modelling undertaken, through an expansion of the existing models to include additional tariffs as well as using the actual customer data to replace the modelled assumptions where applicable.

Modelling completed by Access Economics (2008) for the Clean Energy Council estimated the cost of a gross metered National Feed in Tariff to achieve both a 10 and 20 year payback period for a national scheme, whereas the Victorian models were based around the overall costs for a scheme and not just the payback periods.

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25 Firecone Ventures Pty Ltd, 2008, Options to increase the update of small-scale solar power by Victorian households, Firecone Ventures, pg 25

The previous modelling undertaken by Access Economics did not include the payback periods for a net tariff as at the time the consensus from Access Economics (2008) stated ‘The rapid take up in 2007 in countries applying gross Feed in Tariff programs, is evidence that the Gross Feed in Tariff approach is the prime mechanism for promoting grid-connected PV applications’.

However as noted by Firecone Ventures (2008) ‘the preferred approach depends on the weight placed on different policy objectives and not just on the perceived prime mechanism’ and both net and gross models were included in the subsequent work.

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28 Firecone Ventures Pty Ltd, 2008, *Options to increase the update of small-scale solar power by Victorian households*, Firecone Ventures
3.2 Models

Pricewaterhouse Coopers (PWC) was commissioned by the Victorian Government to assist the Department of Primary Industries (DPI) in the development of a Business Impact Assessment (BIA) to help the Victorian State Cabinet understand the consequences of introducing Feed in Tariff legislation.

The Business Impact Assessment (BIA)\(^{29}\) assessed the impacts from a range of different scenarios for the Victorian Feed in Tariff. It is against these modelled scenarios that the impacts on payback periods from tariffs and metering have been assessed using the existing models and customer data.

The two models used in this study for assessment are the Pricewaterhouse Coopers (PWC)\(^{30}\) and the Department of Primary Industries (DPI)\(^{31}\) models.

In both cases the existing modelling has firstly been expanded to include an assessment of the payback periods at an increased range of Feed in Tariffs and then secondly the actual customer data has been used in the model to determine the payback period which would be achieved if the Feed in Tariff was introduced now, based on the modelling.

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\(^{29}\) The BIA informs Cabinet of the consequences of the proposal and is a confidential document and has not been available for review as part of this study, although the summary model was published and is the basis for the scenarios.


\(^{31}\) Department of Primary Industries, 2009, *DPI_FitModelling_v2.xls*, Department of Primary Industries.
3.3 Assumptions

To develop the models, data assumptions were required where accurate information wasn’t readily available for the customer usage, output from the PV generation system and the amount of electricity exported back to the grid. During this study, accurate data was collected from all the sites and reviewed against the model data as part of the analysis.

Additional assumptions used in the models which will have an impact on the payback period are as below:

A) System Cost

The cost of installing a PV system was different in each model with the DPI using a $12,000 per kW cost, offset with the $8,000 rebate, giving a customer outlay of $4,000 for the purpose of the modelled 1 kW system.

The PWC model used a system cost of $12,500 per kW and an average 1.5 kW system, with the installed customer outlay equating to $9,490 after all rebates and credits were applied.

In both cases the PV system costs falls within the $4,000 to $7,000 per kW range previously estimated by Zahedi (2008)\(^3\), which was calculated, taking into account the cost of a national rooftop PV system.

The time taken to repay this initial outlay from the income generated by the Feed in Tariff determines the payback period for each model.

\(^3\) Zahedi, A, 2008, Development of an economical model to determine an appropriate feed in tariff for grid connected PV electricity in all states of Australia, Renewable & Sustainable Energy Reviews. Available to purchase from www.sciencedirect.com
B) System Output

The PWC modelling identified an expected output of 1400 kWh per kW\textsuperscript{33} per year with the average system size of 1.5 kW, equating to an annual expected output of 2,100 kWh per year.

The McLennan Magasanik Associates (MMA)\textsuperscript{34} research identified that the average output for a 1.5 kW system would be between 1,708 and 2,536 kWh per year and the PWC model has been based on these outcomes.

Additional modelling undertaken for the DPI\textsuperscript{35} used an assumption based on a 1 kW system generating 1,577 kWh per year or for a 1.5 kW system generating 2,365 kWh per year, which is at the upper range of the MMA modelling.

In the PWC and MMA modelling\textsuperscript{36} a ‘solar export factor’ of 30% has been used for the net metered sites, assuming that of the electricity produced by the PV system 30% of the production would be exported back to the grid and would receive the value of the Feed in Tariff. The DPI model in comparison assumes that 25% will be exported in a net model.

\textsuperscript{33}\textsuperscript{Department of Primary Industries, 2009, DPI_FitModelling_v2.xls, Department of Primary Industries.}

\textsuperscript{34}\textsuperscript{McLennan Magasanik Associates, November 2008, Final Report to Victorian Department of Primary Industries - Benefits and Costs of the Victorian FIT Scheme, Department of Primary Industries}

\textsuperscript{35}\textsuperscript{Department of Primary Industries, 2009, DPI_FitModelling_v2.xls, Department of Primary Industries.}

\textsuperscript{36}\textsuperscript{McLennan Magasanik Associates, November 2008, Final Report to Victorian Department of Primary Industries - Benefits and Costs of the Victorian FIT Scheme, Department of Primary Industries}
In a gross metered site all the production is exported so 100% receives the value of the Feed in Tariff.

For the modelling outcomes it is also essential to understand how much of the solar PV generated electricity is now not drawn from the grid as this reduces the customers’ retail bill by the value of the retail tariff for each kWh not supplied from the grid.

A variation in both Feed in Tariff and the customers’ retail tariff will impact the value returned each year which will impact the payback period for an average system.
4  Pricewaterhouse Coopers Modelling

Pricewaterhouse Coopers (PWC) reports on the expected payback periods, as well as the Net Present Value over the proposed 15 year lifetime of the Feed in Tariff scheme.

The PWC modelling \(^{37}\) was designed ‘to provide a cost benefit analysis of the introduction of the a [sic] feed in premium on electricity generated from solar panels’. The model included the expected costs associated with Government advertising as well as the benefits from reduced network losses and the community benefits through avoided greenhouse gas production.

Only the payback period and Net Present Values variations have been assessed in this expansion of the model using additional Feed in Tariff values against the modelling assumptions. The full Net Present Value results can be found in Appendix 9 – 12.

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\(^{37}\) Pricewaterhouse Coopers, 2008, Net Metering Analysis, Pricewaterhouse Coopers, pg 1
4.1 PWC Assumptions

The assumptions outlined in Figure 7 are a summary extracted from the PWC model\textsuperscript{38} and relate to the data used for modelling the payback period.

\textbf{Figure 7} PWC data model assumptions\textsuperscript{39}

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size of household PV System</td>
<td>1.5 kW</td>
<td></td>
</tr>
<tr>
<td>Average installed cost of PV</td>
<td>$12,500 per kW</td>
<td>MMA data</td>
</tr>
<tr>
<td>system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solar output</td>
<td>1400 kWh/kW</td>
<td>MMA assume 1708-2536 kWh per annum for a 1.5 kW system</td>
</tr>
<tr>
<td>Solar Homes rebate</td>
<td>$8,000</td>
<td></td>
</tr>
<tr>
<td>Household annual consumption</td>
<td>8000 kWh</td>
<td>Electricity distribution annual report 2008</td>
</tr>
<tr>
<td>2008/2009 Electricity Tariff</td>
<td>$0.174</td>
<td>VENCORP</td>
</tr>
<tr>
<td>GST included</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Installation date</td>
<td>2009</td>
<td></td>
</tr>
<tr>
<td>Solar Region</td>
<td>Victorian</td>
<td></td>
</tr>
</tbody>
</table>

The Net Present Value of the investment has also been calculated within the model using a discount rate 7.5% representing the rate of return that could be achieved on a similar risk investment. When the 15 year’s life cycle of the proposed scheme has been reached the Net Present Value at that time provides guidance as to whether it would financially beneficial to invest in the system than do nothing.

\textsuperscript{38}Pricewaterhouse Coopers, 2008, Net Metering Analysis, Pricewaterhouse Coopers

\textsuperscript{39}Pricewaterhouse Coopers, 2008, Net Metering Analysis Pricewaterhouse Coopers, pg 2.
A positive Net Present Value shows that it is better to invest than do nothing; where as a negative value shows it is better to do nothing than invest the initial financial outlay on the system based solely on a financial outcome using the rate of return and timeframe. Variation to the rate of return will impact the NPV, however for this study the sensitivity to these variations has not been considered.

The environmental or personal reasons for the investment are not included in the Net Present Value calculation. As can be seen in the summary of the original modelling in Figure 8 with a net metered site with 30% exported, the payback period is 13.60 years with a negative NPV. For this example it would be better to not invest in the scheme as the NPV is -$2557.

In the original PWC modelling it is only with a Gross metered (net with 100% export) with a payback period of 6.53 years that returns a positive NPV.

### Figure 8  PWC Model – Payback period summary

<table>
<thead>
<tr>
<th>Metering configuration</th>
<th>Feed in Tariff value ($)</th>
<th>Export rates</th>
<th>Simple Payback period (years)</th>
<th>NPV* (discount rate 7.5% over 15 years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>net</td>
<td>$0.16</td>
<td>30%</td>
<td>20.72</td>
<td>-$4,810</td>
</tr>
<tr>
<td>net</td>
<td>$0.44</td>
<td>30%</td>
<td>15.79</td>
<td>-$3,403</td>
</tr>
<tr>
<td>net</td>
<td>$0.60</td>
<td>30%</td>
<td>13.60</td>
<td>-$2,557</td>
</tr>
<tr>
<td>net</td>
<td>$0.60</td>
<td>100%</td>
<td>6.53</td>
<td>$2,690</td>
</tr>
</tbody>
</table>

---

40 Pricewaterhouse Coopers, 2008, *Net Metering Analysis,*

Assessing the impacts of Feed in Tariffs and metering configuration (gross or net), on the payback period for an average solar PV system in metropolitan Melbourne
* The PWC model NPV calculations include cost of advertising, scheme implementation and avoided cost of carbon abatement.


4.2 Actual customer data

With the PWC model to assess the impacts on the payback period, there are two immediate areas where the actual customer data differs significantly from the modelled assumptions.

In Figure 7, the household annual consumption of 8000 kWh obtained from Vencorp\(^{41}\) has been used for the average customer. However the customer data shows an average annual consumption of 5392 kWh in a gross metered site with the calculated annual consumption at a net metered site of 4792 kWh.

In both metering configurations the average annual consumption of a solar PV customer is lower than the average non PV customer, but also there is an additional difference in the annual consumption of a PV customer based on their metering configuration.

The previous modelling (DPI and PWC) assumed that the consumption level is based on the ‘average electricity customer’ whereas it can be seen that a solar PV customer has lower than average consumption.

This variation is an important factor in assessing the impact of the Feed in Tariff on the payback periods as the lower overall consumption will impact the level of electricity exported to the grid and hence the value generated.

The second key difference from the modelled assumption is with the electricity generated from the average PV system. This is assumed to be 1400 kWh per kW per year which is significantly higher than the actual customer data showing a calculated output of 1110 kWh


Restructure of the market operations company has merged Vencorp into the Australian Energy Market Operator (AEMO), www.aemo.com.au and the report no longer appears to be available online.
per kW. This has been calculated from the average gross system output of 1667 kWh per year for a 1.5 kW system.

The immediate impact to the model is that the average solar customer uses less power than the model, but also that the PV systems generate less than anticipated. With the payback period reliant on the volume of electricity being exported this will have a negative impact on the payback period.

As there is no direct measurement of the internal electricity usage from a net metered site used for this study, it has been calculated as the difference between the exported amount from a gross site and the exported amount from a net site with the difference having been consumed internally.

For the purpose of the model this difference is as follows:

\[
1667\text{kWh (average gross export)} - 798\text{kWh (average net export)} = 869\text{kWh used internally per year}
\]

When calculating the total consumption for a net metered customer, this calculated internal usage is added to the consumption recorded on the meter, providing an overall level of electricity consumed.
Assessing the impacts of Feed in Tariffs and metering configuration (gross or net), on the payback period for an average solar PV system in metropolitan Melbourne

4.3 Gross Metered Sites

4.3.1 Modelled data

The PWC model only assessed the payback period at the single Feed in Tariff value of $0.60 for a gross metered site.

However to assess the impacts on the payback period at a range of Feed in Tariffs the original $0.60 has been replaced in the model with additional values with the payback periods and Net Present Value summarised in Figure 9, with the full data available in Appendices 5 to 8.

The payback period correlates directly with the level of the Feed in Tariff. With the PWC modelling assuming an annual generated export of 2100 kWh per year the higher the tariff, the quicker the payback period for the $9,490 outlay.

Figure 9 Extended PWC gross model – payback period summary

<table>
<thead>
<tr>
<th>Feed In Tariff rate</th>
<th>$0.44</th>
<th>$0.60</th>
<th>$1.00</th>
<th>$2.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payback period years.</td>
<td>10.27</td>
<td>7.53</td>
<td>4.52</td>
<td>2.26</td>
</tr>
<tr>
<td>NPV (discount rate 7.5% over 15 years)</td>
<td>-$381</td>
<td>$2,690</td>
<td>$10,369</td>
<td>$29,566</td>
</tr>
</tbody>
</table>

With the proposed Feed in Tariff scheme lasting 15 years, a $2 per kWh tariff would see the system paid back in just over 2 years and the additional export after this time would provide financial benefit to the customer showing a very strong NPV.

With such a strong Net Present Value where the financial benefit of investing is much greater than not investing, a tariff set at either $1 or $2 would provide a very strong...
incentive to invest in a system and it can be speculated would rapidly increase the take up rate of solar PV systems.

Even with a $0.60 value for the Feed in Tariff there is a strong incentive to invest. It is only when the Feed in Tariff is set at $0.44 that a negative NPV is obtained; however the system payback period is still within the scheme timeframe.

In supporting the uptake of solar PV a gross metered Feed in Tariff provides clear financial incentives with a tariff set at $0.60 or above where it is better financially to invest than not to due to the positive NPV and short payback periods.
4.3.2 Actual customer data

Using the actual export data obtained from the average gross metered site of 1667 kWh per annum, a longer payback period is obtained at all levels of Feed in Tariff as seen in Figure 10.

This is an expected outcome where the income generated from the Feed in Tariff is directly related to the value of tariff. With the lower than modelled export volume the income is therefore reduced and the payback period extended.

At the $2 per kWh tariff level the payback period based on actual customer export data is longer than the model increasing from 2.26 years to 2.84 years. However it is noted that the payback periods are all less than the program length and only the lowest tariff doesn’t provide a positive NPV.

Figure 10  Customer data - gross metered payback period summary

<table>
<thead>
<tr>
<th>Feed in Tariff rate</th>
<th>$0.44</th>
<th>$0.60</th>
<th>$1.00</th>
<th>$2.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payback period years</td>
<td>12.93</td>
<td>9.48</td>
<td>5.69</td>
<td>2.84</td>
</tr>
<tr>
<td>NPV (discount rate 7.5% over 15 years)</td>
<td>-$2,123</td>
<td>$315</td>
<td>$6,411</td>
<td>$21,650</td>
</tr>
</tbody>
</table>
4.4  *Net Metered Sites*

4.4.1  Net Modelled payback periods

The PWC model originally assessed the impacts on payback periods at three tariff rates and Figure 11, shows the summary of these values as well as the extended model outcomes using additional $1 and $2 values.

The model assumed that 30% of the generated electricity would be exported and would therefore receive the premium value of the Feed in Tariff; the remaining generated electricity would be used internally to offset the consumption drawn from the grid.

With the model assuming that 2100 kWh is generated, the total fed back into the grid equals 630 kWh with the remaining 70% or 1470 kWh receiving the offset benefit by reducing the overall customers’ bill by the value of the retail tariff which was assumed to be $0.174 per kWh.

As Figure 11 indicates, the payback periods at a greater range of tariffs than previously modelled by PWC for a net metered site are longer than those calculated previously for a gross site using the modelling assumptions, and it is only at a $2 tariff that a positive investment outcome is obtained.

**Figure 11  Extended PWC net model – payback period summary**

<table>
<thead>
<tr>
<th>Feed in Tariff</th>
<th>$0.16</th>
<th>$0.44</th>
<th>$0.60</th>
<th>$1.00</th>
<th>$2.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payback period years</td>
<td>26.89</td>
<td>15.79</td>
<td>13.60</td>
<td>10.09</td>
<td>6.08</td>
</tr>
<tr>
<td>NPV (discount rate 7.5% over 15 years)</td>
<td>-$5,263</td>
<td>-$3,639</td>
<td>-$2,717</td>
<td>-$413</td>
<td>$5,345</td>
</tr>
</tbody>
</table>
The NPV values in Figure 11, do not include the total calculated costs of the scheme including the cost of advertising and implementation which was included into the calculations in the original PWC modelling as seen at Figure 8.
4.4.2 Net Actual payback periods

Using customer data obtained from the export at the net metered sites there are again clear variations between the modelled assumptions and the outcomes from the actual customer data which impact the accuracy of the modelling.

As previously indicated the PV system has a lower level of generation with 1667 kWh produced against the 2100 kWh assumed in the original model.

The key difference to the model is that although a lower amount is generated a greater proportion of this electricity is exported to the grid with an export rate of 47% achieved against the 30% level assumed in the PWC model.

With this greater percentage of the generated electricity exported, there will be an increase in the revenue obtained from the Feed in Tariff and an associated drop in the savings obtained from the offset usage with less electricity consumed internally.

The results impacts on the payback period for Net metered sites using the PWC model structure are shown in Figure 12

Whilst the level of electricity exported is higher its impact on reducing the payback period is reduced due to the lower volumes generated.

<table>
<thead>
<tr>
<th>Feed in Tariff</th>
<th>$0.44</th>
<th>$0.60</th>
<th>$1.00</th>
<th>$2.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payback period years</td>
<td>19.57</td>
<td>14.09</td>
<td>9.84</td>
<td>5.34</td>
</tr>
<tr>
<td>NPV</td>
<td>-$4,220</td>
<td>-$3,053</td>
<td>-$135</td>
<td>$7,160</td>
</tr>
</tbody>
</table>
4.4.3 Comparison

The impacts on payback periods of using actual customer data against the PWC modelling assumptions for a net metered site are shown in Figure 13.

Where the Feed in Tariff is set at $0.44 or $0.60 the payback period is longer than in the model.

However when the tariff reaches $1 or $2 per kWh, the payback period for the actual net metered customer is less than in the PWC modelling showing a better outcome is achieved in reality than in the modelling.

Figure 13   PWC net model – payback period comparison

<table>
<thead>
<tr>
<th>Feed in Tariff</th>
<th>$0.44</th>
<th>$0.60</th>
<th>$1.00</th>
<th>$2.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>PWC payback period years</td>
<td>15.79</td>
<td>13.60</td>
<td>10.09</td>
<td>6.08</td>
</tr>
<tr>
<td>Actual payback period years</td>
<td>19.57</td>
<td>14.09</td>
<td>9.84</td>
<td>5.34</td>
</tr>
</tbody>
</table>
4.5 Summary

The PWC model shows a close correlation at the $0.60 and $1 per kWh Feed in Tariff with less than 6 months difference in the calculated payback periods between the modelled assumptions and the actual customer data.

With the 15 years proposed scheme both the PWC and the actual data suggest a payback period close to the life time of the scheme at the $0.60 tariff.

The impact of the lower level of generation but higher export percentage in combination reduces the impact on the modelling assumptions that would be achieved with either variation on its own.

The PWC modelling incorrectly assumed all customers are the same and has not taken into account an allowance that a customer installing solar PV will have lower than average overall consumption.

The customers in this study have installed solar PV at a time when Feed in Tariffs were still in a discussion phase with no clear timeframe for a scheme being implemented. At the time of installation the payback period based on the average $0.16 rate would have been over 25 years for a gross metered site and at least 32 years for a net metered site.

It is therefore expected that these customers have installed their PV system for reasons other than making a profit out of the electricity fed back into the grid.

Without contacting the customers their individual reasons for the installation are unknown. However it could be speculated that wanting to reduce greenhouse gas emissions or environmental footprint is at the forefront of the customers’ expectations.
Therefore it should not be unexpected that a customer who has installed a solar PV system will also have a greater awareness of their energy consumption and would likely be a more efficient than average user of power.

With a difference in payback periods and different usage levels between the gross and net metered customers it suggests greater energy efficiency awareness in the net metered customers who have reduced their energy usage profile to ensure they export excess electricity to the grid.

A gross metered customer’s usage profile makes no difference to the amount exported and subsequently would have less of a driver to reduce overall consumption as the payback periods are not affected.

One problem of comparing the published PWC modelling to the customer data is that the payback periods have been calculated incorrectly which explains why the data in the tables of this study is slightly different to the published outcomes.

The published PWC model at a Feed in Tariff of $0.60 and at 30% export rate shows a payback period of 13.6 years when calculated from 2009, however with the tariff at $0.60 and 100% exported the payback period is calculated to be 6.53 years with the payback period starting calculated from 2010. The actual data shown in this study has all been calculated from 2009.
5 Department of Primary Industries Modelling

5.1 Background

The second modelling assessed from the development of the Feed in Tariff was commissioned by the Department of Primary Industries (DPI) to analyse the financial impact on all customers from the implementation of a Feed in Tariff.

The modelling was designed to help determine whether a gross or net Feed in Tariff model would deliver the goals of the scheme specifically including:

- Safeguards to ensure the schemes cost to Victorians does not exceed $10 per year
- Promote renewable energy and ensuring vulnerable Victorians would not be hit by high electricity prices

Premiers Media Release 2008

This modelling was used to ascertain the financial impacts of a Feed in Tariff on all customers including non solar PV customer as well as calculating the payback periods a customer would expect from either net or gross metering based on a single Feed in Tariff at $0.60.

With the Feed in Tariff subsidy to be funded through increased electricity bills, the level of impact on all consumers was a crucial factor in modelling an outcome for a Feed in Tariff that would not cost each customer more than an additional $10 per year.

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42 Brumby, J, 2008, Feed in Tariff Media Release – Victorians to benefit from the fairest and best solar feed in tariff scheme in Australia, Dept of the Premier, Victorian Government
The DPI modelling compared the impacts of two proposed schemes with one from the Victorian Government and one from Environment Victoria with a Feed in Tariff set at $0.60 per kWh.

The Victorian Government’s net metered scheme had a target to install 100 MW of solar PV capacity across Victoria with the total subsidy cost of $23.7 million per year. This compared with a gross metered scheme proposed from Environment Victoria to install solar PV capacity of 250 MW but with a subsidy cost of $236.5 million. The original model can be seen at Appendix 1.
5.2 Assumptions

The DPI modelling assumptions outlined in Figure 14 are based on a 1kW system and not the 1.5kW system used in the PWC model.

Figure 14 DPI Feed in Tariff model - data assumptions

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Value</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size of household PV System</td>
<td>1 kW</td>
<td></td>
</tr>
<tr>
<td>Average installed cost of PV system</td>
<td>$12,000 per kW</td>
<td>PWC model used $12,500</td>
</tr>
<tr>
<td>Solar Homes and Community Plan rebate</td>
<td>$8,000</td>
<td></td>
</tr>
<tr>
<td>Net cost for 1kW system</td>
<td>$4,000</td>
<td>Payback period is calculated to clear this initial outlay</td>
</tr>
<tr>
<td>Solar output</td>
<td>1577 kWh per kW</td>
<td>25% export rate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>394 kWh exported</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1183 kWh own use</td>
</tr>
<tr>
<td>Average annual household bill</td>
<td>$1,000</td>
<td></td>
</tr>
<tr>
<td>Household annual consumption</td>
<td>6250 kWh</td>
<td>Calculated figure from annual bill divided by average tariff</td>
</tr>
<tr>
<td>Normal electricity cost / kWh</td>
<td>$0.16</td>
<td></td>
</tr>
<tr>
<td>Solar PV Capacity Factor</td>
<td>18%</td>
<td></td>
</tr>
</tbody>
</table>
5.3 Differences between PWC and DPI model

Other than the smaller system, a number of other parameters were different between the two models.

1. Average cost of a system of 1kW system is $12,000 in the DPI model against $12,500 in the PWC model – the calculated outlay is also significantly different with the DPI model having a payback amount of $4,000 as opposed to the PWC model with $9,490 to payback.

2. The DPI model uses a Feed in Tariff only at $0.60 and doesn’t investigate other values and the impacts on the payback period.

3. The expected percentage of the PV generation that is exported to the grid is at 25% for the DPI model and 30% for the PWC.

4. The average household consumption has been calculated from the average bill and tariff and equates to 6250 kWh. This is lower than the 8000 kWh used for the PWC model.

The customer data has been obtained from an average 1.5 kW system and as the DPI model uses a 1kW system, the customers consumption and export from the 1.5 kW system has been calculated at 66% of the actual output.

For the purpose of the modelling this reduces the calculated customer output from 1667 at a 1.5 kW site to 1110 kWh for a 1 kW site. This assumption will have an acceptable degree of accuracy to assess the impacts against the DPI model.

The DPI model introduces the solar capacity factor which determines how much the system could generate if it operated at full capacity for an entire year. The DPI model uses a
capacity factor of 18% which calculates to the 1577 kWh expected to be generated from the system, however the data obtained from the Net metered customers shows that the average Solar capacity factor is very different at 12.6% as calculated in Figure 15.

**Figure 15 Solar Capacity Factor calculation**

366 days multiplied by 24 hours = 8,784 hrs in the year (2008 being a leap year)

The output from a 1kW system is deduced from the 1667 kWh output from a 1.5kW system

1667 kWh multiplied by 2/3 = 1110 kWh that would be produced each year by a 1kW system

The actual amount of 1110 kWh divided by the maximum potential annual output of 8784 kWh therefore gives the Solar Capacity factor of

\[
\frac{1110 \text{kWh}}{8784 \text{kWh}} = 12.6\%
\]
5.4 Modelling

The DPI model shown in Figure 16 indicates that the Environment Victoria Gross scheme would produce 394 MWh per year, but at an individual customer cost of $98.55 per year equating to an almost 10% rise in electricity bills for each customer.

However the $4,000 outlay for the PV system would have a payback period of 4.23 years and with the scheme due to run for 15 years this would provide an ongoing financial benefit to the customer once the system has been paid back.

The Victorian Governments’ net model predicts an annual output significantly lower at 157 MWh, however also has a lower impact to all customers with a less than $10 (or 1%) increase in the average customer bill. The payback period has extended to over 9 years; however the PV system would still be paid back with at least 5 years of the Feed in Tariff scheme remaining.

This option meets the customer impact goals previously outlined for a Feed in Tariff scheme and based on this model outcome would likely have been an instrumental part in confirming the proposed net Feed in Tariff for Victoria.
Assessing the impacts of Feed in Tariffs and metering configuration (gross or net), on the payback period for an average solar PV system in metropolitan Melbourne.
5.5 Analysis

5.5.1 Environment Victoria’s Gross Feed in Tariff

Annual Consumption

With the assumptions outlined in Figure 14 showing the average annual consumption for a customer of 6250 kWh; this is 16% higher than that of an average actual gross metered customer with an average annual consumption of 5392 kWh per year.

The first impact of this difference is that the average bill for a gross solar PV customer is lower than the $1,000 average customer equating to $862 per year at the $0.16 retail tariff.

Generation

The calculated generation of 1110 kWh obtained from the gross metered customers is also lower than the model assumption of 1577 kWh. With a gross metered customer exporting 100% of the generated electricity the annual value of the exported electricity will also be lower when compared to the modelled outcomes.

The Environment Victoria model assumes that each customer will receive over $946 in subsidy from the electricity exported back to the grid providing a simple payback period of 4.23 years, but as can be seen in Figure 17, the actual subsidy received would be lower at $666 which extends the payback period to just over 6 years for the original $4,000 system outlay.
Assessing the impacts of Feed in Tariffs and metering configuration (gross or net), on the payback period for an average solar PV system in metropolitan Melbourne

Figure 17  Environment Victoria model - subsidy and payback period summary

<table>
<thead>
<tr>
<th>Gross Metered Model</th>
<th>DPI Model</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total subsidy received by customer per year</td>
<td>$946.20</td>
<td>$666.00</td>
</tr>
<tr>
<td>Payback period years</td>
<td>4.23</td>
<td>6.01</td>
</tr>
</tbody>
</table>

The lower actual output from the system is the key determinant in the increase in the payback periods as the gross model is simply based on the amount of power generated and exported with no internal household usage to reduce the subsidy.

Variable Feed in Tariff

The Environment Victoria model uses a Feed in Tariff of $0.60, but with alternate tariffs applied across the actual gross metered customer data, the payback periods decrease as the value of the Feed in Tariff increases.

The higher value set on the Feed in Tariff the quicker the payback period. At the lower level tariff at $0.44 the payback period is just over 8 years as seen in Figure 18

Figure 18  Environment Victoria model – subsidy and payback period, customer data

<table>
<thead>
<tr>
<th>Feed in Tariff</th>
<th>Gross Feed in Tariff</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$0.44</td>
</tr>
<tr>
<td>Total subsidy received by customer per year</td>
<td>$488</td>
</tr>
<tr>
<td>Payback period years</td>
<td>8.19</td>
</tr>
</tbody>
</table>

The full calculations across the variation in the gross Feed in Tariffs can be seen in Appendix 3
The key aspect limiting the Government support for a gross metered tariff is the significant impact to non solar PV customers who would need to support the scheme through a $98 a year increase in their annual bills, which is well outside of the scheme goals already determined which set a maximum impact of $10 per customer.
5.5.2 Victorian Government Net Feed in Tariff

The Victorian Governments suggested model is based on a Net metered Feed in Tariff at $0.60 with the impact to all customers limited to a 1% rise in average bill equating to less than $10 per year.

The VIC Government model predicts as in the gross model an average level of generation at 1577 kWh for a 1kW system, however the customer data indicates a much lower amount of 1110kWh actually generated.

The impacts of this reduced generation are shown in Figure 19 and on its own with no other inputs changing would extend the payback period from 9.4 to 13.4 years, simply due to the lower amounts generated impacting both the export value and the amount offset from own internal use.

**Figure 19** Victorian government net model – impact of lower PV generation

<table>
<thead>
<tr>
<th>NET</th>
<th>DPI Model</th>
<th>Actual Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Export kWh</td>
<td>1577</td>
<td>1110</td>
</tr>
<tr>
<td>Subsidy from export - annual</td>
<td>$236.40</td>
<td>$166.20</td>
</tr>
<tr>
<td>Savings from own use</td>
<td>$189.28</td>
<td>$133.28</td>
</tr>
<tr>
<td>Total savings per year</td>
<td>$425.68</td>
<td>$299.48</td>
</tr>
<tr>
<td>Payback period years</td>
<td>9.40</td>
<td>13.36</td>
</tr>
</tbody>
</table>

The export of 1577 has been adjusted in the appendix to take into account the extra day within 2008 as a Leap Year and shows 1581 kWh
The model assumes an export rate of 25% of the generated electricity, slightly lower than in the previous PWC model (30%) which indicates that the customer would use more of the generated power internally to firstly meet the household load.

The key outcome from the customer data is that it shows a significantly higher percentage exported, with 47% of the generated electricity being fed back into the grid, indicating a much greater value obtained from the value of the Feed in Tariff with less used internally at the lower retail rate.

In isolation, either of these inaccurate assumptions (export level and export %) would have a large impact on the payback period at $0.60, however the combined impact on the payback period with less electricity generated but a greater proportion exported is shown in Figure 20 and indicates a variation from the modelled outcome of only 4 months.

**Figure 20** Victorian government net model – payback period summary

<table>
<thead>
<tr>
<th></th>
<th>DPI Model</th>
<th>Actual Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar PV Capacity Factor</td>
<td>18%</td>
<td>12.6%</td>
</tr>
<tr>
<td>Export kWh</td>
<td>1577</td>
<td>1110</td>
</tr>
<tr>
<td>Export %</td>
<td>25%</td>
<td>47%</td>
</tr>
<tr>
<td>Subsidy per customer</td>
<td>$9.88</td>
<td>$13.28</td>
</tr>
<tr>
<td>Increase in average bill</td>
<td>0.99%</td>
<td>2.60%</td>
</tr>
<tr>
<td>Subsidy from export</td>
<td>$236.40</td>
<td>$318.60</td>
</tr>
<tr>
<td>Savings from own use</td>
<td>$189.28</td>
<td>$92.64</td>
</tr>
<tr>
<td>Total savings per year</td>
<td>$425.68</td>
<td>$411.24</td>
</tr>
<tr>
<td>Payback period years</td>
<td>9.40</td>
<td>9.73</td>
</tr>
</tbody>
</table>
5.6 Summary and Results

The DPI modelling assumptions show significant differences between the assumed modelled data and the actual data obtained from customers with Solar PV.

With the DPI model using the same average consumption for both net and gross customers, the difference in actual customer consumption between the two metering configurations hasn’t been factored into the model.

As seen in Figure 20, the modelled net tariff option correlates very closely with the outcome that would be achieved using actual Net metered customer data.

With a gross model the higher the Feed in Tariff will always equate to a shorter payback period and although the actual output from a gross metered customer is much lower than the model, the impacts on the payback period would ensure the system is still paid back well before the expiry of the Feed in Tariff scheme.

The payback period for the Victorian Governments net model are shown in Figure 21 with the actual customer data being used to calculate both the subsidy received each year and the payback period.

Figure 21 Payback periods - net metered - customer data

<table>
<thead>
<tr>
<th>Net Feed in Tariff</th>
<th>$0.44</th>
<th>$0.60</th>
<th>$1.00</th>
<th>$2.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total subsidy received by customer per year</td>
<td>$326.28</td>
<td>$411.24</td>
<td>$623.64</td>
<td>$1,154.64</td>
</tr>
<tr>
<td>Payback period years</td>
<td>12.26</td>
<td>9.73</td>
<td>6.41</td>
<td>3.46</td>
</tr>
</tbody>
</table>
The customers’ data has been obtained when the Feed in Tariff was still in discussion mode and there would have been no financial incentive to have increased the amount exported to the grid as the overall outcome would have been the same financially.

However it is expected that the introduction of a price differential between the retail rate and the Feed in Tariff will change some customers usage patterns to maximise the output from their system, which will in turn reduce the payback periods further and put the customer in a lot more control of the overall outcomes.

This study has not reviewed the specific site details of each location and it should be expected that there will be sites which are not optimal to generate at the maximum capacity due to shading, roof angle etc.

It is expected that these site impacts will account for a proportion of the reduced output actually achieved when compared to the modelled expectations, but even in these non optimal locations the customer will have greater control on their ability to impact their payback period.
6 Results and discussion

6.1 Modelling

With the modelling outcomes clearly indicating that the Government’s net Feed in Tariff will meet the goals set for the scheme, it is clear that a customer’s usage level and profile will be a determining factor in the payback period for an average Solar PV system in Metropolitan Melbourne through a Feed in Tariff.

A gross metered site under both the PWC and DPI models has its payback period impacted by both the amount generated as well as the rate of the tariff. With an average 1kW system generating on average 1100 kWh (originally estimated in the DPI model as 1577 kWh) per annum the payback period would be determined by the value set for the Feed in Tariff. The higher the tariff is set the shorter the overall payback period.

The customer usage profile will have no impact in a gross model as the consumption and generation are both separately measured. This is unlike the net option where the generated electricity is first supplied to meet the internal household load.

The overall outcome across both metering configurations is that the higher the value attributed to the tariff the shorter the payback period will be for that configuration. With a net metered site the retail tariff and the avoided cost also impact the payback period.

The results show the significance of understanding the limitations placed on a model when using assumptions regarding customers behaviour where it is a critical aspect of the model.

The significant discrepancy between the modelling levels of generation, internal usage and export volume could have provided an inaccurate final model result, however in the net
metered DPI model these errors have almost cancelled each other out when reviewing at
the $0.60 tariff with the model and the actual outcomes very close.

The level of electricity exported of PWC (30%) and DPI (25%) underestimates the actual
percentage exported which averaged 47% of the generated electricity.

This level of export has already been obtained in the South Australian market where a study
by the energy network company (ETSA) and referenced in the Firecone paper ‘Options to
increase the update of PV’ (2008)\(^{43}\) indicated that a 50% export rate was achieved, however
the outcome is not included during the Victorian modelling possibly due to the small
sample size that provided this result.

The study also highlights an inherent difficulty with modelling a small specific subset of the
customers using ‘average’ customers data. Across metropolitan Melbourne at the time the
data was obtained there were approx 2500 Solar PV sites from a population of over 3
million customers so reducing the pool of sites from which the average data is calculated.

With energy usage possibly a factor in the customers decision to install a PV system, it
carries an accuracy risk to use in the model the average consumption based on a customer
who doesn’t have the same likely level of interest in overall energy consumption.

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\(^{43}\) Firecone Ventures Pty Ltd, 2008, *Options to increase the update of small-scale solar power by
Victorian households*, Firecone Ventures
This has been reflected in the average consumption levels in both models of 6250 kWh (DPI) and 8000 kWh (PWC) when the actual consumption in both the gross and net sites was much lower, but was also importantly different between the net and gross sites.

For a net metered site using the modelling and actual customer data the impacts on the payback periods at $0.60 are summarised in Figure 22, with a small difference between the expected outcomes from the models and the actual outcomes that would be obtained.

**Figure 22 Payback period comparison – net metered $0.60 tariff**

<table>
<thead>
<tr>
<th></th>
<th>PWC model</th>
<th>PWC Actual</th>
<th>DPI model</th>
<th>DPI Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payback period years</td>
<td>13.59</td>
<td>14.09</td>
<td>9.38</td>
<td>9.73</td>
</tr>
</tbody>
</table>

The full impacts on the payback period will be better understood when the Feed in Tariff is introduced and customer behaviour may be changed due to a financial incentive not available in the current data and with variations in the retail tariff.

Using the DPI Net metered, model the customer data suggest a payback timeframe of 9.73 years, however the data has been obtained during a non Feed in Tariff period and doesn’t factor in any changes to the customers usage pattern or in the increasing level of knowledge and awareness obtained by the customer on how to maximise the export.

With all other aspects staying the same, it could be speculated that the Feed in Tariff will lead to a greater than 50% export level for the average net metered customer, however as previously indicated although the average sized system is reducing from 1.8 kW in 2007 to 1.2 kW in 2009 the DPI model has been based on a 1 kW system.\(^{44}\)


Assessing the impacts of Feed in Tariffs and metering configuration (gross or net), on the payback period for an average solar PV system in metropolitan Melbourne
There are two straight forward methods in which a customer can further reduce the payback period at a net metered site.

Firstly, by simply reducing their overall energy consumption at the time the PV is generating power through more efficient usage. With the amount of power being generated remaining the same, it would now not need to meet the same level of internal load, allowing more to be exported and receive the Feed in Tariff rate.

The second method is based on the consumer understanding when their PV system is generating and exporting power and can help reduce the payback period even though they make no overall reduction in their total energy consumption. By moving energy usage to a timeframe outside of the PV generation period, more electricity will be exported and receive the Feed in Tariff, with the energy use then occurring outside of the PV generation timeframe. This could have a further benefit to the payback period reduction if this load shifting occurs to a period of lower retail tariff (Off Peak period) as the customer’s bill will then also be lower even though they have the same overall level of consumption.

With the interval data obtained from the meters and plans for a national smart meter roll out program putting interval data into every property the greater availability of billing data will provide greater opportunities for customers, retailers and networks to develop tariffs which either reward or penalise usage during constrained periods. Customers will be penalised for using at Peak load times, but be able to benefit from cheaper periods with low demand.
6.2  **Data Comparison**

The following graphs for actual gross and net customers show the average daily export amounts and timeframes for export averaged across the month.

It is clear from both Figure 23 and Figure 24, that the generated PV electricity has a short period where there is a high level of export which correlates with the sun’s position in the sky.

During the period between 11.30 and 14.30 the majority of the PV electricity is exported and it is clear that there is a higher daily average exported in the gross sites than the Net for reasons previously explained.

The impacts on the payback period for a solar PV system indicate that to maximise the amount of energy fed back into the grid the customer needs to understand when their system is generating the most electricity, so that they can in turn minimise their internal consumption in a net metered site.

The gross metered sites provide the most accurate evidence of when a system will be generating power as the export levels are not impacted through any internal consumption.

With Melbourne’s temperate climate, the summer months are also generally the sunniest and driest months and hence the greatest levels of generation can be seen from the gross sites during January with October and December as the next highest.
The high output for October 2008 was unexpected but is clarified by the Bureau of Meteorology (2008)\textsuperscript{45} which stated in its October summary report that ‘The very dry atmosphere allowed for fronts to pass through the State with very little moisture. As a consequence, the month was exceptionally dry - large areas of the State registered less than 20% of the usual allocation of rainfall.’

With stable sunny conditions and little cloud cover, October 2008 had unusually good conditions for generating solar PV.

\textbf{Figure 23} Average daily export – gross metered customer

\begin{figure}[!h]
\centering
\includegraphics[width=\textwidth]{figure23}
\caption{Gross: average daily watts exported}
\end{figure}

Assessing the impacts of Feed in Tariffs and metering configuration (gross or net), on the payback period for an average solar PV system in metropolitan Melbourne

From a Metropolitan Melbourne aspect the dry summer months are the ideal periods for generation with a high sun angle and longer periods of unbroken sunshine and ensuring a customer is maximising their output during this time will have a large impact on their payback period.

Minimising internal consumption during the middle of the day during the summer months will help a customer reduce their payback period further.

Although Figure 24 shows a much lower level of output for a net customer, it needs to be taken into account that this outcome was achieved when there was no additional incentive to increase the output. It would be expected that post implementation of a Feed in Tariff that there will be an average increases in the daily exported amounts.

**Figure 24** Average daily export – net metered customer
6.3 Customers Knowledge

One area not directly assessed in this study is the level of customer knowledge both in relation to the PV system they have installed as well as their ability to extract the maximum benefit.

There is an assumption that a customer who has invested at least $4,000 in a solar PV system prior to a Feed in Tariff being available will have a greater than average awareness of energy consumption or energy efficiency tools.

The technical system knowledge and operational maintenance do not appear to be at this same level, as despite the average system size being used for this study there is a large disparity between the highest and lowest levels of export at the customer’s site. With the highest and lowest net sites showing a range from 2181 kWh to 26 kWh exported and the gross sites showing a range from 3601 kWh down to a lowest at 298 kWh exported.

In 5 cases the data extracted from the customer’s meter shows there are periods of up to 4 weeks where the level of exported electricity is at zero for the entire day.

With other customers generating at the same time it is clearly not a climate issue or power outage and could be due to the non operation or fault within their PV system.

The customer’s lack of awareness as to whether the system is operational will be important aspects in their ability to reduce the payback period. The lack of operational understanding may in fact increase the payback period due to lost opportunities during down time. The average export obtained for this study includes the data where a system appears to be non operational and makes it a more realistic outcome and more accurate reflection of what will likely occur with a tariff introduced.
It is unknown whether the customers were immediately aware of the non operating periods of their systems or only noticed it after an external event such as power outage or the electricity bill was received and then arranged for their system to be checked.

With the payback period impacted by the amount of energy exported, a system problem during the sunnier summer months could have a disproportionate impact on the customer’s payback period if it reduced their output at that time.

As this study has been undertaken prior to a Feed in Tariff there will be future opportunities to assess the customer’s data and their ability to load shift and the impacts this has on the amount exported as well as the length of non operational systems as an overall percentage of lost opportunity.

With the greatest level of export during the middle of the day the payback period will be shorter in a net site for those customers who are away from their property or who can minimise their overall consumption. A working family with children at school and the house empty during the lunchtime period will have a shorter payback period than to an elderly person or young family who are at home during the day.

The benefit from a net metered Feed in Tariff scheme will reduce the payback periods for those properties with low usage during the midday peak generation period.

A combination of lower overall consumption, load shifting away from peak PV generating periods and shifting load to cheaper retail tariffs will all provide additional opportunities for a consumer to reduce the payback period through maximising the amount of power being exported and the price differential obtained.
As per Figure 1 the rapid increase in customers installing a solar PV system is likely due to the pending implementation of the net Feed in Tariff and the customers’ awareness or belief that they can use this as a means to reduce their energy bills.

Anecdotal evidence suggest that customers currently installing a solar PV system during late 2009 have significantly less understanding and awareness of the impacts and how to best manage their export to impact the payback period than those who have installed a solar PV system prior to 2009.

However with many of the installations now being offered at very low cost or at no charge (Clear Solar\(^{46}\)) the payback periods are also subsequently almost nonexistent so the drivers for the customers to export generated PV may now also be different.

For some customers the Feed in Tariff will provide strong drivers to maximise the output so that the system is paid back quickly, however for others with very little outlay on a system, the simple reduction in their energy bill through offsetting usage from the grid by the PV generation may be enough for them to be accepting of the outcomes and timeframe.

It is expected however that there will also be some customers who have installed solar PV and who expect it to pay itself back much quicker than can be realistically expected.

These factors will be identified post implementation of the tariff and provide additional opportunity for future study.

\(^{46}\) Clear Solar (www.clearsolar.com.au) are one example where a 1kW system was advertised as being installed without cost, as the Government rebate of $8,000 and the selling of the Renewable Energy Certificates covered the costs and provided a profit margin to the installers.
6.4 Demand Management

As shown previously in Figures 23 and 24, with the daily export profiles, solar PV generation occurs is at its maximum during the 11.30 to 14.30 period each day.

Without the data streams and profiles being available for non PV customers for assessment due to the limited extent of interval meters, it is not possible to easily confirm the ‘average’ non PV customer’s daily usage profile.

However, Figure 25 shows the usage profile for the average gross customer which shows an early morning peak which would likely be due to cheaper rate hot water heating and then a steady increase in consumption levels during the day before an early evening peak at 17.30 through to 20.30. The Gross customer profile has been used in the analysis due to its separation from the export data so it accurately reflects the levels of PV generated and exported from the site.

Figure 25 Daily usage profile – gross metered customer
Comparison of the times of peak generation and the times of peak load show that they do not coincide; with the afternoon peak load occurring after the PV system has almost stopped generating. This would indicate that solar PV on its own is not an effective tool in reducing peak network demand and hence as a demand management tool on the network without some sort of storage to use the energy generated by PV during peak periods of peak network load.

This outcome replicates the work of Watt et al (2006) and which studied the peak generation and peak load timeframes from the Newington Olympic Village in Sydney, with an outcome with a very similar pattern with peak export between 11am and 2pm and then peak network load from 7.30pm to 9pm. However a separate study by Borenstein (2005) found that in the California market PV production peaked only slightly earlier than network demand peak and would provide a demand management response. This study has not looked at the different climatic conditions and customers usage profile within the California market.

The average daily consumption profile from an average net metered customer, measured at the meter is shown in Figure 26. The impacts of the solar PV can be seen when compared to Figure 25, with a drop in consumption used from the grid during the 11.00 to 15.00 period when the internal usage is being supported from the PV system. The 02.00 peak is also not apparent with net metered sites who may have switched to gas hot water or who have control of the switching times for their storage hot water systems and manage them accordingly.

47 Watt, M., Passey, R. Barker, F. and Rivier, J., 2006, Newington Village – An Analysis of Photovoltaic Output, Residential Load and PV’s ability to Reduce Peak Demand, Report for the NSW Department of Planning, CEEM UNSW.

In both the gross and net sites the dedicated off peak tariff for the hot water service has been removed when the solar meter has been installed.

This is supported by the work of Watt et al (2004) where it was also found that the PV output didn’t coincide with the peak load periods at a residential level and to have an impact on demand management would likely need storage or displacement of the PV output curve.

With the lower consumption from the grid during the early afternoon period, the effects of a solar PV customer also enhance the ‘peakiness’ of the supply required from the grid as the PV output drops just prior to the peak load period.

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The highest afternoon peaks for net metered customers as seen in Figure 26, are during June, July and August which would indicate an associated heating load, however there is not the same peak during the summer months when the network air conditioning load is at its highest and the network is the most constrained during the early evening period. Future work would be required to understand the prevalence of air conditioning in sites which have installed solar PV as to whether they have the same air conditioning requirements due to other energy efficiency aspects.

In a study by Pop, 2005\textsuperscript{50} based on a South Australian load profile, the peak supply requirements from the South Australian grid were between 12.00 and 15.00 which correlated closely with the PV peak export timeframes on a January day, however this is not

\textsuperscript{50} Pop.M., Watt.M., Rivier.J., Birch.A., Tariff Implications for the Value of PV to Residential Customers, Centre for Energy & Environmental Markets, UNSW,
replicated in the Metropolitan Melbourne results and the specific network load requirements will vary between states due to climate zones and demand needs across the country.

Zahedi, 2008\textsuperscript{51} also identified that ‘different states need a different feed in tariff...and that a single feed in tariff of Solar PV electricity is not appropriate’. Each state needs to determine its Feed in Tariff to meet the goals required for the scheme and one size will not fit all cases.

Further investigation into just the summer usage profiles for both the actual gross and net metered customers are shown in Figure 27 and Figure 28.

It can be seen that the afternoon peak is not overly pronounced in the Gross customer profile, but is clearly indicated for the net metered sites with the afternoon consumption being lower during the PV export supported period and then increasing rapidly.

\textsuperscript{51} Zahedi, A, 2008, Development of an economical model to determine an appropriate feed in tariff for grid connected PV electricity in all states of Australia, Renewable & Sustainable Energy Reviews. Available to purchase from www.wciencedirect.com
Although solar PV doesn’t provide an effective demand management tool by supplementing the grid during peak load periods, these customers’ sites are also not contributing significantly to the Peak summer load demand.

Rather than using the generated solar PV as a demand management tool, it appears just by installing solar PV system a customer reduces the peak impacts associated with the hot summer afternoon air conditioning load and reduces the strain on the network.
Assessing the impacts of Feed in Tariffs and metering configuration (gross or net), on the payback period for an average solar PV system in metropolitan Melbourne

Figure 28 Average daily summer usage – net metered customer

Daily summer usage - Net customer

- Jan Average
- Feb Average

Assessing the impacts of Feed in Tariffs and metering configuration (gross or net), on the payback period for an average solar PV system in metropolitan Melbourne
### 6.5 Historical Consumption 2007 and 2008

The interval data used in the Feed in Tariff analysis relates to 2008, however for the purpose of the comparison below, quarterly energy consumption data from 2007 was also obtained for 60 net and 42 gross sites studied.

The total metered consumption per annum for both the average gross and net customer is shown below in Figure 30, for 60 net and 42 gross metered sites.

#### Figure 29  Annual consumption comparison where PV data available for 07 and 08

<table>
<thead>
<tr>
<th></th>
<th>Net Metered Consumption (kWh)</th>
<th>Gross Metered Consumption (kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>3923</td>
<td>5392</td>
</tr>
<tr>
<td>2007</td>
<td>4042</td>
<td>5413</td>
</tr>
<tr>
<td>% Difference</td>
<td>-2.9%</td>
<td>-0.4%</td>
</tr>
</tbody>
</table>

It has been assumed that the output of the PV systems in the net sites has remained consistent and it is just the electricity required from the grid which has been measured. As previously identified a net metered customer has a greater incentive to reduce their overall internal consumption as it will help maximise the export back into the grid and although in both cases there has been an overall drop in consumption between 2007 and 2008, it is much more pronounced in the net metered sites having a 2.9% or 121 kWh per year decrease.

This reduction may be driven by greater consumer awareness of their energy usage and may be the start of energy efficiency gains that will further increase with the introduction of a Feed in Tariff or could be due to a natural fluctuation in demand levels.
7  Aims achieved

The aims of the study to assess the impacts of Feed in Tariff value and the metering configuration on the payback period for an average solar PV system have been achieved in that it has identified that both the tariff and the metering configuration play an important role in determining the expected payback period.

The payback periods determined by the DPI and PWC modelling are at best a guide, with the significant variations between the modelling assumptions and the customer data introducing a degree of error to the model when factoring in customer behaviour and optimum operating conditions for a solar PV system.

The results using customer data are significant with Victorian Government planning to introduce a net Feed in Tariff at $0.60 per kWh from the start of November 2009. The modelling using actual customer data supports the proposed net Feed in Tariff as the option to provide certainty of investment and a reasonable payback period, whilst also minimising the financial impacts to customers without solar PV customers through increased tariffs to subsidise the scheme. However the goal of the scheme of impacting the customer by less than $10 has not been achieved as the overall subsidy per customer is $13.28.

There is an additional significant outcome regarding the customers’ behaviour and usage profile and the impact this will have on the payback period for their system. Through the understanding of their export profile and internal usage, the control of the amount of energy exported is very much with the customer, which will then determine the payback periods.
The aim to assess the effectiveness of PV as a demand management tool has also been achieved and is clear that the peak export periods do not coincide with the peak network load periods. Within the Melbourne Metropolitan region solar PV is not an effective demand management tool as it is not exporting at the same time as the peak load.

However the aspects of lower overall consumption and the speculation that those PV customers are not also high energy users (minimal air conditioning) suggests that a greater PV penetration will provide demand management benefits through overall more efficient and lower usage.

The use of customer data provides an increased degree of accuracy to the PWC and DPI models which at the time they were completed provided a good indication of solar PV system costs: however with the rapid changing conditions (closure of the Solar Homes and Community Plan) and system costs reducing, the modelling will need to be continually adapted to take into account the current costs for an installed PV system and the overall impact on the payback periods.

The degrees of energy efficiency will also likely increase following the start of a Feed in Tariff and the customer’s usage profiles should be reviewed after the introduction of the tariff to understand the current export levels and percentage.
8 Conclusion

The introduction of a defined rate for a Feed in Tariff will provide clarity regarding the payback periods the customer should expect and realistically achieve from their investment in the installation of a solar PV system.

The customers used for this study have all installed solar PV during 2007 or earlier, prior to any clear expectations as to when a Feed in Tariff would be introduced.

Currently neither metering configuration provides a better nor worse outcome as all exported PV electricity is effectively used as an offset at the same rate as the retail tariff. Energy used internally in a net metered site provided the same financial benefit as energy exported directly to the grid in a gross metered site. The impacts on the final electricity bill would be financially the same with GST applied against both methods.

It is clear from both the modelling and the customer data that a gross metered site will have a shorter payback than a net site at the same tariff, with the higher the Feed in Tariff, the shorter the payback period.

The goals outlined for the Victorian scheme determined that a net Feed in Tariff is the only realistic option due to tariff impacts for non PV customers and that a gross tariff provides no additional energy efficiency incentive.

Customers will have better control of their individual payback periods due to the introduction of a net metered Feed in Tariff and the key conclusions from this study are summarised below.
1. The easiest way in which the payback period can be reduced is to increase the tariff rate of the Feed in Tariff.

2. A net metered system provides opportunities for consumers to reduce the payback period further as the outcomes have been calculated based at a time with no price differential between ‘feed in’ and ‘retail’ tariffs during 2008.

3. A net metered customer can influence the amount of power exported to the grid. The more effective implementation of these factors can further reduce the payback period.
   a. Reduce total consumption so that the PV export volumes become a greater overall component of the energy bill – thereby increasing the value of the export.
   b. Minimise consumption during the periods when the PV is exporting at its peak (11.00 to 15.00) by load shifting internal consumption away from this period
   c. Load shift consumption to an Off Peak period and be charged a lower retail tariff, thereby further increasing the price differential between feed in rate and retail rate.
   d. Ensure the system is optimally positioned, operating and monitor the export levels to ensure it is exporting what is expected and adjust consumption accordingly to maximise output
4. Solar PV consumers are more efficient energy users with a net metered customer only using on average 60% and a gross metered customer using 67% of the average consumer. The modelling assumptions did not take into account any differences in consumption between a PV and non PV customer.

5. The consumption difference has occurred despite there not being a Feed in Tariff as an incentive to minimise consumption. This study recommends that the 2009, 2010 and 2011 data is also obtained for these sites so as to assess the impacts post introduction of the Feed in Tariff and to enable comparison against the average non solar PV consumer.

6. The annual consumption for both gross and net metered sites shows a slight drop in overall usage and this would need to be studied post the implementation of a Feed in Tariff to assess whether the drop in Net metered sites increase in rate as the consumer aims to maximise their ability to export to the grid.

7. Consumers who have previously installed gross metering may review the effectiveness of their system configuration with the introduction of the Feed in Tariff which is applicable only against net metered sites and there may be benefits in switching to a net metered site to take advantage of the Feed in Tariff and not just getting the buyback rate at the retail tariff.

8. Only two years worth of data provides for minimal comparison but should be part of a longer term study which can review over an extended period the variation in consumption as well as against a non solar PV customer.

9. An education program is also recommended for solar PV consumers to enable them to better understand their consumption and export profile and to enable them to
maximise the benefit of the proposed scheme. Energy efficiency advice can further enhance the effectiveness of the scheme and in turn reduce further the payback period.

10. Solar PV is not an effective demand management tool as the peak solar generation period does not coincide with the peak usage periods and has there is minimal export during peak network load.

11. Ongoing access to the metering data as well as the ability to interpret the data will provide customers with a greater ability to impact their payback period. As all solar customers will have an interval meter, customers should have a method to obtain this data in addition to just receiving an electricity bill so as to best manage their export.

12. With the rapid installation of solar PV installations during 2009 further investigation is recommended to assess the consumption profiles against the new installations and those from pre 2007.

With a smart meter roll out program commencing in 2009 across Victoria greater volumes of data will be readily available for all customers. This will also likely see the introduction of Time of Use tariffs with greater variation in price between Peak and Off Peak periods and will likely have a further impact on the customer’s consumption profile when it becomes more of an incentive to switch load out of the peak cost periods.

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However with the planned Feed in Tariff set at $0.60 for 15 years, the price differential between retail and feed in tariff to encourage customers to install solar PV needs to be maintained. At the time of the modelling the average electricity price was $0.16 however Time of Use prices for 2009 have already increased as far as $0.257 for Peak rates and may during the lifetime of the scheme become more expensive than the Feed in Tariff at which point a customer may be better to switch back to a gross metered configuration and sell the generated electricity back at a higher retail rate rather than the $0.60 set for the Feed in Tariff.

This concern with the ability to react flexibly and quickly was identified by Wiser, Hamrin and Wingate (2002), and it may eventuate that the 15 years life cycle of the scheme will be found to be too long, as retail prices may increase to a level higher than the Feed in Tariff. The impact of an Emissions Trading Scheme or carbon tax on retail electricity prices was not factored into the PWC and DPI modelling which were developed using the assumptions available at the time of modelling.

This paper only analyses the impacts on payback periods and demand management from a simple energy usage aspect and doesn’t take into account the additional network augmentation cost savings or the retailer impacts through pricing and the wholesale market. However the clear outcome is that the most effective Solar PV Feed in Tariff for Victoria is a net metered configuration with the Feed in Tariff set at $0.60. Although not

53 Your Choice – energy rate comparison website. Selecting Time of Use tariff in United Energy area, highest price obtained from Australian Power and Gas of $0.2575 Peak and $0.1036 Off Peak www.yourchoice.vic.gov.au

meeting all the requirements outlined for the scheme with the impact for customers above the $10 a year cut off, at $13.28 the overall outcome shows it to be the most efficient method for introducing a Feed in Tariff.

The data supports this outcome for different reasons than in the prepared DPI and PWC modelling and it is a fortunate outcome that inaccuracies within the models of export volume and generation volumes effectively cancel each other out within the model.

For some customers the payback periods will be very short as they maximise the ability to export to the grid and for those with a substantial financial outlay this is a likely occurrence. However with many customers having installed their panels very cheaply during 2009, the payback periods will be much shorter and there may be less of an incentive to change their usage behaviour as the payback may be obtained simply through offsetting the usage and not through becoming a more efficient energy user.
Assessing the impacts of Feed in Tariffs and metering configuration (gross or net), on the payback period for an average solar PV system in metropolitan Melbourne

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Assessing the impacts of Feed in Tariffs and metering configuration (gross or net), on the payback period for an average solar PV system in metropolitan Melbourne

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Appendices
### Feed in Tariffs

#### Cost

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<thead>
<tr>
<th>Inputs</th>
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<tbody>
<tr>
<td>$0.60</td>
<td>EV Gross Fit (per kWh)</td>
</tr>
<tr>
<td>25%</td>
<td>Prodn Exported (source: MMA)</td>
</tr>
<tr>
<td>$0.60</td>
<td>Vic Govt Net Fit (per kWh)</td>
</tr>
</tbody>
</table>

- 18% Solar PV capacity factor
- 24 hrs per day
- 365 days per year
- 2.4 Total Vic energy customers (mil)
- $0.16 Normal electricity cost / kWh
- $1,000 Avg annual household bill
- 250 Solar installed (MW) - EV model
- 100 Solar installed (MW) - Vic Govt model
- $12,000 Installed cost per kW
- $6,000 PVRP per customer

#### Statewide Calcs - EV Model

- 250 Solar capacity installed (MW)
- 394,200 MWh per year produced
- 236.5 Gross - total subsidy ($mil)

#### Statewide Calcs - Vic Govt Model

- 100 Solar capacity installed (MW)
- 157,680 MWh per year produced
- 23.7 Net - total subsidy ($mil)

#### Individual Calcs for a 1kW system

- 1.0 Solar capacity (kW)
- 1,577 kWh produced per year
- 394 kWh exported
- 1,183 kWh own use
- $4,000 Net cost for 1kW system

#### Gross Feed In - EV Model

- $98.55 Subsidy paid per customer
- 9.9% Increase in avg. bill - Gross
- $946 Total subsidy received/yr
- 4.2 Payback Years - Gross

#### Net Feed In - Vic Govt Model

- $9.86 Subsidy paid per customer
- 1.0% Increase in avg. bill - Net
- $237 Subsidy from Export
- $189 Savings from own use
- $426 Total savings received/yr
- 9.4 Payback Years - Net

Assessing the impacts of Feed in Tariffs and metering configuration (gross or net), on the payback period for an average solar PV system in metropolitan Melbourne
### Appendix 2  
**DPI model net metered – variable Feed in Tariff Values**

<table>
<thead>
<tr>
<th>DPI Model</th>
<th>Actual Net Metered Customer data</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIC SMP Net FIT (per kWh)</td>
<td>$0.60</td>
</tr>
<tr>
<td>Profit Exported (source MVA)</td>
<td>25%</td>
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<tr>
<td>Solar PV capacity factor</td>
<td>18.6%</td>
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<tr>
<td>hrs per day</td>
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<tr>
<td>days per year</td>
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</tr>
<tr>
<td>Total energy customers</td>
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<tr>
<td>Normal electricity cost (kWh)</td>
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<tr>
<td>Average annual bill</td>
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<tr>
<td>Solar Installed (kW)</td>
<td>250</td>
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<tr>
<td>Solar Installed (kW) Vic Govt Model</td>
<td>100</td>
</tr>
<tr>
<td>Installed cost per kW</td>
<td>$12,000</td>
</tr>
<tr>
<td>PVHP per customer</td>
<td>$8,000</td>
</tr>
<tr>
<td>Statewide Calc Vic Govt Model</td>
<td>100</td>
</tr>
<tr>
<td>Solar capacity installed (kW)</td>
<td>157600</td>
</tr>
<tr>
<td>NWh per year produced</td>
<td>157600</td>
</tr>
<tr>
<td>Net + Total subsidy (kWh)</td>
<td>$23,700.00</td>
</tr>
</tbody>
</table>

#### Individual Calc

| Solar Capacity | 1 | 1 | 1 | 1 | 1 |
| kW per year produced | 1581 | 1113 | 1113 | 1113 | 1113 |
| kWh exported | 395 | 531 | 531 | 531 | 531 |
| kWh own use | 1183 | 579 | 579 | 579 | 579 |
| Net Cost for 3kW system | $4,000 | $4,000 | $4,000 | $4,000 | $4,000 |

**NET**

| Subsidy per customer | $9.88 | $9.74 | $13.28 | $22.13 | $44.25 |
| Increase in average bill | 6.99% | 9.12% | 2.60% | 4.30% | 8.87% |
| Subsidy from export | $237.17 | $233.64 | $316.90 | $331.02 | $1,082.60 |
| Savings from own use | $189.28 | $92.64 | $92.64 | $92.64 | $92.64 |
| Total savings per year | $426.45 | $326.28 | $411.24 | $423.64 | $1,154.64 |
| Payback | 5.38 | 12.28 | 9.33 | 6.41 | 3.48 |
### Appendix 3  
**DPI model gross metered – variable Feed in Tariff values**

<table>
<thead>
<tr>
<th></th>
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<th>Actual Gross Metered Customer Data</th>
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<td><strong>EV Gross FIT (per kWh)</strong></td>
<td>$0.60</td>
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<tr>
<td><strong>Prod Exported (source MMA)</strong></td>
<td>25%</td>
<td>25%</td>
</tr>
<tr>
<td><strong>VIC GOV Net FIT (per kWh)</strong></td>
<td>$0.60</td>
<td>$0.44</td>
</tr>
<tr>
<td><strong>Total VIC energy customers</strong></td>
<td>2,400,000</td>
<td>2,400,000</td>
</tr>
<tr>
<td><strong>Normal electricity cost (kWh)</strong></td>
<td>$0.16</td>
<td>$0.16</td>
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<tr>
<td><strong>Average annual bill</strong></td>
<td>$1,000.00</td>
<td>$862.72</td>
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<td><strong>Solar Installed (MW) EV Model</strong></td>
<td>250</td>
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<tr>
<td><strong>Solar Installed (MW) Vic Govt Model</strong></td>
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<td>100</td>
</tr>
<tr>
<td><strong>Installed cost per kW</strong></td>
<td>$12,000</td>
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</tr>
<tr>
<td><strong>PVRP per customer</strong></td>
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<tr>
<td><strong>State wide Calc EV Model</strong></td>
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<tr>
<td><strong>Solar Capacity Installed (MW)</strong></td>
<td>250</td>
<td>250</td>
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<tr>
<td><strong>MW per year produced</strong></td>
<td>394,200</td>
<td>277,500</td>
</tr>
<tr>
<td><strong>Gross - total subsidy ($mil)</strong></td>
<td>236,500,000</td>
<td>122,100,000.00</td>
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<tr>
<td><strong>Individual Calc</strong></td>
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<tr>
<td><strong>Solar Capacity kW</strong></td>
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<td><strong>kWh per year produced</strong></td>
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<tr>
<td><strong>kWh exported</strong></td>
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<tr>
<td><strong>kWh own use</strong></td>
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<tr>
<td><strong>Net Cost for kW system</strong></td>
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<td><strong>GROSS</strong></td>
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<tr>
<td><strong>Subsidy payable by each customer</strong></td>
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<td><strong>Increase in average bill</strong></td>
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<tr>
<td><strong>Total subsidy received by customer per year</strong></td>
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<tr>
<td><strong>Payback period years</strong></td>
<td>4.23</td>
<td>8.19</td>
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</table>
Appendix 4 Data file example – de identified
Appendix 5  

PWC Model, gross metered

Income – export: the income generated from exporting the PV electricity to the grid and receiving the feed in tariff rate

Income – offset: the benefit received from using the PV generated electricity and not having to draw electricity from the grid. Calculated using the existing retail tariff rates and the amount of PV electricity used within the property.

### PWC Modelling with 100% of generated power exported

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<tr>
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</thead>
<tbody>
<tr>
<td>Income - export</td>
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<td>$224.00</td>
<td>$224.00</td>
<td>$224.00</td>
<td>$224.00</td>
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<tr>
<td>Income - Offset</td>
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</table>

Assessing the impacts of Feed in Tariffs and metering configuration (gross or net), on the payback period for an average solar PV system in metropolitan Melbourne
### Appendix 6  PWC Model, net metered

**PWC Modelling with 30% of generated power exported**

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<tbody>
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<td>$230.56</td>
<td>$230.56</td>
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<td><strong>Income - Offset</strong></td>
<td>$231.64</td>
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<td><strong>Expenditure - system</strong></td>
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<td><strong>Total Income</strong></td>
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### Feed in Tariff

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### Feed in Tariff

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Assessing the impacts of Feed in Tariffs and metering configuration (gross or net), on the payback period for an average solar PV system in metropolitan Melbourne

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3
## Appendix 7  
**PWC Model – gross metered – actual customer data**

**PWC Gross Feed in Tariff with real time data**

### Feed in Tariff $0.44

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### Feed in Tariff $0.60

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Assessing the impacts of Feed in Tariffs and metering configuration (gross or net), on the payback period for an average solar PV system in metropolitan Melbourne.
### PWC Net Feed in Tariff with real time data

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#### Expenditure - system

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#### Total Income

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#### Feed in Tariff 50.60

Appendix 8  **PWC Model, net metered, actual customer data**

Assessing the impacts of Feed in Tariffs and metering configuration (gross or net), on the payback period for an average solar PV system in metropolitan Melbourne
## Appendix 9  
**PWC Model, gross metered, 100% of generated power exported – Net Present Value**

<table>
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<th>Period</th>
<th>Feed in Tariff Description</th>
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*Note: The table above represents the Net Present Value (NPV) calculations for a solar PV system in metropolitan Melbourne, under the PWC Model with gross metering and 100% of generated power exported. The NPV is calculated using a 1.5% annual discount rate.*
### Appendix 10  PWC Model, net metered, 30% of generated power exported

PWC Modelling with 30% of generated power exported

<table>
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<th>Feed in Tariff Description</th>
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<th>Description</th>
<th>$854</th>
<th>Feed in Tariff Description</th>
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<th>Description</th>
<th>$864</th>
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<th>Description</th>
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### Assessing the impacts of Feed in Tariffs and metering configuration (gross or net), on the payback period for an average solar PV system in metropolitan Melbourne
**Assessing the impacts of Feed in Tariffs and metering configuration (gross or net), on the payback period for an average solar PV system in metropolitan Melbourne**

### Appendix 11

**PWC Model, gross metered, Actual Customer data – Net Present Value**

<table>
<thead>
<tr>
<th>$0.04</th>
<th>Feed in Tariff Description</th>
<th>$0.06</th>
<th>Feed in Tariff Description</th>
<th>$1.00</th>
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</table>

**PWC Gross Feed in Tariff with real time data**

- **Initial cost of investment and year from today**
- **Return from first year**
- **Return from second year**
- **Return from third year**
- **Return from fourth year**
- **Return from fifth year**
- **Return from sixth year**
- **Return from seventh year**
- **Return from eighth year**
- **Return from ninth year**
- **Return from tenth year**
- **Return from eleventh year**
- **Return from twelfth year**
- **Return from thirteenth year**
- **Return from fourteenth year**
- **Return from fifteenth year**
- **Return from sixteenth year**
- **Return from seventeenth year**
- **Return from eighteenth year**
- **Return from nineteenth year**
- **Return from twentieth year**
- **Return from twenty-first year**
- **Return from twenty-second year**
- **Return from twenty-third year**
- **Return from twenty-fourth year**
- **Return from twenty-fifth year**
- **Return from twenty-sixth year**
- **Return from twenty-seventh year**
- **Return from twenty-eighth year**
- **Return from twenty-ninth year**
- **Return from thirtieth year**

**Appendix 11**

<table>
<thead>
<tr>
<th>$0.04</th>
<th>Feed in Tariff Description</th>
<th>$0.06</th>
<th>Feed in Tariff Description</th>
<th>$1.00</th>
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<tbody>
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</table>

**Formula Description (Result)**

- **NPV** Net present value of this investment
- **NPV2** Net present value of this investment
- **NPV3** Net present value of this investment
- **NPV4** Net present value of this investment
- **NPV5** Net present value of this investment
- **NPV6** Net present value of this investment
Assessing the impacts of Feed in Tariffs and metering configuration (gross or net), on the payback period for an average solar PV system in metropolitan Melbourne

### Appendix 12  
PWC Model, net metered, Actual Customer data – Net Present Value

<table>
<thead>
<tr>
<th>Year</th>
<th>Feed in Tariff (Net)</th>
<th>Description</th>
<th>Year</th>
<th>Feed in Tariff (Net)</th>
<th>Description</th>
<th>Year</th>
<th>Feed in Tariff (Net)</th>
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<td>Return from eighth year</td>
<td>2020</td>
<td>$16,996</td>
<td>Return from eighth year</td>
</tr>
<tr>
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<td>$13,996</td>
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<td>2018</td>
<td>$14,996</td>
<td>Return from ninth year</td>
<td>2019</td>
<td>$15,996</td>
<td>Return from ninth year</td>
<td>2020</td>
<td>$16,996</td>
<td>Return from ninth year</td>
<td>2021</td>
<td>$17,996</td>
<td>Return from ninth year</td>
</tr>
<tr>
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<td>$14,996</td>
<td>Return from tenth year</td>
<td>2019</td>
<td>$15,996</td>
<td>Return from tenth year</td>
<td>2020</td>
<td>$16,996</td>
<td>Return from tenth year</td>
<td>2021</td>
<td>$17,996</td>
<td>Return from tenth year</td>
<td>2022</td>
<td>$18,996</td>
<td>Return from tenth year</td>
</tr>
<tr>
<td>2019</td>
<td>$15,996</td>
<td>Return from eleventh year</td>
<td>2020</td>
<td>$16,996</td>
<td>Return from eleventh year</td>
<td>2021</td>
<td>$17,996</td>
<td>Return from eleventh year</td>
<td>2022</td>
<td>$18,996</td>
<td>Return from eleventh year</td>
<td>2023</td>
<td>$19,996</td>
<td>Return from eleventh year</td>
</tr>
<tr>
<td>2020</td>
<td>$16,996</td>
<td>Return from twelfth year</td>
<td>2021</td>
<td>$17,996</td>
<td>Return from twelfth year</td>
<td>2022</td>
<td>$18,996</td>
<td>Return from twelfth year</td>
<td>2023</td>
<td>$19,996</td>
<td>Return from twelfth year</td>
<td>2024</td>
<td>$20,996</td>
<td>Return from twelfth year</td>
</tr>
</tbody>
</table>

**Appendix 1**

<table>
<thead>
<tr>
<th>Description (Result)</th>
<th>Description (Result)</th>
<th>Description (Result)</th>
<th>Description (Result)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$5,986</td>
<td>Net present value of this investment</td>
<td>$6,991</td>
<td>Net present value of this investment</td>
</tr>
</tbody>
</table>
Assessing the impacts of Feed in Tariffs and metering configuration (gross or net), on the payback period for an average solar PV system in metropolitan Melbourne