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Seed Advisory

# SRES Uptake: Postcode Demographics and Penetration Rates

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Final Report to the Australian Energy Markets  
Commission

7 July 2011



## Contents

<b>1</b>	<b>EXECUTIVE SUMMARY .....</b>	<b>3</b>
1.1	Purpose of this study .....	3
1.2	Key Findings .....	4
1.3	Further Directions for Research .....	10
1.4	The structure of this report .....	10
<b>2</b>	<b>METHODOLOGY .....</b>	<b>11</b>
2.4.1	Data Analysis: Data Provided	14
2.4.2	Data Quality Review: ORER Data	14
2.4.3	Data Preparation: ORER Data	16
2.4.4	Data Preparation: Other Data	17
2.4.5	Combining the Data	18
2.4.6	Mapping	18
2.4.7	Analysis at the Postcode Level	18
2.5	Identifying Significant Linear Relationships .....	19
2.6	Other Non-Linear Relationships.....	23
2.7	Reading the charts.....	24
<b>3</b>	<b>KEY FINDINGS .....</b>	<b>26</b>
3.1	Postcodes with higher penetration of small scale renewable technology .....	27
3.2	Multivariate Analysis: Truncated Results.....	31
3.3	Univariate Analysis: Key Areas of Interest .....	34
3.3.1	Income bands	34
3.3.2	Median Family Income: negative relationship with penetration	40
3.3.3	Socio Economic Disadvantage and Advantage: relationships with penetration	43
3.3.4	Employment by industry sector and occupation	46
3.3.5	Density	48
3.3.6	Housing Type and other characteristics	48
3.3.7	Age	50
3.3.8	Solar Hot Water Systems: New and Replacement	51
3.3.9	Jurisdictional differences	52
<b>4</b>	<b>FURTHER DIRECTIONS FOR RESEARCH .....</b>	<b>57</b>



<b>A. VARIABLES USED IN THE ANALYSES.....</b>	<b>60</b>
<b>B. RESULTS FOR SOLAR PV INSTALLATIONS .....</b>	<b>72</b>
<b>C. RESULTS FOR SOLAR HOT WATER SYSTEMS.....</b>	<b>104</b>
<b>D. RESULTS FOR SMALL WIND GENERATION UNITS .....</b>	<b>135</b>



# 1 Executive Summary

## 1.1 Purpose of this study

Seed Advisory has been commissioned by the Australian Energy Markets Commission (AEMC) to undertake an historic analysis of relationships underlying successful applications for the Small-scale Renewable Energy Scheme (SRES) program, based on Office of the Renewable Energy Regulator (ORER) data, census data and other publicly available small area data. Merging the ORER data with additional demographic data at a postcode level is designed to assist in identifying historic explanatory drivers of the uptake of technologies beyond financial payback, including potentially age, average income, family characteristics and education.

A number of previously published studies have analysed and identified relationships with subsets of the ORER data and specific demographic variables, but these have been generally narrowly focused and have investigated a specific relationship type. This study has the advantage of using ORER's data nationally, from the inception of the first program and combined it with a wide range of demographic variables to identify a broader set of relationships. The findings of this report can provide the platform for further more targeted work and leverage off the relationships identified and the recommended directions for further research.

In our work, we have looked at the characteristics of postcodes, *not* people. We do not identify the characteristics of the families and households who have installed solar PV and solar hot water (SWH) systems, only the *average characteristics of the postcodes in which the installations have been made*.

In looking at the characteristics of postcodes, we have considered a wide range of variables, each in isolation from all the other variables tested. Our results should, therefore, be understood as meaning that a postcode with higher penetration of solar PV installations has *at least one* of a range of characteristics that have been identified as significant, for example, a higher proportion of detached and semi-detached houses that are owned or being purchased. The postcode may have a range of other significant differentiating characteristics — a higher number of cars per household, a larger proportion of households with young children, or a larger number of bedrooms per dwelling — but we have not tested this.



## 1.2 Key Findings

Australia-wide, there are around 40 solar PV installations per 1,000 dwellings and around 88 solar hot water systems<sup>1</sup>. Penetration, expressed as the number of installations per 1,000 dwellings, varies widely by postcode across Australia, as Figure 1.1 and Figure 1.2 illustrate.

Looking first at *who benefitted* from the range of government assistance, Federal and State or territory available to encourage the installation of small scale renewable energy technologies, then our conclusions are:

- Program uptake has *not* been disproportionately dominated by participants in postcodes with higher average incomes: higher income postcodes have, on average, fewer installations per 1,000 households than the national average. We believe that this finding can be extended to postcodes with higher wealth.
- However, our preferred measures for socio economic status, the ABS's 2006 Socio-Economic Indexes from Areas, suggest low socio-economic areas have *not* benefitted. Postcodes with the lowest index scores, indicating relatively high levels of socio economic disadvantage at the postcode level, have, on average, low levels of solar PV penetration relative to the national average.

In looking at the characteristics of postcodes to identify what distinguishes a postcode where penetration is high from a postcode where penetration is low, as Table 1.1<sup>2</sup> shows:

- in postcodes where the postcode has one or more of the following characteristics, the penetration of solar PV installations is **higher** where:
  - The proportion of the population in a given postcode in the 35-74 year age group is higher;
  - The share of detached and semi-detached houses that are owned or being purchased in a given postcode is higher;
  - Dwellings in a given postcode have on average a larger number of bedrooms;
  - There is a higher proportion of dwellings in the given postcode with young children;
  - There is a higher number of cars per household in a given postcode;
  - Density is relatively low, measured by people per square kilometer in a postcode;
  - A higher proportion of the population in the postcode has an income in the range between (\$2006) \$1,000 to \$1,700/week, or between 1 and 1.7 times Male Average Weekly Ordinary Times Earnings in August 2006.

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<sup>1</sup> Based on data supplied by the Office of the Renewable Energy Regulator, covering the period from 1 January 2001 to mid-March 2011 and using dwelling numbers from the 2006 Census.

<sup>2</sup> Table 1.1 includes a selection of the variables with strong linear relationships with penetration of solar PV in Table 3.1. We have omitted from Table 1.1 those variables relating to industry and occupation that we believe are related to income and other factors. See the discussion in Sections 3 and 3.1.



- where the postcode has one or more of the following characteristics, the penetration of solar PV installations is **lower** where:
  - The proportion of people in younger age range (20 – 34) in a given postcode is higher;
  - The proportion of people with poor English in a given postcode is higher;
  - The higher Average Salary or Wages in a given postcode;
  - The higher the number of persons per sq. km (density) in a given postcode;
  - The higher the Median Family Income in a given postcode;
  - The higher the Median Household Income in a given postcode;
  - The higher the proportion of family or households with weekly gross income \$1,700 and above.

Similar results for solar hot water systems can be found in Table 1.2.

Other results from our analysis of the relationship between solar PV and solar hot water system penetration and the characteristics of postcodes include:

- For both new and replacement installations of solar hot water systems, penetration is lower in postcodes with higher density (a higher number of people per square kilometer). However, penetration varies with different variables when installations are characterised as new or replacement, suggesting two different dynamics may be at play (see Table C. 6 on page 129).
  - Postcodes with a high penetration of solar hot water on new buildings have one or more of the following: high proportions of families with young children; high proportions of separate or semi-detached dwellings that are owned or being purchased; higher average household sizes; higher numbers of bedrooms; and higher numbers of cars per dwelling.
  - Postcodes with a high penetration of solar hot water systems replacing pre-existing systems have one or more of the following: higher proportions of their populations in the 35 – 74 years age group; higher proportions of their populations employed in the agricultural sector and a higher proportion of Aboriginal and Torres Strait Islanders as a share of the population.
- We found relatively few variables at a national level that vary with the average size of installation of Solar PV or solar hot water systems and none with a relationship that is consistent across more than a few states (see Table B. 7 and Table C. 7)
- Significant relationships between penetration of small scale renewable energy technologies and the characteristics of postcodes with high (or low) penetration differ from state to state and across time (see Table B. 3. and Table C. 4).



Figure 1.1: Penetration of Solar PV by Postcode, installations per 1,000 dwellings

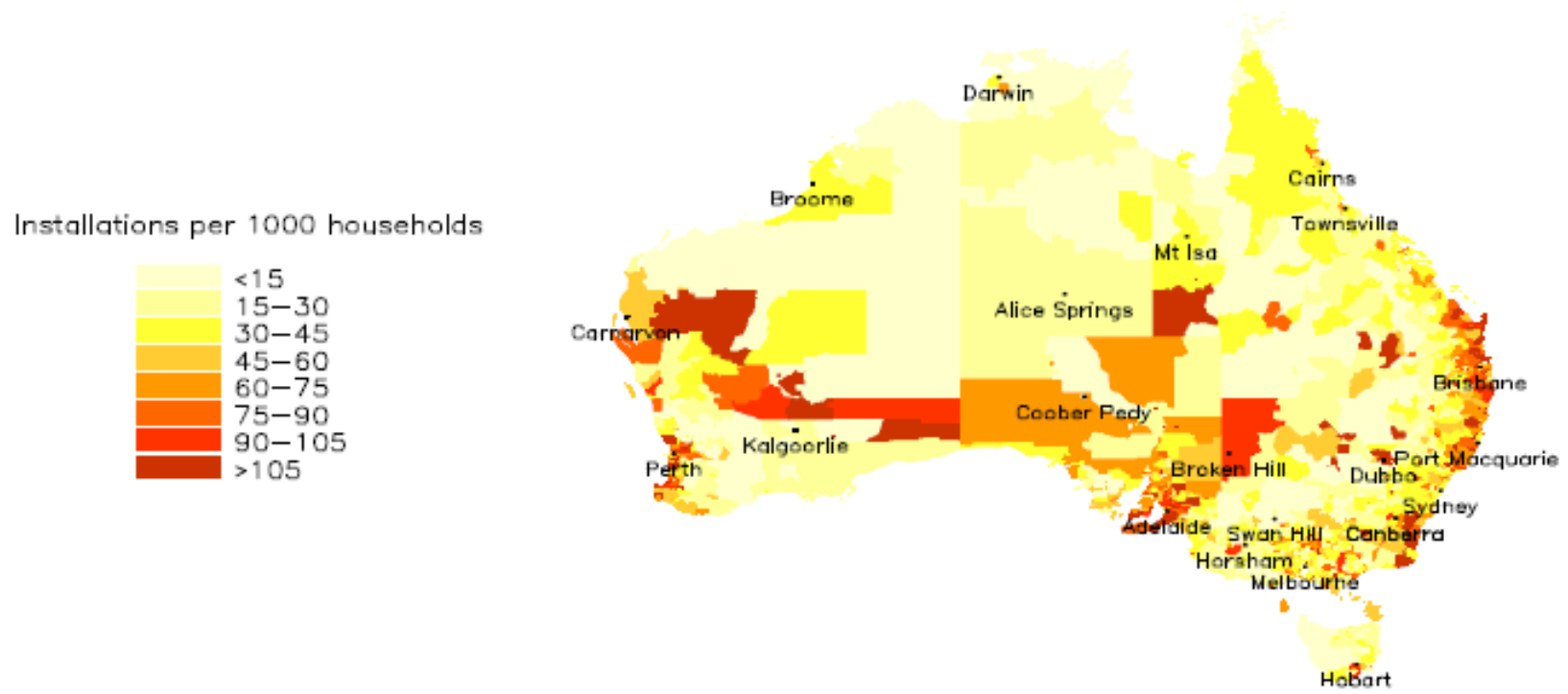
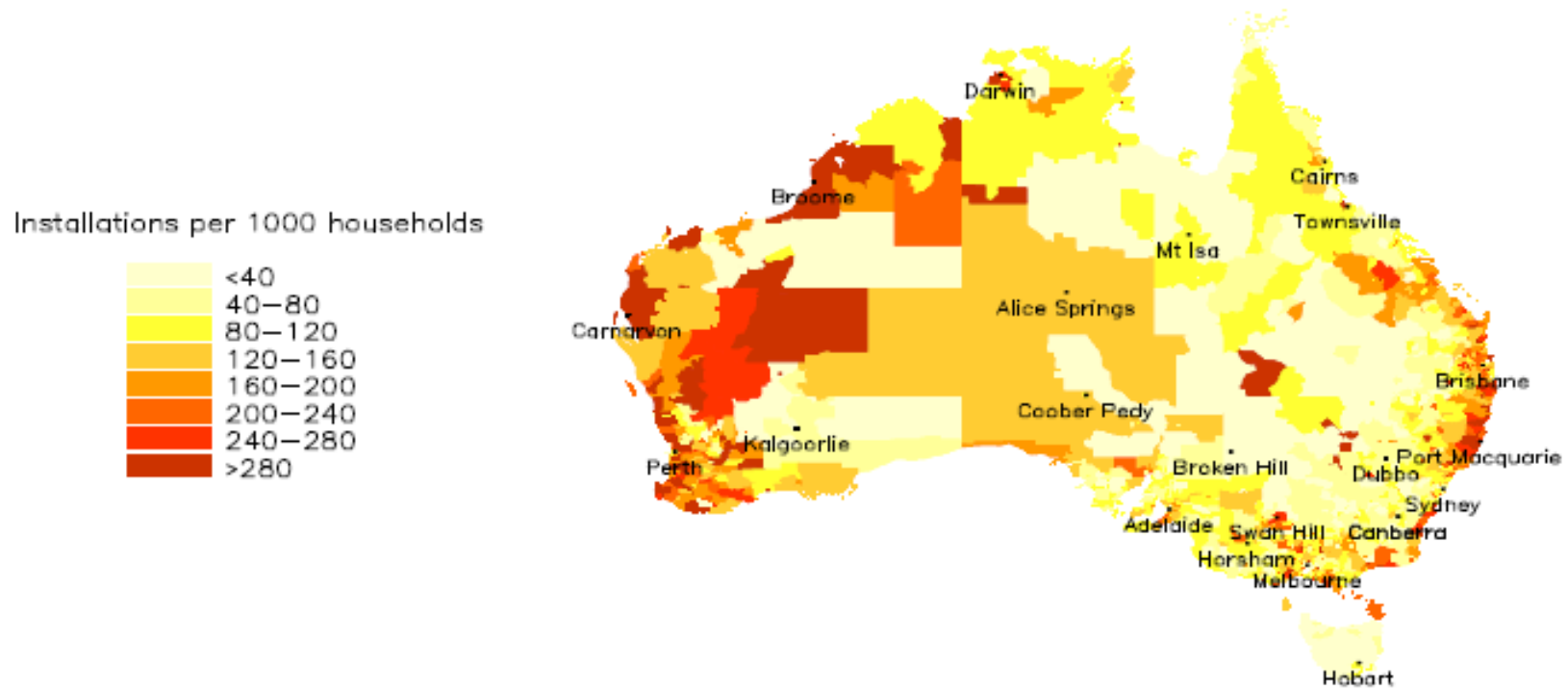




Figure 1.2: Penetration of Solar Hot Water Systems by Postcode, installations per 1,000 dwellings







**Table 1.1: All Postcodes, Penetration of Solar PV by postcode, selected variables and relationships**

Relationship type	Penetration increases with:	Penetration decreases with:
<b>Significant, strong relationship</b>		<ul style="list-style-type: none"> <li>• Proportion of people in younger age range (20 – 34)</li> <li>• Proportion of people with poor English</li> </ul>
<b>Significant relationship, not classified as strong</b>	<ul style="list-style-type: none"> <li>• Proportion of people in most likely age range (35-74)</li> <li>• Proportion of people caring for their own children</li> <li>• Proportion of young children (age &lt; 15)</li> <li>• Proportion of most likely dwellings to install solar PV (house, semi-detached etc.)</li> <li>• Proportion of houses that are separate or semi-detached and are owned or being purchased</li> <li>• Proportion of households that are families</li> <li>• Average number of bedrooms per dwelling</li> <li>• Proportion of family or households with weekly gross income between \$1,000 - \$1,699 (below means test threshold for capital contribution from Federal government but sufficient incomes)</li> <li>• Proportion of family or households with weekly gross income \$250 - \$649 Average rent stress (rent/income)</li> <li>• Proportion of dwellings with 3 or more cars</li> </ul>	<ul style="list-style-type: none"> <li>• Average salary or wages (ATO)</li> <li>• Persons per sq. km(density)</li> <li>• Median family income</li> <li>• Median household income</li> <li>• Proportion of family or households with weekly gross income \$1,700 and above (higher incomes)</li> </ul>



**Table 1.2: All Postcodes, Penetration of Solar Hot Water Systems by postcode, selected variables and relationships**

Relationship type	Penetration increases with:	Penetration decreases with:
<b>Significant, strong relationship</b>	<ul style="list-style-type: none"> <li>• Proportion of young children (age &lt; 15)</li> <li>• Proportion of most likely dwellings to install solar PV (house, semi-detached etc.)</li> <li>• Proportion of family or households with weekly gross income between \$1,000 - \$1,699 (below means test threshold but sufficient incomes)</li> <li>• Proportion of Aboriginal &amp; Torres strait islanders</li> </ul>	<ul style="list-style-type: none"> <li>• Proportion of people in younger age range (20 – 34)</li> <li>• Persons per sq. km</li> <li>• Proportion of people with poor English</li> </ul>
<b>Significant relationship, not classified as strong</b>	<ul style="list-style-type: none"> <li>• Proportion of people caring for their own children</li> <li>• Proportion of Australian citizens</li> <li>• Proportion of houses that are separate or semi-detached and are owned or being purchased</li> <li>• Proportion of households that are families</li> <li>• Average number of bedrooms per dwelling</li> <li>• Proportion of family or households with weekly gross income \$250 - \$649 (very low incomes)</li> <li>• Proportion of dwellings with 3 or more cars</li> </ul>	<ul style="list-style-type: none"> <li>• Proportion with schooling year 11 or higher aged (35-74)</li> <li>• Proportion who live at same address five years ago</li> <li>• median family income</li> <li>• Proportion of family or households with weekly gross income \$1,700 and above (higher incomes)</li> </ul>



### 1.3 Further Directions for Research

We have identified a number of areas for further work that can better identify and understand the characteristics of customers taking up these technologies to assist policy makers in refining and better targeting renewable energy technology initiatives. These include:

- possibilities for further work on existing material, including:
  - undertaking further comparisons of the experience of uptake by States and Territories;
  - establishing the significance of the non-linear relationships identified;
  - identifying and understanding correlations between linear relationships;
  - identifying causal relationships.
- possibilities for supplementing the current material, including:
  - supplementing the data set to more comprehensively capture dimensions of Wealth and Social Advantage not captured by the current analyses ;
  - restating the results at the LGA level and comparing with survey data, so as to compare our findings with other findings on the incidence of costs and relative disadvantage;
  - developing a predictive model by refining the multivariate work already undertaken;
  - testing the effects of Social Attitudes on Program Participation: survey material to supplement data.

These possibilities are discussed at greater length in Section 4.

### 1.4 The structure of this report

The background to the study, including the range of Federal, State and territory initiatives relating to the take-up of small scale renewable technology, is briefly described in Section 2.3. Section 2.3 also describes the basis for our approach and our methodology. Appendix A provides detail on the data provided by the ORER and our selected census variables. Detailed results and the interpretation of some of our findings are discussed in Section 3, while Appendices B, C and D contain detailed results for Solar PV, solar hot water and wind installation penetration from 2001 to mid-March 2011, using a range of approaches to looking at the underlying installation data, including size, prevailing regulatory regime and, in the case of solar hot water installations, whether the installation was a replacement system or part of new build. Section 4 discusses the opportunities for further research that could build on the findings of this report.



## 2 Methodology

### 2.1 Background

The Small Scale Renewable Energy Scheme (SRES) was established as part of the enhanced Renewable Energy Target (RET) legislation in 2010 and is designed to encourage the take-up of small scale renewable energy systems over the 10 years to 2020 through providing eligible households and others with an incentive to install small scale renewable energy systems. The SRES followed a number of other Federal government schemes with similar objectives, detailed in SKM-MMA's recent study for the Office of the Renewable Energy Regulator (ORER)<sup>3</sup>, all of which are collectively referred to in this report as SRES for ease.

From late 2007 onwards, various state governments offered households direct incentives to install certain small scale renewable energy systems, including heat pumps and solar hot water systems, as well as additional incentives through the introduction of subsidies for the output of solar PV systems from feed-in tariffs<sup>4</sup>. In the case of feed-in tariffs, the subsidy is incremental to the assistance provided through the SRES, resulting in markedly different costs to households from state to state and across different periods for solar PV installations.

A combination of more generous Federal assistance and the introduction of the state feed-in tariff schemes resulted in a very significant increase in the rate of take-up of qualifying renewable energy technologies, slowing more recently following the changes to the scheme preceding the introduction of SRES<sup>5</sup>.

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<sup>3</sup> SKM-MMA, *Small-scale Technology Certificates Data Modelling for 2011 to 2013: Final Report*, 29 November 2010.

<sup>4</sup> Again, see SKM- MMA for a chronology of the schemes by eligible technology and level of assistance

<sup>5</sup> For example, the NSW Solar Bonus Scheme exceeded the expected cumulative uptake originally projected for around 2012 in an 11 month period and on the basis of trend uptake was projected, prior to its amendment in late 2010, to deliver nearly 1,000 MW of capacity by the end of the Scheme on 31 December 2016, at a total cost of approximately \$2.7 billion (net present value, \$2010) of tariff payments (Department of Industry and Investment, *NSW Solar Bonus Scheme: Statutory Review, Report to the Minister for Energy*, October 2010, pps 11, 35). Projected uptake in other states, while lower than that in NSW, has been sufficiently strong to result in the date at which the scheme cap is reached being bought forward. (See, for example, SKM-MMA's discussion of projected Victorian uptake.)



## 2.2 Purpose of this study

Seed Advisory has been commissioned by the AEMC to undertake an historic analysis of relationships underlying successful applications for the SRES program, based on ORER data, census data and other publicly available small area data. Merging the ORER data with additional demographic data at a postcode level is designed to assist in identifying historic explanatory drivers of the uptake of technologies beyond financial payback, including potentially age, average income, family characteristics and education. We have undertaken our analysis using a ‘first principles’ based approach which necessarily required a broad selection of demographic variables and an analysis at an independent variable by variable level.

Analysis of the data has been undertaken using R, a statistical package that uses a wide range of statistical methods for time series and statistical analysis. We have not audited the ORER data and we have used, without auditing, the net cost data provided by ACIL Tasman.

Our methodology is outlined below, while the variables included in our analysis and the variables from the ORER data base used in the analysis and the basis for their selection are detailed in Appendix A.

## 2.3 Choice of Variables

In selecting the variables to be included in the analysis, we considered the available information on the take-up of the SRES, as well as other information related to the characteristics of people with an interest in action on climate change<sup>6</sup>, to identify variables that were likely to be of interest and to formulate hypotheses about their potential contribution.

We considered: the results of IPART’s 2010 survey of utility customers in Sydney and the Hunter Valley<sup>7</sup>; comments made by the ACT Regulator about the take-up of solar PV in the ACT<sup>8</sup>; the report by AECOM for the NSW Department of Primary Industries on the

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<sup>6</sup> CSIRO’s Energymark program provides some interesting insights into groups in the community most likely to participate in an information program and respond to increased information by reducing their carbon footprint. See Mendham, Carr-Cornish and Dowd, *Energymark Trial: Final Report*, South Australian Local Government Association, July 2010, EP104243

<sup>7</sup> Independent Pricing and Regulatory Tribunal, *Residential Energy and Water Use in Sydney, the Blue Mountains and Illawarra: Results from the 2010 Household Survey*. Electricity, Gas and Water – Research Report, December 2010

<sup>8</sup> Independent Competition and Regulatory Commission, *Final Report — Electricity Feed-in Renewable Energy Premium: Determination of Premium Rate*, 2010



performance of the Solar Feed-In Tariff Scheme in NSW<sup>9</sup>; the Australia Institute paper on the cost-effectiveness and fairness of the SRES<sup>10</sup>; as well as various submissions made by interested parties, such as the Public Interest Advocacy Center on the NSW Feed-In Tariff Schemes. Generally, this material looked at only single dimensions to the uptake of small scale renewable energy technologies – income or the share of suitable (separate or semi-detached) dwellings or socio economic status, for example – suggesting variables for consideration, rather than identifying testable hypotheses on the characteristics of program uptake, which, as Figure 1.1 and Figure 1.2 show, is characterised by marked differences spatially across Australia<sup>11</sup>. To the extent that the existing studies had looked at ORER data, only a sample of that data – in most cases, looking only at one state - had been considered, where this study has the advantage of ORER's data nationally, from the inception of the first program.

In addition to considering the published information on the SRES program, we consulted with a former senior executive of a company installing solar PV systems nationally to identify the characteristics that large scale installers focus on when selecting areas for blanket marketing. We also consulted with the AEMC staff about potential variables and hypotheses.

Appendix A lists the variables selected from the census and the ATO data, together with a description of each variable and the hypothesis behind the inclusion of the variable in the univariate analysis.

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<sup>9</sup> AECOM, *Solar Bonus Scheme: Forecast NSW PV Capacity and Tariff Payments*, Industry & Investment NSW, 25 October 2010

<sup>10</sup> Macintosh and Wilkinson, ANU Centre for Climate Law and Policy, *The Australian Government's solar PV rebate program: An evaluation of its cost-effectiveness and fairness*, The Australia Institute, Policy Brief No. 21 November 2010. See Section 3.3, which discusses our findings on penetration by IRSAD, which are inconsistent with the conclusions on fairness in this paper.

<sup>11</sup> Following the completion of our draft report, we became aware of the study by Bruce, A, Watt, M. E. and Passey, R., *Who Buys PV Systems? A survey of NSW residential PV rebate recipients*, Solar09, the 47th ANZSES Annual Conference, 29 September-2 October 2009, which looks at the results of a small survey of NSW solar PV program participants. Our results cannot be directly compared to the findings of this paper; we have looked at a different set of age ranges, for example. However, the significance of the findings of this paper is unclear. For example, the finding that older age groups (61 years plus) are disproportionately represented in the sample compared with the NSW population is not qualified by any reference to the standard error relating to the sample size or methodology.



## 2.4 Methodology

A similar process was followed for the analysis of solar PV and solar water heater data supplied by the ORER:

- the data and its quality was reviewed;
- where necessary, the ORER data was cleaned;
- the census, taxation, economic and payback data was prepared;
- the different data sources were combined into a single file;
- maps were prepared on city, state and Australia-wide scales, showing penetration at the post code level, expressed as the number of installations per 1,000 dwellings;
- analysis of the postcode level data was undertaken by individual variables (univariate) and with all variables simultaneously (multivariate) was undertaken.

### 2.4.1 Data Analysis: Data Provided

ORER provided data on installations of Solar PV, solar hot water systems and eligible small generating unit (SGU) wind installations for the period from 2001 to mid-March 2011.

Table 2.1 and Table 2.2 contain installations by year and state for Solar PV and solar hot water systems.

### 2.4.2 Data Quality Review: ORER Data

For each of the categories, each of the data fields supplied was tabulated to see what values were included in the dataset and the number of unknown or clearly invalid values. Where possible, checks were made for internal consistency.

Some fields included in the data supplied had not been used in earlier period(s) or their values had changed over time. Where this was the case, the analysis possible was limited. For example, looking at the data for solar hot water systems:

- the commercial/domestic classification was characterised by a large number of Unknowns in the earlier years, with the number of Unknowns reducing from 2007;
- the installation type (new/replacement) appears to be split into additional values in 2006;
- fuel source name has only been split between heat pumps and solar for creation dates from 2011.

Overall, the quality of the data seemed reasonable, although the solar hot water system data seems likely to be of lower quality, based on the number of invalid postcodes - 1008 or 0.2 per cent for solar hot water compared to 17 or 0.01 per cent for Solar PV. Table 2.3 provides a reconciliation of total records provided and records used in the analysis, by category of installation.



Table 2.1: Solar PV Installations by State and Year of Installation, number of installations

Installation year	State/Territory								Total
	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	
2001	93	2,065	651	4,340	696	26	550	2,420	10,841
2002	277	4,773	1,115	7,921	1,923	97	1,410	5,018	22,534
2003	395	7,294	987	8,860	3,544	169	1,496	6,165	28,910
2004	479	7,895	1,185	8,941	3,011	150	1,784	7,682	31,127
2005	413	7,830	1,214	8,596	3,170	140	2,501	9,213	33,077
2006	219	7,669	1,344	9,988	2,432	140	4,883	9,990	36,665
2007	487	8,958	1,471	17,008	2,920	374	9,545	12,680	53,443
2008	1,040	20,261	1,345	23,378	5,120	865	21,012	12,733	85,754
2009	2,176	87,089	1,865	36,225	8,606	2,079	40,241	15,967	194,248
2010	1,008	37,816	13,92	33,382	6,251	1,303	25,188	15,327	121,667
2011	86	2,514	58	2,402	327	171	888	1,000	7,446
<b>Total</b>	6,673	19,4164	12,627	161,041	38,000	5,514	109,498	98,195	625,712

Table 2.2: Solar Hot Water System Installations by State and Year of Installation, number of installations

Installation year	State/Territory								Total
	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	
2001	0	15	16	57	44	0	26	19	177
2002	0	25	19	120	138	1	27	42	372
2003	7	135	12	204	287	9	109	21	784
2004	5	242	23	417	322	18	160	37	1,224
2005	3	298	43	375	431	13	256	97	1,516
2006	17	210	23	194	412	4	200	57	1,117
2007	57	768	26	471	1,037	25	828	261	3,473
2008	279	2,891	92	3,082	3,456	161	2,035	2,068	14,064
2009	779	14,041	251	18,244	8,571	1,452	8,412	11,157	62,907
2010	2,084	59,714	758	41,245	14,699	1,716	31,508	21,236	172,960
2011	238	11,068	9	5,425	2,677	115	2,061	3,840	25,433
<b>Total</b>	3,469	89,407	1,272	69,834	32,074	3,514	45,622	38,835	284,027





Table 2.3: ORER Records by type of installation, original records and records included in the analysis

Category	Solar PV	Solar Hot Water	Wind
<b>Records in original ORER file</b>	284,027	635,796	338
<i>Less Records assumed to be commercial installations</i>	-	10,081	0
<b>Record count for assumed residential installations</b>	284,027	625,715	338
<i>Less records with unmatched postcodes</i>	0	3	0
<b>Records used for analysis</b>	284,027	625,712	338

### 2.4.3 Data Preparation: ORER Data

After the review and initial cleaning of the data:

- Each column of the ORER data was summarised to find invalid or missing values;
- Postcodes were checked against the current Post Office list for invalid values;
- Postcodes were checked against the list of postcodes in the census. The census postcode areas do not match post office postcode areas exactly. Some postcodes are not included in the census as they were split between several other postcodes, usually because of their small number of dwellings. Other postcodes are not delivery areas, for example, post office boxes, so they are not included in the census areas. For those postcodes that were not matched, the location (city and state) was checked against the locations in the Post Office list of postcodes and, if an exact match was found, the corresponding postcode was used in place of the postcode in the data.
- For the remaining unmatched postcodes, Google Earth was used to find the latitude and longitude of the location. The nearest postcode in the census list was found using the latitudes and longitudes in the census maps and that nearest postcode was used in the place of the postcode in the data.
- Some postcodes are in two Australian states, so it is not possible to uniquely assign a state to a postcode. An arbitrary choice of state was made.
- For Solar PV installations, the Renewable Energy Certificate (REC) multiplier was checked against the number of RECs calculated from the zone and kW. If the



stated number of RECs was less than the calculated number of RECs, the multiplier was set to 1. As a result, 85 values were changed.

The following changes to the data as a result of the data quality review and data preparation were made:

- **Solar PV:** 1224 postcodes were changed to nearby postcodes as they were either not valid postcodes (17), not in the census postcodes, or were too small to have a meaningful average.
- **Solar Hot Water:** 4088 postcodes were changed to nearby postcodes as they were either not valid postcodes (996), not in the census postcodes, or were too small to have a meaningful average. A record was classified as domestic if it had type domestic or had at most 50 RECs. Eleven (11) records were re-classified as domestic from commercial and 85,783 records were re-classified from unknown to domestic. Three (3) records without a usable postcode were removed.
- **SGU Wind:** Two postcodes were changed to nearby postcodes as they were either not in the census postcodes, or were too small to have a meaningful average.

#### 2.4.4 Data Preparation: Other Data

In addition to the ORER data, four additional sources of data were used:

- 2006 census data and the 2006 Socio-Economic Indexes from Areas (SEIFA) from the Australian Bureau of Statistics;
- Taxation data for 2006/7 from the Australian Taxation Office;
- Three economic series from the Reserve Bank of Australia;
- Payback data for Solar PV installations, provided by ACIL Tasman.

Appendix A lists the variables selected from the census and the ATO data, together with a description of each variable and the hypothesis behind the inclusion of the variable in the univariate analysis.

##### Census Data

The census was checked for postcodes with fewer than 10 dwellings and these postcodes were removed from the census list as they would not have sufficient data to give stable averages. This is a simple approximation to the more complex filtering that is done for the SEIFA indices.

Various ratios were calculated from combinations of census variables.

The SEIFA indices – Index of Relative Social Advantage and Disadvantage (IRSAD), Index of Economic Resources (IER) and the Index of Education and Occupation (IEO) – are calculated by the ABS from the 2006 census data.



### **Taxation Data Preparation**

Taxation data for 2006/7 was classified by postcode of the taxpayer. Various ratios were calculated from combinations of the taxation variables: in most cases, the average per taxpayer was calculated.

### **Economic Data Preparation**

Quarterly economic data from the RBA was collated for the relevant dates. The variables used were: GDP (RBA Table G10); CPI (Table G2, all groups); and unemployment rate (Table G7).

### **Solar PV Net Cost Data Preparation**

Net cost data was provided by ACIL Tasman for 2008 onwards, quarterly, by state, and in the case of WA, by network, for a range of kW. For each installation, the date for the installation quarter for the relevant state and supplier was used and the net cost was interpolated based on the kW. For dates prior to 2008, it was assumed that the net cost decreased by 3 per cent annually from 2001 to reconcile to the values provided by ACIL Tasman from 2008. While this assumption may not represent the actual path for solar PV costs in the period prior to 2008, the number of installations in this period is small and we believe the assumption will not bias the results.

## **2.4.5 Combining the Data**

The census, SEIFA and taxation data were combined with the ORER data by matching the postcode. The economic data and payback data were combined with the ORER data by matching the installation quarter and, in the case of the net cost data, by state and network.

## **2.4.6 Mapping**

Maps were based on the census postcode boundaries supplied with the 2006 census data. The scale of the legend was selected to have 5 to 10 per cent of the installations in the highest range.

## **2.4.7 Analysis at the Postcode Level**

### **Univariate Analysis**

The univariate analysis looks at the relationship between a variable such as the number of installations per thousand dwellings in a postcode – the dependent variable, on the vertical axis– with a single average attribute of that postcode, for example, the average age – the independent variable, on the horizontal axis.

To do this comparison, postcodes need to be grouped by the independent variable in some way. We chose to do this simply, by putting equal numbers of dwellings in each group. In most cases, ten groups (deciles) were used, so the lowest group or decile is



the 10 per cent of dwellings in postcodes with the lowest values of the independent variable. For example, looking at median family income, the average median family income in the first (lowest) decile is (\$2006) \$882/week or approximately (\$2006) \$46,000/year, while the value for the tenth (highest) decile is higher than (\$2006) \$1,777 or around (\$2006) \$92,000/year.

Relationships are often highly non-linear, so there is no simple way of describing the strength of the relationship. Visual inspection of the smoothness of the graph is the best way of making that judgement, but this was not practical with the large number of relationships, so a simplified criterion related to the linearity of the relationship was used that may miss some significant but highly non-linear relationships. For key variables where the relationship appears to be non-linear – for example, certain income variables or the results for the Index of Relative Social Advantage and Disadvantage – the results have been discussed in Section 3.3, even though the significance of the relationship may appear unclear.

An approximate standard error measure was calculated that can be used to assess the significance of differences between rates for each decile. However, in the case of the wind data, the number of installations was too small to split the data, so a single average was compared with the average for the solar PV data. The standard error for each of the averages – solar PV and wind – was used to calculate a standard error of the difference between the averages. Dividing the difference by its standard error gives a rough measure of significance – if the value is greater than two, the difference is judged to be significant, that is, that variable is significantly different for wind and solar.

### **Multivariate Analysis**

The multivariate analysis models the number of installations as a non-linear function of selected ORER, census, taxation, economic, time and payback variables. The modelling was done using the GBM (Generalized Boosted Models) package in the R software. The software rates variables by “importance”, which measures the contribution of each variable to explaining the number of installations. Truncated results for the initial multivariate analysis using all variables chosen are presented in Section 3.2. However, as Section 4.5 discusses, further work should be done on this analysis, in particular to refine the variables included.

## **2.5 Identifying Significant Linear Relationships**

In the discussion that follows and in the tables presented in the appendices, we have classified the relationships resulting from our initial analysis in the following categories, excluding all variables where the relationship with penetration, measured by



installations per 1,000 dwellings, has an R-squared of less than 0.7<sup>12</sup>. For SGU wind installations, however, this analysis has not been undertaken, given the small number of installations.

In further classifying the relationships, we have used the following sub-categories:

- **Strong Positive:** the slope of the relationship (and the correlation) is positive and the slope is such that as the average value of the independent variable increases from decile one through to decile ten the penetration rate increases by more than its average value. For example, the average penetration per 1,000 dwellings for solar PV at a national level is 40, so a strong positive relationship is one where the penetration at decile ten for the independent variable is at least 40 installations per 1,000 dwellings higher than the penetration at decile one for the same independent variable. The relationship between the number of Solar PV installations per 1,000 dwellings and the share of persons employed in the construction industry falls into this category: as the average share of persons employed in the construction industry increases as a proportion of employed persons, the penetration of Solar PV installations increases<sup>13</sup>. This sub-category is illustrated in Figure 2.1.
- **Positive:** the slope of the relationship (and the correlation) is positive and the slope is such that as the average value of the independent variable increases from decile one through to decile ten the penetration rate increases by between 50 per cent - 100 per cent of its average value. For example, the average penetration per 1,000 dwellings for solar PV at a national level is 40 so a positive relationship is one where the penetration at decile ten for the independent variable is between 20 – 40 installations per 1,000 dwellings higher than the penetration at decile one for the same independent variable. The relationship between the number of Solar PV installations per 1,000 dwellings and the share of most likely dwellings (detached and semi-detached single family dwellings) falls into this category: as the most likely dwellings increase as a proportion of total dwellings, the penetration of Solar PV installations increases. This sub-category is illustrated in Figure 2.2.

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<sup>12</sup> We are confident that these results have a statistically significant linear relationship: given the number of observations in the data set, the standard errors associated with each decile are very small and even two standard errors in either direction would result in no material change to the cut off points for each decile or the results.

<sup>13</sup> Section 3.3 discusses the findings on industry of employment and employment classification. Some part of the explanation is likely to be income related and some part of the explanation lies in locational factors. Male Average Weekly Ordinary Time Earnings (AWOTE) in the construction industry in 2006 was relatively low, which may partly explain this finding. However, employment in the mining sector is positively related to penetration, although AWOTE was more than 50 per cent higher than in construction: in this case, we believe the explanation is locational.



- **Flat:** the slope of the relationship is such that as the average value of the independent variable increases from decile one through to decile ten the penetration rate increases or decreases by between 0 - 50 per cent of its average value. For example, the average penetration per 1,000 dwellings for solar PV at a national level is 40 so a positive relationship is one where the penetration at decile ten for the independent variable is between 0 - 20 higher installations per 1,000 dwellings or lower than the penetration at decile one for the same independent variable. The relationship between the number of Solar PV installations per 1,000 dwellings and the share of most likely dwellings (detached and semi-detached single family dwellings) *with* broadband falls into this category: as share of the most likely dwellings with broadband increases as a proportion of total dwellings, the penetration of Solar PV installations shows very little variation<sup>14</sup>. This sub-category is illustrated in Figure 2.3.
- **Negative:** the slope of the relationship (and the correlation) is negative and the slope is such that as the average value of the independent variable increases from decile one through to decile ten the penetration rate decreases by between 50 per cent - 100 per cent of its average value. For example, the average penetration per 1,000 dwellings for solar PV at a national level is 40 so a negative relationship is one where the penetration at decile ten for the independent variable is between 20 – 40 installations per 1,000 dwellings lower than the penetration at decile one for the same independent variable. The relationship between the number of Solar PV installations per 1,000 dwellings and the number of persons per square kilometer (density) falls into this category: as average number of persons per square kilometer increases, the penetration of Solar PV installations falls. This sub-category is illustrated in Figure 2.2.

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<sup>14</sup> Contrary to our expectations! This variable was included in an attempt to include a representation of “early adopter” behaviours.



Figure 2.1: Strong Positive and Negative Relationships, sample relationship with penetration, installations per 1,000 dwellings

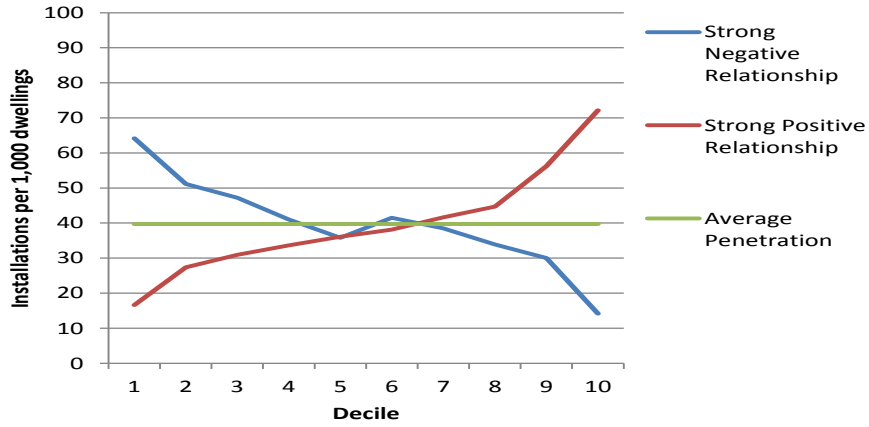


Figure 2.2: Positive and Negative Relationships, sample relationship with penetration, installations per 1,000 dwellings

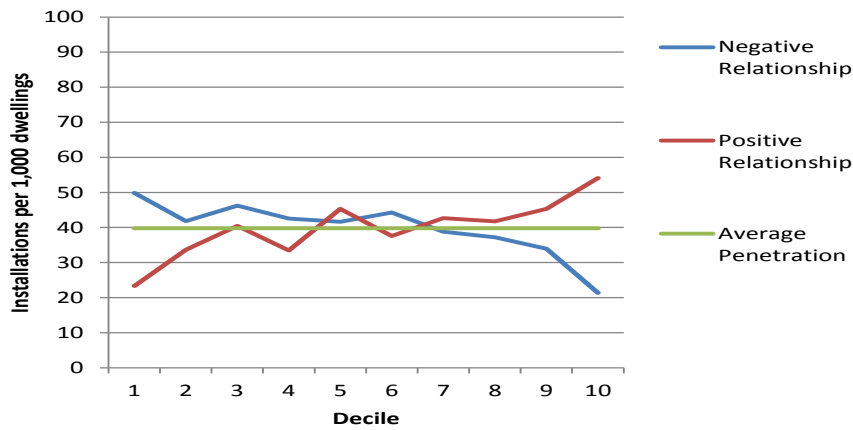
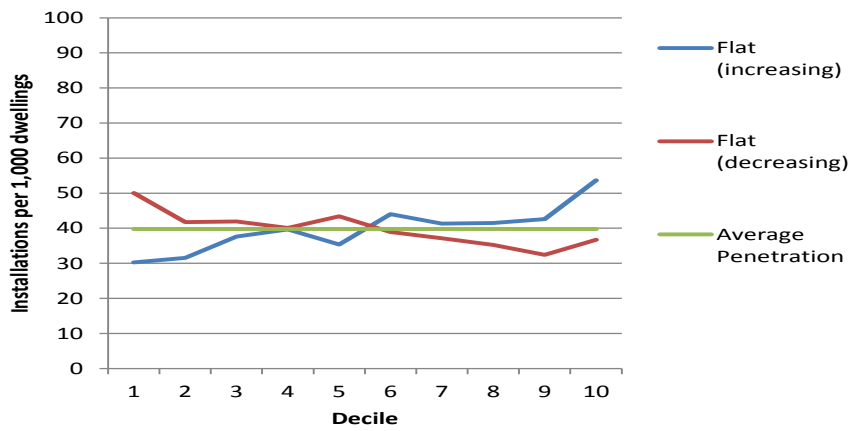


Figure 2.3: Flat Relationships, sample relationship with penetration, installations per 1,000 dwellings





- **Strong Negative:** the slope of the relationship (and the correlation) is negative and the slope is such that as the average value of the independent variable increases from decile one through to decile ten the penetration rate decreases by more than its average value. For example, the average penetration per 1,000 dwellings for solar PV at a national level is 40 so a strong positive relationship is one where the penetration at decile ten for the independent variable is at least 40 installations per 1,000 dwellings lower than the penetration at decile one for the same independent variable. The relationship between the number of Solar PV installations per 1,000 dwellings and the share of the population aged 20 to 34 years falls into this category: as the share of the population in this group increases as a proportion of total population at the postcode level, the penetration of Solar PV installations falls. This sub-category is illustrated in Figure 2.1 .

A similar approach has been used for relationships looking at relationships with the size of installation: the results for this analysis, which are of significantly less interest than the results for solar PV penetration, are included in Appendix B for Solar PV.

Corresponding results for solar hot water systems similar to those included for Solar PV installations are included in Appendix C.

## 2.6 Other Non-Linear Relationships

Very few of the income variables and wealth surrogates we tested had significant linear relationships with the penetration of small scale renewable energy technologies, contrary to our initial hypotheses and inconsistent with other findings<sup>15</sup>. Median family income at the postcode level has a significant negative, but not strong, relationship with penetration of Solar PV, while household income falling in the range of \$2006 1,000 to

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<sup>15</sup> Macintosh and Wilkinson (2010) find, for example, “The results show that the rebates under the [program] were skewed toward postal areas with medium-high to high SES ratings; 66 per cent of all successful applicants were from these postal areas. In the early years of the [program], the distribution was more equitable, with a greater proportion of applicants coming from postal areas with low and medium-low SES ratings. However, as the program matured and the number of successful applicants increased, the proportion of successful applicants from these lower SES postal areas declined. In the final 18 months of the program ... only 11 per cent of successful applicants came from low SES postal areas.”

However, the the ACT regulator, the Independent Competition and Regulatory Commission, has undertaken some work on the outcomes of the ACT feed-in tariff scheme and concluded:

“Following the release of the draft report the Commission undertook some preliminary work to identify whether installation of renewable energy generators was higher in suburbs with higher average income levels. However, such a trend was not apparent at this time from the available data. It may be that take-up is more closely related more to wealth than income, given the up-front capital required. This is an issue that can be explored at some future time when additional information is available. “ ICRC, 2010, p 49





1,700/week, equivalent to an annual income of between \$20,000 and 85,000, and eligible for government assistance under the 2007/08 program, has a significant positive, but not strong positive, relationship with penetration. To put this result into some perspective, this income range represents a range from 1.0 to 1.7 times AWOTE in 2006 and is consistent with a household with 2 adult employed persons.

However, further consideration of this issue suggests that the relationship between income and penetration is unlikely to be linear. Below a certain income level, a household is unlikely to have the resources to provide a contribution to the cost of the installation, while above the eligibility threshold the household would have received no government assistance towards the installation and the net cost of the installation would have been correspondingly higher. Our results suggest this pattern can be observed, although the significance of the relationships differs from variable to variable. Section 3.3 discusses this issue and illustrates our results in more detail.

## 2.7 Reading the charts

In Section 3, the results are presented in two types of charts.

- The first type of chart illustrates the relationship between the independent variable – say, density – on the horizontal axis and the dependent variable, the average number of solar PV or solar hot water installations per 1,000 dwellings, on the vertical axis.
  - Reading from left to right along the horizontal axis the chart moves from low to high through decile values of the independent variable at the postcode level. The postcodes are grouped so that each decile grouping contains the number of postcodes that results in the total number of installations being roughly equal in each group.
  - For density, for example, the first (lowest) decile contains all postcodes where there are fewer than 7.6 people per square kilometre. The last (highest) decile includes all postcodes where there are more than 2,886 people per square kilometre.
  - Figure 3.8 illustrates this relationship and shows the penetration rate for the first decile as 41 solar PV installations per 1,000 dwellings, increasing up to decile 3 and then decreasing until the penetration rate associated with the last (tenth) decile, when the penetration rate is 12.8 solar PV installations.
- The second type of chart looks at the percentage difference between national average penetration and the penetration for a particular decile for a given independent variable.
  - Figure 3.5 falls into this category and looks at the difference between the national average penetration rate for solar PV installations and the penetration



rate for each decile of installations, ranked by Median Family Income. The difference is expressed as a percentage of the national average penetration rate, so in Figure 3.5, penetration of solar PV for postcodes in the lowest (first) decile is 25 per cent higher than the national average, or fractionally under 50 installations per 1,000 dwellings<sup>16</sup>.

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<sup>16</sup> For these charts, generally speaking, the standard error associated with each decile is around or under 2.5 per cent. So, any difference between the national average penetration rate and the decile value of more than 5 per cent is likely to be significant.



### 3 Key Findings

As at mid-March 2011, there were fractionally under 40 solar PV installations for every 1,000 dwellings Australia wide (“the penetration rate”), calculated from the number of dwellings in the 2006 census. For solar hot water heaters, there were approximately 88 solar hot water heaters for every 1,000 dwellings nationally (“the penetration rate”). Figure 1.1 shows the penetration of Solar PV, expressed as installations per 1,000 dwellings by postcode for Australia. The highest penetration areas include: a number of remote areas in Western Australia, South Australia and western NSW<sup>17</sup>; coastal areas, from north of Port Macquarie to north of Brisbane and north of Perth; and Hobart and its surrounds, including Bruny Island.

Our findings attempt to identify characteristics that explain some of the variation displayed at the postcode level in Figure 1.1 and suggest that the uptake of small scale renewable technologies is affected by a range of variables, including family and dwelling characteristics, location, age, industry of employment and employment role.

Looking first at the results of the univariate analysis, then:

- There are strong linear relationships between the penetration of solar PV and solar hot water systems and around a third of the census and ATO variables included in our analysis. Penetration of both technologies displays a relationship with similar variables. Section 3.1 lists these variables and our views about their contribution to understanding uptake of small scale renewable energy technologies. Appendices B and C contain information on all variables reviewed, classified by the significant linear relationship found, if any, for Australia and the individual states and territories.
- There are also a number of non-linear relationships that vary in significance, but which may be important in understanding the characteristics of the uptake of small scale renewable technologies. In this report, we discuss the relationships between penetration and income, wealth and social disadvantage and disadvantage, the last of which clearly has a non-linear relationship with penetration rates for solar PV and solar hot water.
- We found relatively few variables at a national level that vary with the average size of installation of Solar PV or solar hot water systems and none with a relationship that is consistent across more than a few states (see Table B. 7 and Table C. 7)
- Significant relationships between penetration of small scale renewable energy technologies and the characteristics of postcodes with high (or low) penetration

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<sup>17</sup> Penetration in these areas may be the result of a relatively small number of dwellings at the individual postcode.



differ from state to state and across time (see Table B. 3. and Table C. 4). The material contained in these appendices is based on decile values for the independent variable taken from the national distribution. Although we compared the results using national and state deciles and believe that the state deciles generally add very little additional insight, in some areas this approach may not adequately control for differences in the state population and may obscure the underlying driver for take-up of small scale renewable energy technologies. For example, looking at penetration by state and income decile using national income deciles means that no Tasmanian postcodes are included in the top income decile because no Tasmanian postcode has an average income that falls into the top decile of the national distribution. This has the effect of suggesting that the decline in penetration rates associated with income is sharper than in other states, whereas the slope of the line is determined by the interaction of the characteristics of Tasmanian postcodes with the national distribution.

- The preliminary analysis of relationships at the multivariate level suggests that different relationships may be significant when the variables are tested together. There are relatively few commonalities between the truncated results of the preliminary multivariate analysis and the significant relationships identified at the univariate level.

### 3.1 Postcodes with higher penetration of small scale renewable technology

Looking first at the significant relationships identified for Solar PV installations, then Table 3.1 lists the variables with a significantly linear relationship to the penetration of Solar PV at the postcode level Australia-wide. A similar list of variables for solar hot water installations is contained in Table 3.2. As we discuss below, we believe that some part of the explanation – but not all – for the significance of the industry of employment and employment role variables is income, so our discussion of overall trends focuses on the italicized variables.

These results suggest that the penetration is higher in postcodes where the share of the population falling in the 35-74 year age group is higher. In contrast, where the share of the population characterised by a younger age group (between 20 and 34 years) is higher, penetration is lower. Postcodes with higher penetration rates also include postcodes with: a higher share of detached and semi-detached houses that are owned or being purchased; a larger number of bedrooms; a higher proportion of dwellings with young children; a higher number of cars per household; relatively low density; and a higher proportion of the population with an income in the range between (\$2006) \$1,000 to \$1,700/week. We have not, however, tested this set of characteristics for



their correlation with each other, so we cannot conclude that all postcodes with high levels of penetration are characterised by all of these features.

Table 3.1 and Table 3.2 also include a number of variables related to industry of employment and employment role. In some cases – for example, considering the significant positive relationship between the share of employment in the mining industry and penetration – we believe the relationship is related to the finding for density, while in other cases we believe the finding is related to the finding on income. Section 3.3 discusses this issue further. The tables in Appendices B and C highlight where the relationships identified at a national level differ at the state level.



Table 3.1: Penetration of Solar PV by postcode, variable and relationship type

Relationship type	Penetration increases with:	Penetration decreases with:
<b>Significant, strong relationship</b>	<ul style="list-style-type: none"> <li>• Proportion of people in the likely age range (35 – 74) and employed in the following industries:               <ul style="list-style-type: none"> <li>— construction</li> </ul> </li> <li>• Proportion of people in the likely age range (35 – 74) and employed in the following roles:               <ul style="list-style-type: none"> <li>— technical and trade workers</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• <i>Proportion of people in younger age range (20 – 34)</i></li> <li>• <i>Proportion of people with poor English</i></li> </ul>
<b>Significant relationship, not classified as strong</b>	<ul style="list-style-type: none"> <li>• <i>Proportion of people in most likely age range (35-74)</i></li> <li>• <i>Proportion of people caring for their own children</i></li> <li>• <i>Proportion of young children (age &lt; 15)</i></li> <li>• <i>Proportion of most likely dwellings to install solar PV (house, semi-detached etc.)</i></li> <li>• <i>Proportion of houses that are separate or semi-detached and are owned or being purchased</i></li> <li>• <i>Proportion of households that are families</i></li> <li>• <i>Average number of bedrooms per dwelling</i></li> <li>• <i>Proportion of family or households with weekly gross income between \$1,000 - \$1,699 (below means test threshold for capital contribution from Federal government but sufficient incomes)</i></li> <li>• <i>Proportion of family or households with weekly gross income \$250 - \$649 (very low incomes)</i></li> <li>• <i>Average rent stress (rent/income)</i></li> <li>• <i>Proportion of dwellings with 3 or more cars</i></li> <li>• Proportion of people in the likely age range (35 – 74) and employed in the following roles:               <ul style="list-style-type: none"> <li>— service workers</li> <li>— sales workers</li> </ul> </li> <li>• Proportion of people in the likely age range (35 – 74) and employed in the following industries:               <ul style="list-style-type: none"> <li>— agriculture, forestry and fishing</li> <li>— electricity / gas / water / waste services</li> <li>— health care and social assistance</li> <li>— mining</li> <li>— rental, hiring and real estate services</li> <li>— retail trade</li> <li>— other services</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• <i>Average salary or wages (ATO)</i></li> <li>• <i>Persons per sq. km(density)</i></li> <li>• <i>Median family income</i></li> <li>• <i>Median household income</i></li> <li>• <i>Proportion of family or households with weekly gross income \$1,700 and above (higher incomes)</i></li> </ul>



Table 3.2: Penetration of Solar Hot Water Systems by Variable and Relationship Type

Relationship type	Penetration increases with:	Penetration decreases with:
<b>Significant, strong relationship</b>	<ul style="list-style-type: none"> <li>• Proportion of young children (age &lt; 15)</li> <li>• Proportion of most likely dwellings to install solar PV (house, semi-detached etc.)</li> <li>• Proportion of family or households with weekly gross income between \$1,000 - \$1,699 (below means test threshold but sufficient incomes)</li> <li>• Proportion of Aboriginal &amp; Torres strait islanders</li> <li>• Proportion of people in the likely age range (35 – 74) and employed in the following roles: <ul style="list-style-type: none"> <li>— technical and trade workers</li> <li>— community and personal service workers</li> </ul> </li> <li>• Proportion of people in the likely age range (35 – 74) and employed in the following industries: <ul style="list-style-type: none"> <li>— agriculture, forestry and fishing</li> <li>— construction</li> <li>— mining</li> <li>— retail trade</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Proportion of people in younger age range (20 – 34)</li> <li>• Persons per sq. km</li> <li>• Proportion of people with poor English</li> <li>• Proportion of people in the likely age range (35 – 74) and employed in the following industries: <ul style="list-style-type: none"> <li>— financial and insurance services</li> <li>— information, media or telecommunications</li> </ul> </li> </ul>
<b>Significant relationship, not classified as strong</b>	<ul style="list-style-type: none"> <li>• Proportion of people caring for their own children</li> <li>• Proportion of Australian citizens</li> <li>• Proportion of houses that are separate or semi-detached and are owned or being purchased</li> <li>• Proportion of households that are families</li> <li>• Average number of bedrooms per dwelling</li> <li>• Proportion of family or households with weekly gross income \$250 - \$649 (very low incomes)</li> <li>• Proportion of dwellings with 3 or more cars</li> <li>• Proportion of people in the likely age range (35 – 74) and employed in the following roles: <ul style="list-style-type: none"> <li>— sales workers</li> </ul> </li> <li>• Proportion of people in the likely age range (35 – 74) and employed in the following industries: <ul style="list-style-type: none"> <li>— electricity / gas / water / waste services</li> <li>— public administration and safety</li> <li>— rental, hiring and real estate services</li> <li>— other services</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Proportion with schooling year 11 or higher aged (35-74)</li> <li>• Proportion who live at same address five years ago</li> <li>• median family income</li> <li>• Proportion of family or households with weekly gross income \$1,700 and above (higher incomes)</li> <li>• Proportion of people in the likely age range (35 – 74) and employed in the following industries: <ul style="list-style-type: none"> <li>— wholesale trade</li> </ul> </li> </ul>



## 3.2 Multivariate Analysis: Truncated Results

Table 3.3 contains the results of our initial multivariate analysis, truncated to show only those variables where our analysis shows a relative influence of more than 1 per cent. Collectively, these variables explain around 70 per cent of the variation from postcode to postcode in the penetration of Solar PV per 1,000 dwellings. Although the analyses are very different in their approach and interpretation, we have included the classification employed in the univariate analysis, where we had identified a strong linear relationship exists for a variable included in Table 3.1. In Table 3.3, where a Strong Positive, Positive, Negative, Strong Negative or Flat relationship was found in the univariate analysis, this has been noted. Where the variable has not been included in the univariate analysis, it is noted as “N/A” and where no significant relationship was observed in the univariate analysis, “–” has been used. Similar results for the penetration of solar hot water installations are included in Table 3.4.

These results are very preliminary and may differ significantly once the variables included are reviewed to exclude double-counting<sup>18</sup>, as well as removing variables that appear to contribute little to the analysis. As we discuss in Section 4.5, in narrowing the data set through a process of refining, testing and retesting, we may be able to develop a predictive model for small scale renewable technology penetration.

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<sup>18</sup> Double counting may take a variety of forms. For example, the net cost of technology and the net cost of technology as a share of income may be reflecting the same influence. Less obviously, the share of employment in the agricultural and mining sectors may be reflecting similar influences to density.





Table 3.3: Truncated Results, Penetration of Solar PV, Variables by Relative Influence and Relationship

Variable	Relative influence	Relationship in univariate analysis (national)
Quarterly unemployment rate (national)	10.4	N/A
State	10.2	N/A
Net cost of technology as a percentage of income	8.2	N/A
Proportion of people employed in health care and social assistance and in the likely age range (35-74)	7.0	Positive
Net cost of technology	5.9	N/A
Quarterly CPI (national)	3.4	N/A
Regulatory Period	3.2	N/A
Gross Domestic Product	2.9	N/A
Proportion of family or households with weekly gross income \$250 - \$649 (low but not very low incomes)	2.2	Positive
Proportion of people with poor English	2.0	Strong Negative
Proportion who live at same address as five years ago	1.9	-
Time period (Quarter) of installation	1.8	N/A
Proportion of machinery operators and drivers in mostly likely age range (35 - 74)	1.8	-
% Unemployment	1.7	-
Proportion of people employed in other services and in the likely age range (35-74)	1.7	Positive
Proportion of community and personal service workers in mostly likely age range (35 - 74)	1.6	Positive
Income (median household)	1.4	Flat
Average net capital gain	1.4	-
Proportion of people employed in education and training services and in the likely age range (35-74)	1.2	-
Proportion of people employed in agriculture, forestry & fishing in likely age range (35-74)	1.2	Positive



**Table 3.4: Truncated Results, Penetration of Solar Hot Water Systems, Variables by Relative Influence and Relationship**

Variable	Relative influence	Relationship in univariate analysis (national)
State	10.0	N/A
Proportion who live at same address five years ago	9.2	Negative
Quarterly unemployment rate (national)	8.0	N/A
Proportion of people employed in retail trade and in the likely age range (35-74)	4.0	Strong Positive
Proportion of Aboriginal & Torres strait islanders	3.6	Strong Positive
Quarterly CPI (national)	3.4	N/A
Regulatory Period	3.3	N/A
Gross Domestic Product	3.2	N/A
Persons per sq. km	3.0	Strong Negative
Proportion who live at same address one year ago	2.5	-
Proportion of clerical and administrative workers in mostly likely age range (35 - 74)	2.4	-
% Unemployment	2.2	-
Proportion of family or households with weekly gross income between \$1,000 - \$1,699 (below means test threshold but sufficient incomes)	2.1	Strong Positive
Proportion of people employed in construction and in the likely age range (35-74)	1.9	Strong Positive
Proportion of community and personal service workers in mostly likely age range (35 - 74)	1.8	Strong Positive
Proportion of sales workers in mostly likely age range (35 - 74)	1.8	Positive
Proportion of managers in mostly likely age range (35 - 74)	1.8	-
Proportion of people employed in health care and social assistance and in the likely age range (35-74)	1.7	-
Proportion of people employed in rental, hiring and real estate services and in the likely age range (35-74)	1.7	Positive
Average net capital gain	1.6	-



### 3.3 Univariate Analysis: Key Areas of Interest

#### Income bands

In this Section, we look at first at the linear relationships we observed between the specific income bands as a share of postcode population and penetration. These relationships suggest that penetration is higher, the higher the proportion of certain defined income groups in a given postcode as a share of the postcode population.

We then look at some income measures where a linear relationship appears to exist suggesting penetration decreases with income and discuss the implications of this finding taking into account our results for various wealth measures.

Finally, we look at the results of our findings on the relationship between penetration and the ABS's 2006 Socio-Economic Indexes from Areas, which appear to have a non-linear relationship with penetration and suggest that penetration of solar PV and solar hot water systems is lowest for both the lowest and highest groups in the Australian community, considering social disadvantage and advantage broadly.

To establish context, the distribution of the Australian and state and territory populations between income and age variables based on the 2006 census is given in Table 3.5. Table 3.6 provides details on the decile values for the median family income and median household income variables on a weekly and annualised basis.

#### 3.3.1 Defined income bands: positive relationship with penetration

Looking at indicators of income in our results, we have identified significant positive relationships between penetration and the proportion of families or households in a postcode with:

- weekly gross incomes between (\$2006) \$250 – \$649
- weekly gross incomes between (\$2006) \$1,000 – \$1,699, the cut-off point being just below the eligibility threshold for government assistance towards the capital cost of the installation under the SHCP program.

These relationships are displayed in Figure 3.1 and Figure 3.2 for Solar PV and solar hot water systems respectively.

We have also identified a significant negative relationship between penetration and the proportion of households in a postcode with incomes in excess of (\$2006) \$1,700/week. This relationship is illustrated by Figure 3.3 for Solar PV installations and Figure 3.4 for solar hot water services. Although the relationship is negative based on the slope of the line, the slope is heavily influenced by the lowest (first) and highest (deciles). Across the larger part of the distribution, the values are very similar and the slope of the relationship, while still negative, is significantly flatter.



Postcodes characterised by the proportion of households described as having sufficient income – all households with household income over (\$2006) \$1,000 week – display no significant linear relationship with penetration. This relationship is displayed Figure 3.1 and Figure 3.2 for Solar PV and solar hot water systems respectively.

These results cannot be interpreted as meaning, for example, that people with low incomes are more likely to install solar PV panels than other people. First, postcodes are not people. The values found in our analysis are averages for a group of postcodes, but we cannot identify whether, in a postcode with a low (or high) average income, low (or high) income families have installed solar PV. What we can say is:

- That the penetration of solar PV panels is higher as the share of the postcode's population with low incomes increases from around 7 per cent in the lowest (first) decile to between 22 per cent and 50 per cent in the highest (tenth) decile, but not who has installed solar PV in those postcodes. Our results show a similar effect as the share of the population with a weekly gross income of between \$1,000 and \$1,699 increases.
- The selected income bands appear to be independent – the characteristics relate to different postcodes, not to postcodes where two of the groups are simultaneously represented. The results appear to suggest that, as the level of homogeneity – measured by the proportion of the postcode population in the \$250 - \$649/week or \$1,000 to \$1,699/week groups – increases, so does penetration.
- The reverse appears to be the case for postcodes with an increasing proportion of households with an income higher than \$1,700/week – the higher the share of this group in the postcode population, the lower the penetration.
- These results relate only to part of the distribution of incomes. Other parts of the distribution of incomes – below \$250/week or between \$650 and \$999/week appear to have no significant relationship with penetration.
- As we illustrate in the next section, when we look at the entire distribution of income, not truncating it around a particular range, the direction of the relationship appears to also be negative.



Table 3.5: Australia, Population Distribution, Income and Age Variables chosen by State and Territory, per cent of total population

Variable	State / Territory								National
	ACT	NSW	NT	QLD	SA	TAS	VIC	WA	
<b>Income (percentage of households)</b>									
Proportion of family or households with weekly gross income between \$1,000 - \$1,699 (below means test threshold but sufficient incomes)	18	20	21	23	22	22	22	21	21
Proportion of family or households with weekly gross income \$1,700 and above (higher incomes)	36	24	29	21	17	14	22	24	22
Proportion of family or households with weekly gross income over \$1,000 (sufficient incomes)	54	44	50	44	39	36	43	45	43
Proportion of family or households with weekly gross income \$250 - \$649 (low but not very low incomes)	7	15	9	14	16	18	14	13	14
<b>Age (percentage of persons)</b>									
Proportion of persons in most likely age range (35 – 74)	45	47	41	46	48	49	47	47	47
Proportion of younger persons (20 – 34)	24	20	25	20	19	17	21	20	20
Proportion of older persons (75+)	4	7	2	6	8	7	7	6	6

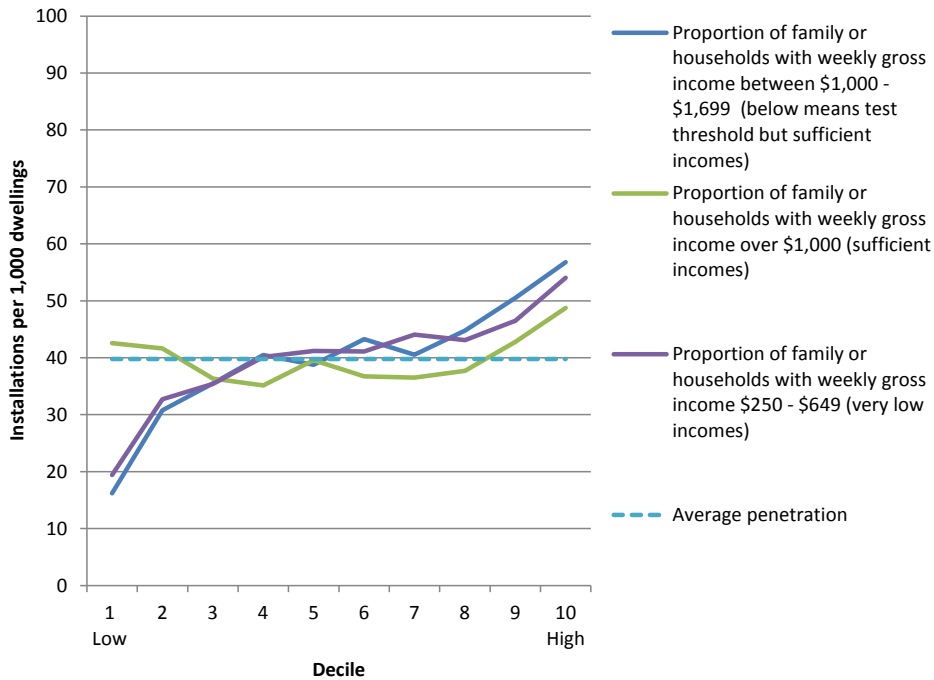


Table 3.6: All Postcodes, selected Significant Income Variables by Decile, Weekly and equivalent Annual Incomes, \$2006

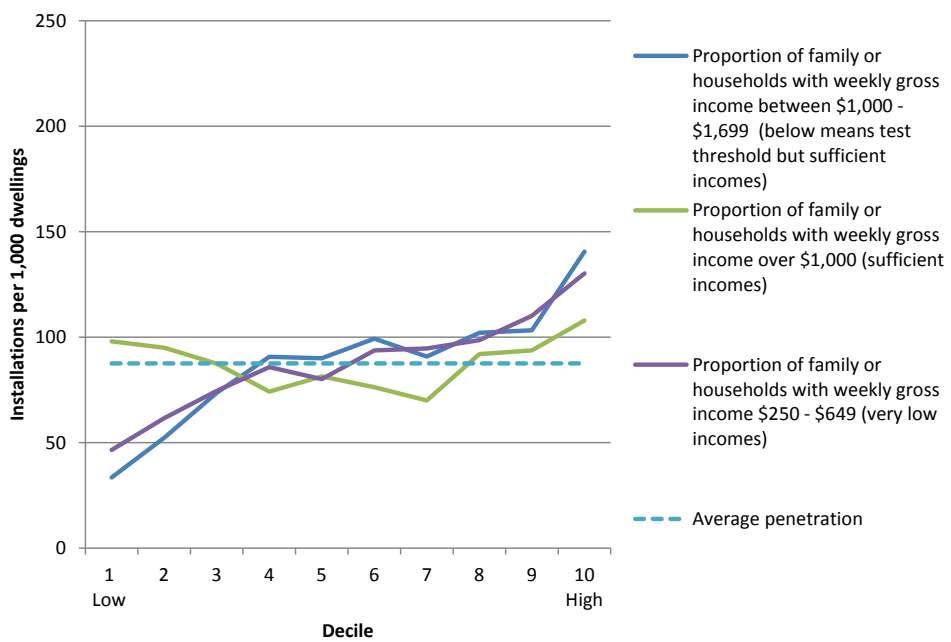
Variable	Decile									
	1	2	3	4	5	6	7	8	9	10
<b>Weekly Income, \$2006</b>										
<b>Median Family Income</b>	<882	882 - 1,001	1,002 - 1,067	1,068 - 1,117	1,118 - 1,165	1,166 - 1,231	1,232 - 1,337	1,338 - 1,502	1,503 - 1,777	>1,777
<b>Median Household Income</b>	<699	699 - 766	767 - 860	861 - 959	960 - 1,024	1,025 - 1,081	1,082 - 1,138	1,139 - 1,219	1,220 - 1,443	>1,443
<b>Annual Income, \$2006</b>										
<b>Median Family Income</b>	<45,859	45,859 - 52,036	52,037 - 55,494	55,495 - 58,058	58,059 - 60,559	60,560 - 64,007	64,008 - 69,545	69,546 - 78,120	78,121 - 92,404	>92,404
<b>Median Household Income</b>	<36,343	36,343 - 39,848	39,849 - 44,736	44,737 - 49,878	49,879 - 53,269	53,270 - 56,202	56,203 - 59,192	59,193 - 63,409	63,410 - 75,031	>75,031
<b>Average Salary or Wages</b>	<30,555	30,555 - 33,467	33,468 - 35,285	35,286 - 37,275	37,276 - 38,612	38,613 - 40,000	40,001 - 41,752	41,753 - 43,638	43,639 - 48,027	>48,027



**Figure 3.1: Penetration of Solar PV by postcode, selected income variables by decile, number of installations per 1,000 dwellings**

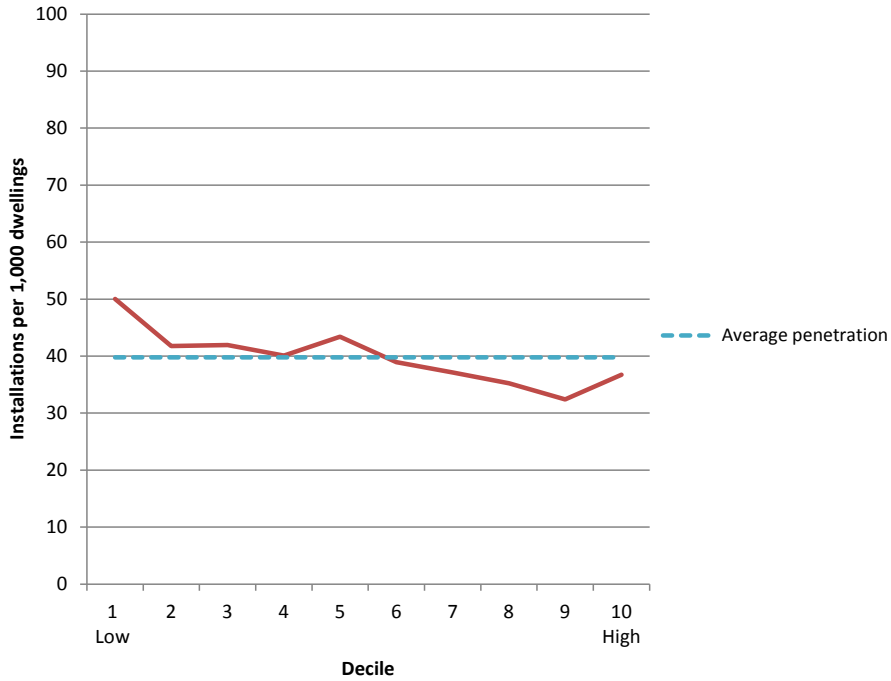


**Figure 3.2: Penetration of Solar Hot Water Systems by selected household income measures, number of installations per 1,000 dwellings**

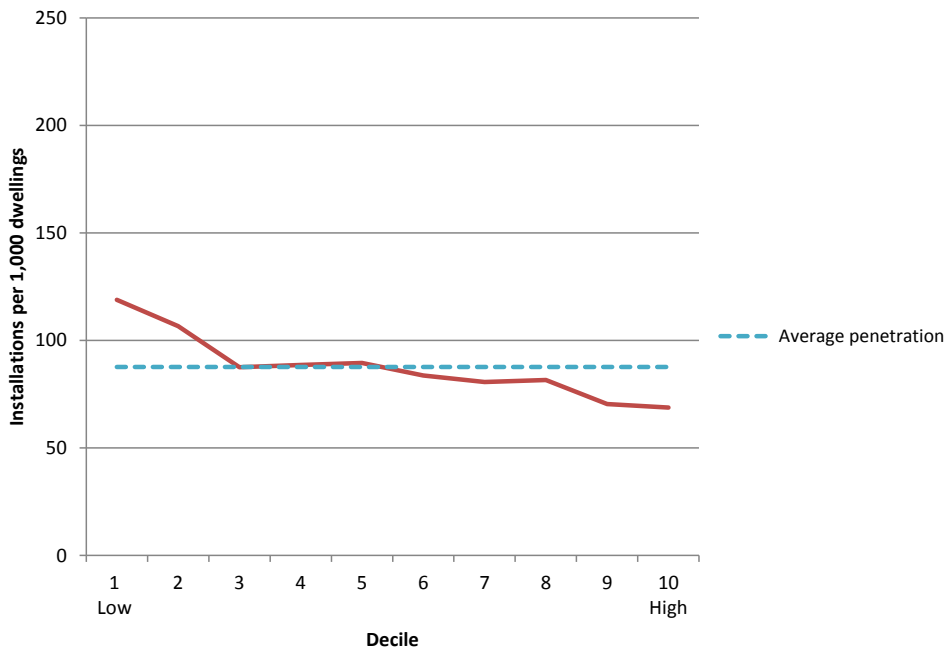




**Figure 3.3: Penetration of Solar PV by decile, share of the population with weekly gross income greater than \$1,700, number of installations per 1,000 dwellings**



**Figure 3.4: Penetration of Solar Hot Water Systems by decile, share of the population with weekly gross income greater than \$1,700, number of installations per 1,000 dwellings**







### 3.3.2 **Median Family Income: negative relationship with penetration**

In contrast to the positive relationships between the two income band variables above, three direct income measures show a significant negative, but not strong negative relationship between the value at a postcode level and penetration – Median Family Income, Median Household Income and Average Salary or Wages. As average postcode Median Family Incomes, Median Household Incomes and Average Salary and Wages increase, the number of solar PV installations per 1,000 households falls. The values for the data series are highly correlated at the postcode level, so we can use one series – in this case, Median Family Income – as shorthand for a discussion of the behaviour of all three values.

As Figure 3.5 shows, looking at the difference at the decile level between the average national penetration rate for solar PV and the average postcode penetration rate for the relevant decile for Median Family Income:

- Penetration rates are higher than the national average in the lowest (first) decile and the difference is statistically significant.
- Penetration rates in the highest (tenth) decile are lower than the national average and the difference is statistically significant.
- In between these points, for deciles 2 to 8 the difference between penetration rates and the national average is not significantly different from zero in most deciles, based on our estimated standard errors: the penetration rate is not different from the national average on a statistically robust basis.

How should we interpret this result?

- First, postcodes are not people. The values found in our analysis are averages for a group of postcodes, but we cannot identify whether, in a postcode with a low (or high) average income, low (or high) income families have installed solar PV.
- Looking at the highest (tenth) decile, these results suggest that program uptake has not been disproportionately dominated by participants in postcodes with higher average incomes: higher income postcodes have, on average, fewer installations per 1,000 households than the national average. We believe that this finding can be extended to postcodes with higher wealth and reflects the operation of the eligibility criteria on uptake of small scale renewable energy technologies. Higher income groups were excluded from eligibility for Federal Government assistance under the various programs from 2001<sup>19</sup>.

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<sup>19</sup> Note, however, that the income ranges corresponding to the two highest deciles of median family income are below the eligibility cut off. Growth in median household incomes between 2006 and 2008 may explain part of this difference.



Figure 3.5: Penetration of Solar PV by Median Family Income, variation from average penetration, per cent of average

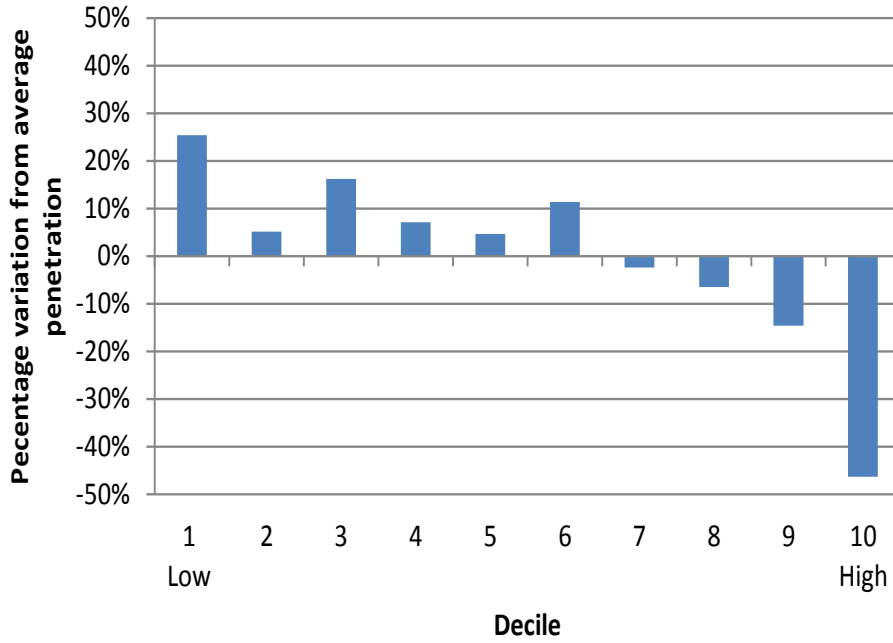
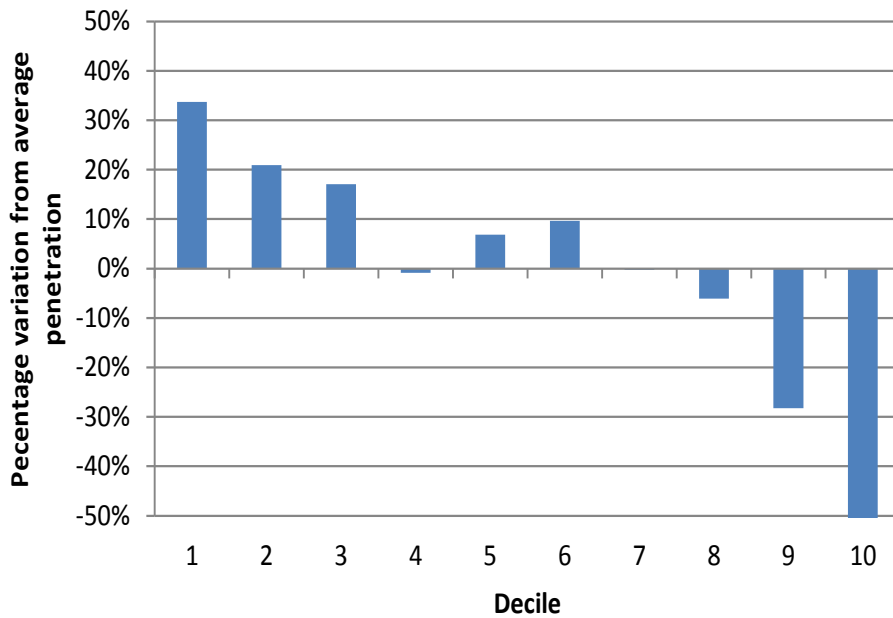


Figure 3.6: Penetration of Solar Hot Water Systems by Median Family Income, variation from average penetration, per cent of average





- Australian data on the distribution of wealth suggests that wealth and income are reasonably well correlated. (See also findings on IEO, below, as education and income are reasonably well correlated also.)
- Going beyond income and in the absence of postcode level information on housing values — still the dominant contributor to Australian households' balance sheets — we have tested the relationship between penetration and average imputation credits, which are a proxy for share ownership, which is regarded as being reasonably correlated with wealth<sup>20</sup>. Imputation credits do not have a significant relationship, either positive or negative with penetration of solar PV. Further, there are only marginal differences between average national penetration rates and penetration for postcodes ranked by imputation credits received taking into account the estimated standard errors, except for the highest (tenth) decile, where average penetration is *lower than* the national average and the difference is statistically significant.
- Looking at deciles 2 to 8, which include postcodes in which 70 per cent of total solar PV installations have been made, it is worth noting that the difference in the average value of the variable from decile to decile is small. Table 3.6 highlights that for Median Family Income, the difference in median household income between deciles 3 and 4 or deciles 4 and 5 is just under (\$2006) \$50/week. The small size of the differences in the average for median family income, median household income or average salary and wages raises the question whether any of these variables over this range provide a basis for distinguishing differences in the characteristics of program participants.
- Finally, looking at the lowest (first) decile, the result should not be interpreted as suggesting that poorer people have disproportionately installed solar PV. As before, postcodes are not people: the observation that installations are higher than average in postcodes in the lowest decile does not imply that program participants in those postcodes have low incomes.
  - The range of incomes included in the lowest (first) decile for the three significant variables is quite wide, consistent with a wide range of family and household circumstances. For Median Family Income, the first decile includes all postcodes with median family incomes below (\$2006) \$882/week, or, assuming that this value is consistent with annual median family income, an annual average value of just under (\$2006) \$46,000. This range covers such widely different groups as recipients of the age pension through to households

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<sup>20</sup> Bureau of Infrastructure, Transport and Regional Economics (BITRE), 2008, *Household wealth*. Information paper 63, Canberra ACT. BITRE (2008) estimates that the top wealth decile in Australia held 69 per cent of all household holdings of shares and trusts in 2003-04. Their analysis also suggests income as reasonably strongly correlated with wealth and housing values, reflecting the significance of housing investments in household wealth in Australia. We also tested average gross interest and average net capital gains declared, based on ATO data. See Appendix A for details of the variables included.



with one full time employed person – working in the Retail Industry, for example - earning up to 80 per cent of AWOTE, as well as people in part time employment. The corresponding values for Median Household Income and Average Salary and Wages are (\$2006) \$699/week (just over \$36,000) and (\$2006) \$30,550 respectively.

- Low income should not be conflated with socio economic disadvantage. Median family income and median household income are weekly figures and may not be representative of family or household incomes over longer periods of time<sup>21</sup>.
- The results for penetration by IRSAD (see below) suggest strongly that, when a range of indicators of low socioeconomic advantage and disadvantage are taken into account, postcodes with the lowest IRSAD score (the most disadvantaged) have penetration rates for solar PV installations that are lower than the national average and the difference is statistically significant.

### 3.3.3 Socio Economic Disadvantage and Advantage: relationships with penetration

Our results for the ABS's 2006 Socio-Economic Indexes from Areas – the Index of Relative Social Advantage and Disadvantage (IRSAD), the Index of Economic Resources (IER) and the Index of Education and Occupation (IEO) – suggest no strong linear relationships between these variables and take up of solar PV or solar hot water systems<sup>22</sup>. To the extent that a relationship does exist between penetration and these indices, it appears to be non-linear<sup>23</sup>.

- Consistent with the results for the income variables, penetration is relatively lower for the top two deciles for IRSAD and IEO. The most advantaged groups in the

<sup>21</sup> Australian surveys of income and expenditure identify a number of households that would qualify as poor looking at their income at a point in time as being in this category only on a transient basis. Reasons for transient or temporary poverty include being between jobs, studying and taking a temporary break from the workforce. To the extent that Census values reflect transient circumstances, then they may not represent the more disadvantaged groups in the community.

<sup>22</sup> ABS Cat No 2039.0, *Information Paper: An Introduction to Socio-Economic Indexes for Areas (SEIFA)*, 2006 discusses the construction of the indexes and the variables included. IRSAD includes data on incomes, occupations, employment status, housing characteristics and access to broadband, while IER looks at income and housing characteristics and IEO looks at school leaving age and post school qualifications.

<sup>23</sup> These results differ from the findings of Andrew Macintosh and Deb Wilkinson (2010), who found that penetration of solar PV installations differed systematically with IRSAD value, disproportionately benefitting the top quartile of postcodes ranked by IRSAD. Macintosh and Wilkinson, ANU Centre for Climate Law and Policy, *The Australian Government's solar PV rebate program: An evaluation of its cost-effectiveness and fairness*, The Australia Institute, Policy Brief No. 21 November 2010. Macintosh and Wilkinson's findings can be explained by their use of postcode data unweighted for population. When postcodes are adjusted to reflect population differences, in the case of our analysis by expressing penetration per 1,000 dwellings, Macintosh and Wilkinson's findings are not replicated.



population, measured at the postcode level, have a significantly lower penetration of solar PV installations than the national average. For IER, the result for the highest (last) decile is statistically significant and in the opposite direction than the results for IRSAD and IEO.

- However, for deciles 2 to 7, penetration appears to be relatively higher than average for IRSAD and IEO and the difference is statistically significant in a number of deciles.
- In the lowest (first) decile, both the value for IRSAD and IER suggest that penetration is relatively *lower* than average at a statistically significant level, while the IEO value is not significantly different from the average<sup>24</sup>.
- These results are preferable to the findings from the univariate analysis because they take into account weighted combinations of census variables. These results suggest that, taking into account a broad range of characteristics of socio economic disadvantage, penetration of small scale renewable energy technologies has been significantly lower in the lowest socio economic decile than the national average.
- In turn, this suggests that the finding relating to penetration and incomes between \$250 and \$649/week needs to be treated carefully and, in particular, should not be interpreted as implying that disadvantaged groups benefitted from the SRES.

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<sup>24</sup> In the lowest decile, the IRSAD value for the postcodes included is below a score of 910. The ABS constructs IRSAD so that around 17.5 per cent of the population falls into postcodes with an IRSAD score of less than 900. Given the shape of the IRSAD distribution, this implies around 20 to 25 per cent of the lowest socio economic areas are included in the lowest decile in our results, and suggests these groups are over-represented in the lowest decile of penetration of both solar PV and solar hot water systems.



Figure 3.7: Penetration of Solar PV by Socio-Economic Indexes from Areas, variation from national average penetration, per cent of average

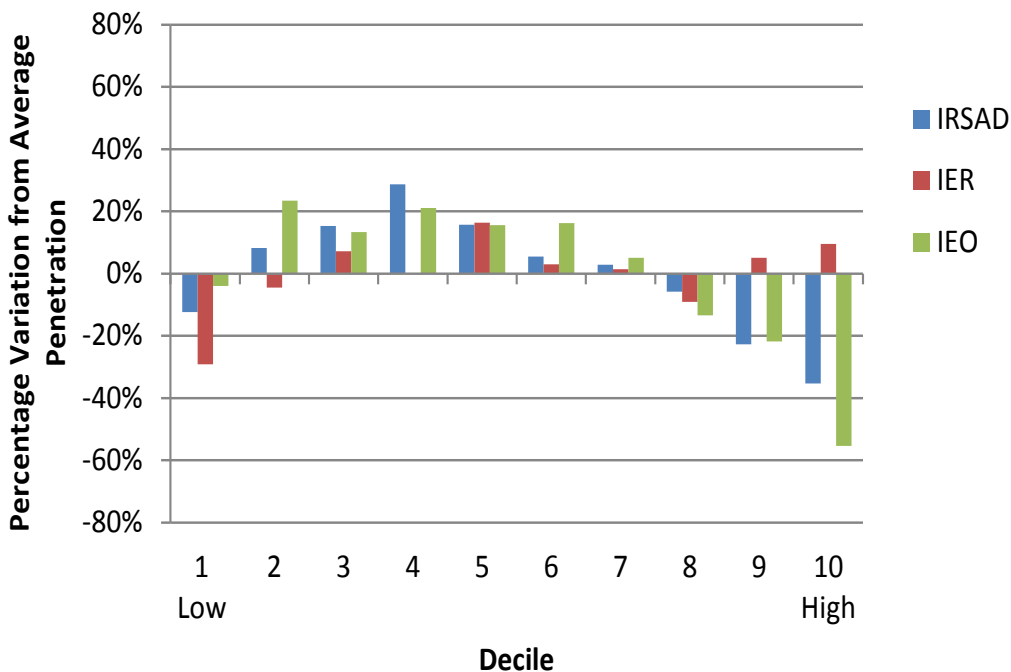
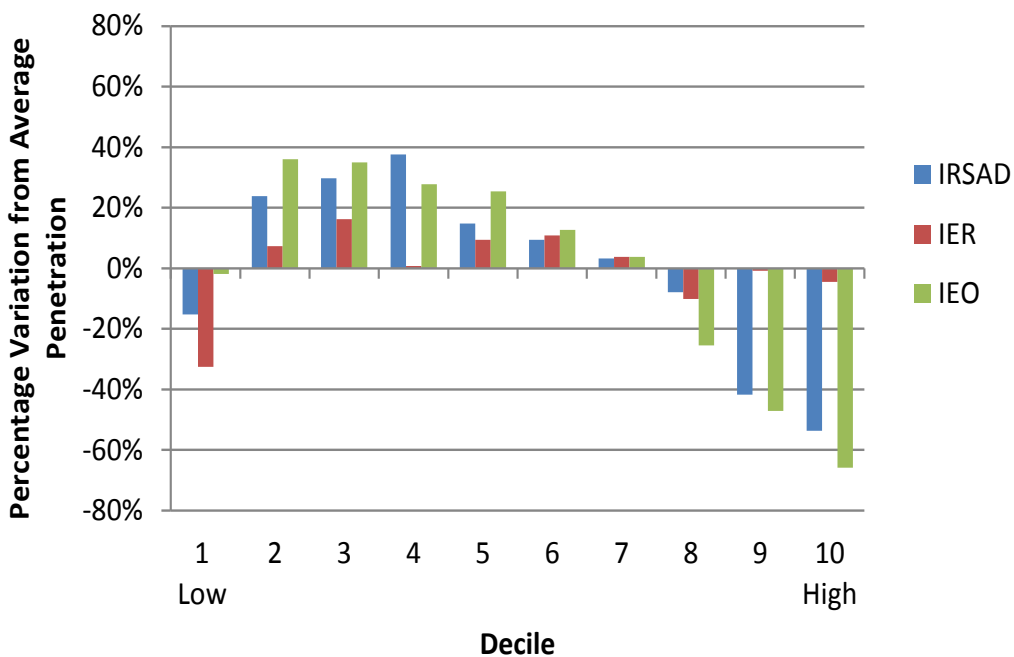


Figure 3.8: Penetration of Solar Hot Water by Socio-Economic Indexes from Areas, variation from national average penetration, per cent of average





### 3.3.4 **Employment by industry sector and occupation**

Table 3.1 and Table 3.2 suggest that a large number of variables relating to industry of employment and a smaller number of variables relating to occupation are positively or strongly positively related to penetration of Solar PV and solar hot water systems. Tempting as it is to interpret these results as meaning that in postcodes where a high proportion of construction industry workers live, the penetration of solar PV could be up to twice as high as the national average because of some innate characteristic of members of the construction industry, we believe that some part of these results is related to income.

Table 3.7 gives the range of median family income per week in \$2006 for the deciles used in our analysis and, for each category where available, lists industries where, in August 2006, Male Average Weekly Ordinary Time Earnings (AWOTE) would have fallen in the relevant decile. AWOTE in the construction industry is relatively low, which may go some way to explaining our results. AWOTE in the Financial and Insurance Services industry is relatively high, which is consistent with our findings that the relationship between the share of Financial and Insurance Services industry employees in a postcode is negatively related to penetration for deciles 7 to 10. Other influences are clearly at work, however. The relationship with the proportion of employees of the mining sector is likely to be related to density.

Results relating to occupations are more difficult to interpret. The proportion of technicians in the most likely (35 to 74 years) age range is strongly positive and might be hypothesized as being due to background and inclination. A similar relationship for the proportion of community workers in a postcode population is more difficult to explain.



**Table 3.7: Median Family Income, by decile and range, \$2006**

Decile	1	2	3	4	5	6	7	8	9	10	
<b>Median family income (\$ / week)</b>	<882	883 – 1,001	1,002 – 1,067	1,068 - 1,117	1,118 – 1,165	1,166 – 1,230	1,231 – 1,337	1,338 – 1,502	1,503 – 1,777	>1,777	
<b>Example industries</b>	<ul style="list-style-type: none"> <li>• Accom’n and food services</li> <li>• Retail trade</li> </ul>	<ul style="list-style-type: none"> <li>• Construction</li> <li>• Arts and recreation services</li> <li>• Other services</li> </ul>	<ul style="list-style-type: none"> <li>• Admin and support services</li> <li>• Transport, postal and warehousing</li> <li>• Wholesale trade</li> <li>• Manufacturing</li> </ul>		<ul style="list-style-type: none"> <li>• Public admin and safety</li> </ul>	<ul style="list-style-type: none"> <li>• Rental, hiring and real estate services</li> <li>• Electricity, gas, water and waste services</li> <li>• Education and training</li> </ul>	<ul style="list-style-type: none"> <li>• Health care and social assistance</li> <li>• Information, media and telecoms</li> </ul>	<ul style="list-style-type: none"> <li>• Professional, scientific and technical services</li> </ul>	<ul style="list-style-type: none"> <li>• Financial and insurance services</li> <li>• Mining</li> </ul>		





### 3.3.5 Density

Figure 3.9 and Figure 3.10 show penetration per 1,000 dwellings by postcodes ranked by the number of persons per square kilometer for Solar PV and solar hot water installations respectively. Penetration increases over the first three deciles and then declines sharply. In the third decile penetration of Solar PV installations is just over 150 per 1,000 dwellings, or nearly 4 times the national average. In contrast, installations in the densest deciles in Australia average around 15 per 1,000 dwellings, or a tenth of the penetration rate in the highest decile.

This pattern is illustrated by Figure 3.13, which shows penetration per 1,000 dwellings for Melbourne suburbs. Higher density inner city suburbs show lower penetration than the outer suburbs, while as Figure 1.1 shows, the highest penetration per 1,000 dwellings can be found in a small number of areas in regional Victoria.

A range of possible hypotheses could explain this finding, including differences in the housing stock between postcodes with higher and lower density – for example, a lower penetration of suitable (detached and semi-detached) dwellings in postcodes with higher density or a higher incidence of rental housing in postcodes with higher density – and differences in the costs and reliability of electricity supply in some less dense (more remote) postcodes. We have not tested these hypotheses in this study.

### 3.3.6 Housing Type and other characteristics

Nationally, the penetration of both Solar PV and solar hot water systems is strongly positively related to the proportion of dwellings in a given postcode that are suitable – stand-alone or semi-detached – and owned or being purchased. A positive relationship exists between penetration for both technologies and the proportion of suitable dwellings. Our analysis can't distinguish whether ownership or dwelling characteristics is the key variable in this relationship: both make the cut-off point for significance<sup>25</sup>.

Expanding the definition of suitable dwellings to include flats reduces the significance of the relationship to below our cut-off point. Adding flats *and* caravans to the definition of suitable dwellings improves the  $R^2$ , but not to a level consistent with our cut-off point. We are aware of some industry commentary about penetration in caravan parks used for permanent occupancy, but this is simply an hypothesis. We have not tested this.

Finally, consistent, we believe, with the earlier observations about families, penetration is higher in postcodes where the dwellings have a larger number of bedrooms. The lowest ten per cent of postcodes by penetration of solar PV have 2 or less bedrooms, while eighty per cent of Solar PV installations are in postcodes where, on average, dwellings have between 2 and 2.7 bedrooms.

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<sup>25</sup> The *strong positive* classification refers to the slope of the relationship, rather than the explanatory value of the relationship. Looking purely at the  $R^2$  for the two variables, it would suggest that the relationship with dwelling type has greater explanatory value than that with dwelling type and occupancy status.



Figure 3.9: Penetration of Solar PV by Population Density and postcode, persons per square km, installations per 1,000 dwellings

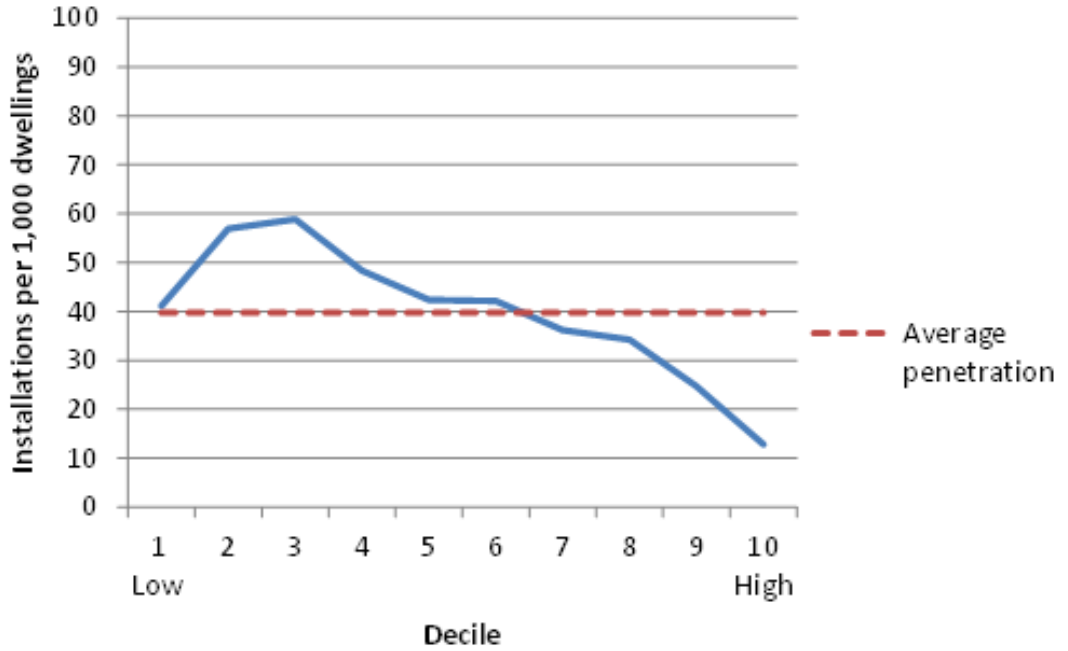
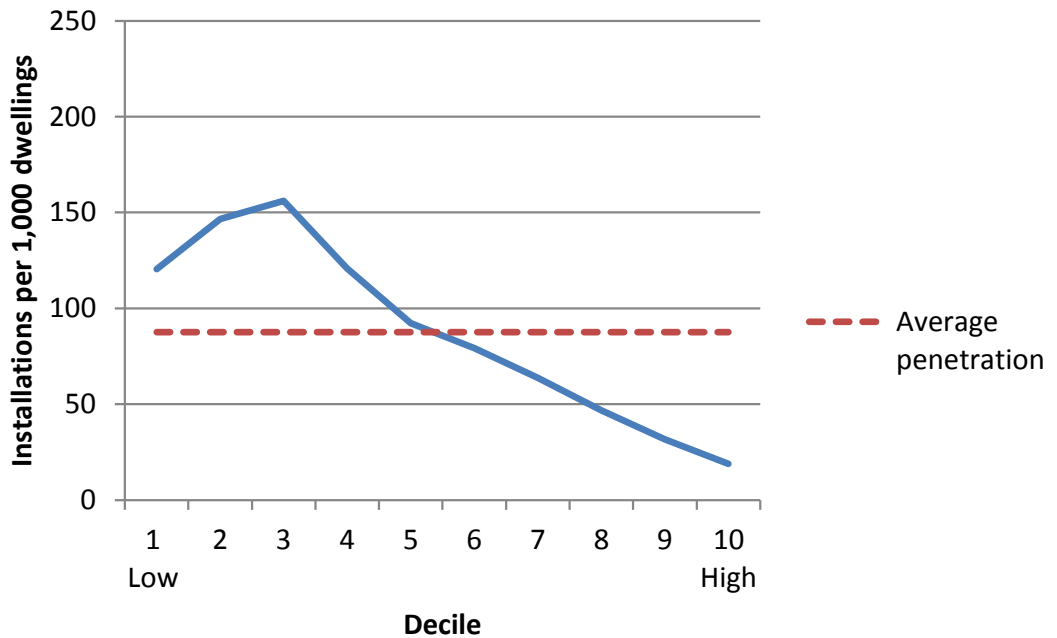


Figure 3.10: Penetration of Solar Hot Water Systems by Population Density and postcode, persons per square km, installations per 1,000 dwellings

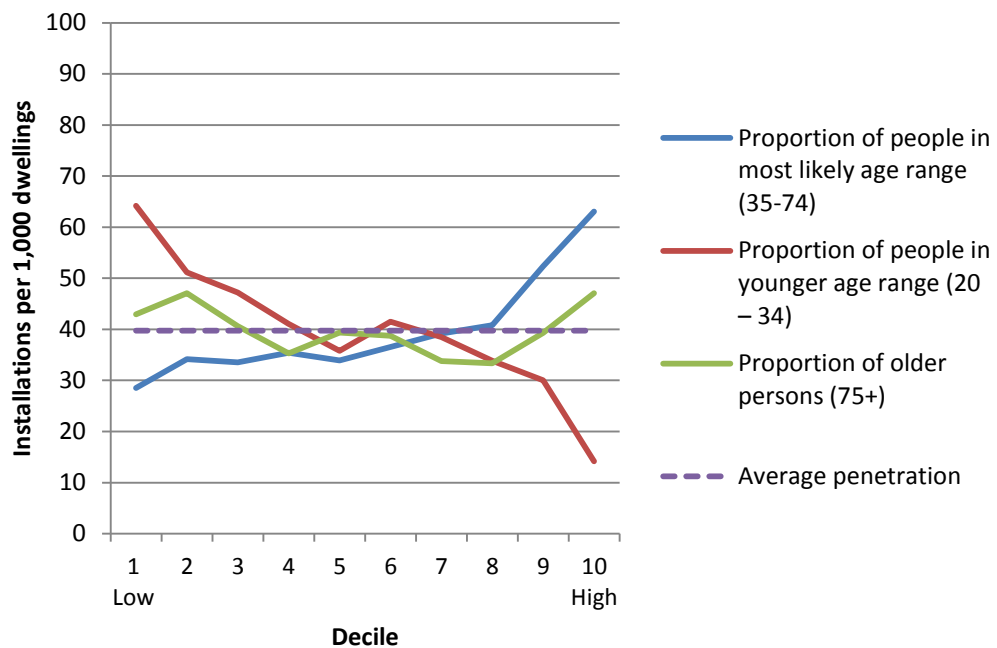




3.3.7 Age

Nationally, the penetration of both Solar PV and solar hot water systems is positively related to the proportion of the postcode population in the 35 – 74 year age range and strongly negatively related to the proportion of the population in the 20 – 34 year age range. Figure 3.11 shows the relationships between Solar PV penetration and the three age ranges tested at the national level.

Figure 3.11: Penetration of Solar PV by proportion of the population in relevant age range, installations per 1,000 dwellings



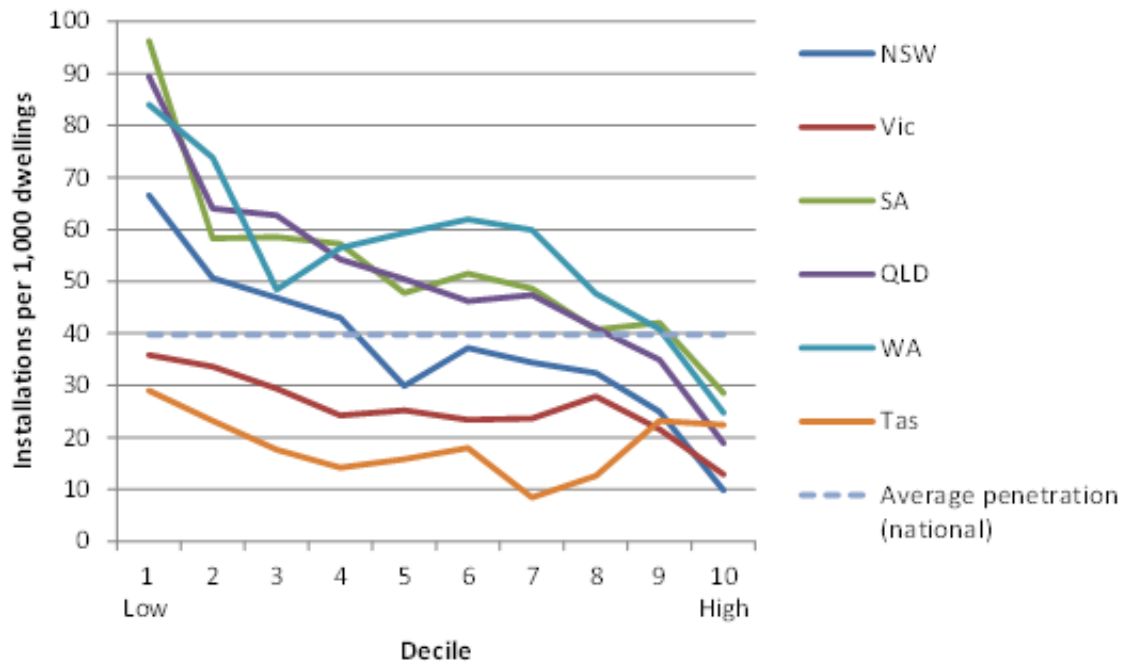
At the state level, the penetration data for the proportion of the population in the young (20 to 34 year) age range displays significant variation, as shown Figure 3.12. In all states, the relationship is negative: the higher the proportion of younger people, the lower the penetration rate. However, in Victoria and Tasmania, the results for all deciles are below the national average of 40 installations per 1,000 dwellings and significantly below the results for Western Australia, South Australia and Queensland.

The data suggests no relationship between penetration and the proportion of the population in the 75 years plus age range: the variation from decline to decile around the national average is generally within the estimated standard error for the relevant decile and therefore, statistically no different from zero<sup>26</sup>.

<sup>26</sup> This is not consistent, however, with a conclusion that postcodes characterised by a higher proportion of people in the 75 years plus age group “do not care about the environment”. Rather, the data supports a conclusion that old age is not a *differentiating* factor.



Figure 3.12: Penetration of Solar PV by proportion of the population in younger age range by state, installations per 1,000 dwellings



### 3.3.8 Solar Hot Water Systems: New and Replacement

Because the data on solar hot water systems allows us to distinguish between new and replacement installations, we can look at the characteristics of the significant relationships in each of these categories to understand if there are material differences. For both new and replacement installations of solar hot water systems, penetration is lower in postcodes with higher density (a higher number of people per square kilometer). However, penetration varies with different variables when installations are characterised as new or replacement, suggesting two different dynamics may be at play (see Table C. 6 on page 129).

- Postcodes with a high penetration of solar hot water on new buildings have one or more of the following: high proportions of families with young children; high proportions of separate or semi-detached dwellings that are owned or being purchased; higher average household sizes; higher numbers of bedrooms; and higher numbers of cars per dwelling.
- Postcodes with a high penetration of solar hot water systems replacing pre-existing systems have one or more of the following: higher proportions of their populations in the 35 – 74 years age group; higher proportions of their populations employed in the agricultural sector and a higher proportion of Aboriginal and Torres Strait Islanders as a share of the population.



We also know that there are a number of relationships that appear to be common to both solar PV and solar hot water installations, including:

- the proportions of families with young children;
- the proportions of separate or semi-detached dwellings that are owned or being purchased;
- higher numbers of bedrooms;
- higher numbers of cars per dwelling.

This suggests that characteristics of postcodes with a higher uptake of solar PV are similar to those with high penetrations of new solar hot water installations – by definition, areas with newer developments and younger families in outer urban areas. We have not, however, tested for this group of characteristics explicitly.

### 3.3.9 **Jurisdictional differences**

Table B. 1 and Table C. 1 detail our findings for the variables tested for each state and territory as well as for Australia as a whole. There are a large number of differences in both the significance and, but less often, the sign of the relationship (positive or negative), which are likely to reflect the effects of the timing and nature of any state Feed-In Tariff, as well as differences in the age composition, incomes and the composition of industry and occupation at state level. Our results in this study do not seek to control for these differences.

The penetration of solar PV installations in NSW and Tasmania is discussed below to illustrate the differences between penetration levels and relationships at the state level.

#### **NSW Feed-In Tariff**

Figure 3.14 illustrates the penetration of solar PV installations as a share of dwellings at the postcode level in NSW as at mid-March 2011.

An analysis of the univariate relationships in the NSW data which separates the analysis into the periods prior to and during the NSW Feed In Tariff Scheme indicates that, reflecting the significant increase in installations following the introduction of the Feed-In Tariff, there is a high degree of consistency between nature and direction of the identified relationships during the feed-in tariff and over the entire period of the analysis. Over the entire period, the NSW results differ from those for Australia as a whole in a number of areas, including:

- The absence of any relationship with: the most likely age range; the proportion of young children; the proportion of children; and the average of bedrooms per dwelling, all of which are significant on a national basis. Despite these differences, density (number of people per square kilometer) has the same relationship with



penetration in NSW as in Australia: the higher the density, the lower the penetration per 1,000 dwellings<sup>27</sup>.

- The strong positive relationship between solar PV penetration per 1,000 dwellings and Australian citizens as a proportion of the postcode population. Industry insights suggest that this may reflect access to finance: citizenship is a usual precondition to loans to finance the solar PV installation.

### Tasmania

Figure 3.15 shows Solar PV penetration per 1,000 households for Tasmania and suggests Tasmania is different. Penetration is highest in some of the suburbs of Hobart and on Bruny Island, but is, looking at Tasmania as a whole, significantly below the national average. The data in Appendix B and Appendix C that looks at the univariate relationships established by the analysis could also be read as supporting a view that Tasmania is different.

A number of factors need to be taken into account, however, in interpreting the data.

- Lower penetration in Tasmania is a desired outcome of the policy that bases the REC multiple on zones, where Tasmania is in the zone with the lowest multiple for RECs, meaning that, all other things being equal, payback in Tasmania would be slower than, for example, in Western Australia or NSW.
- Although we have found that, in general, using deciles determined by state averages resulted in relatively few differences compared with the Australia wide data, there are likely to be areas where our approach conceals differences between the states. For example, to the extent that absolute incomes are lower in Tasmania than in other states or relative to the national average, using the national average may give rise to differences in the interpretation of the data. For example, the Tasmanian data suggests a positive relationship between median income and penetration rates for solar PV installations for deciles 1 to 9. No Tasmanian postcodes are included in decile 10: no Tasmanian postcodes have a median income consistent with this national value. There are a number of other variables where our approach does not adjust for state by state differences – share of the population employed in the mining sector, for example.

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<sup>27</sup> In the case of NSW, the results for density before and during the Feed In Tariff are very interesting. Before the introduction of the Feed In Tariff, a relationship exists, but it's flat – penetration doesn't vary with density, from decile to decile. Following the introduction of the Feed In Tariff, density appears not to have a relationship with penetration, but over the data as a whole, density and penetration have the expected strong negative relationship displayed by the Australia wide data.



Figure 3.13: Penetration of Solar PV by Postcode, Melbourne and Suburbs, installations per 1,000 dwellings

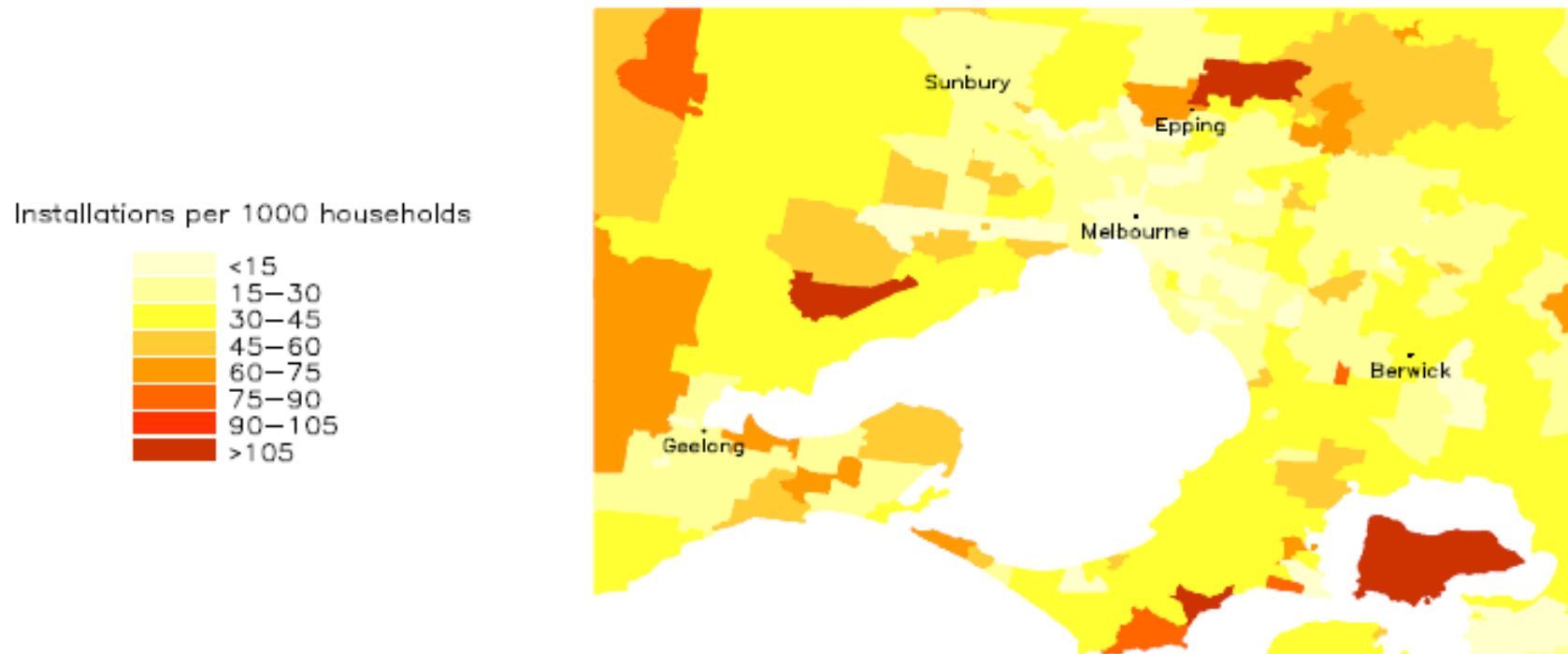




Figure 3.14: Penetration of Solar PV by Postcode, NSW, installations per 1,000 dwellings

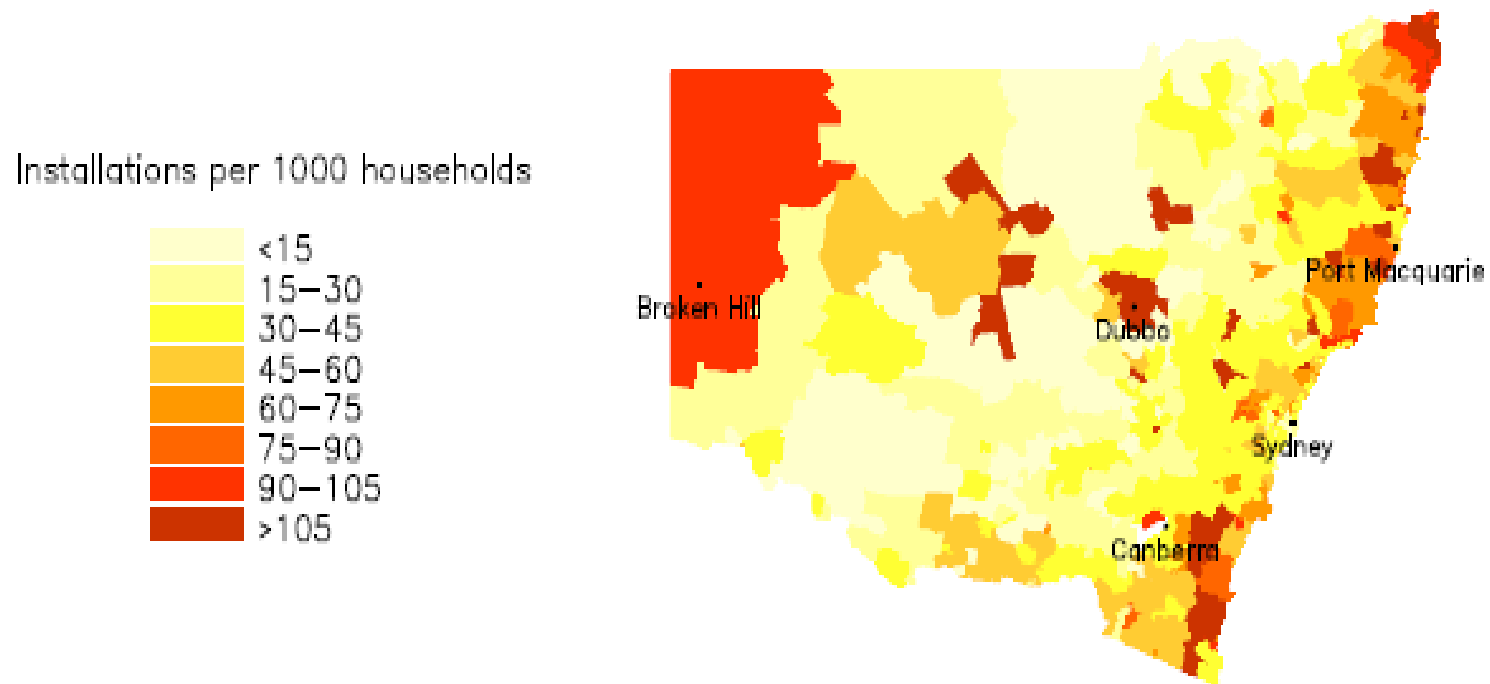
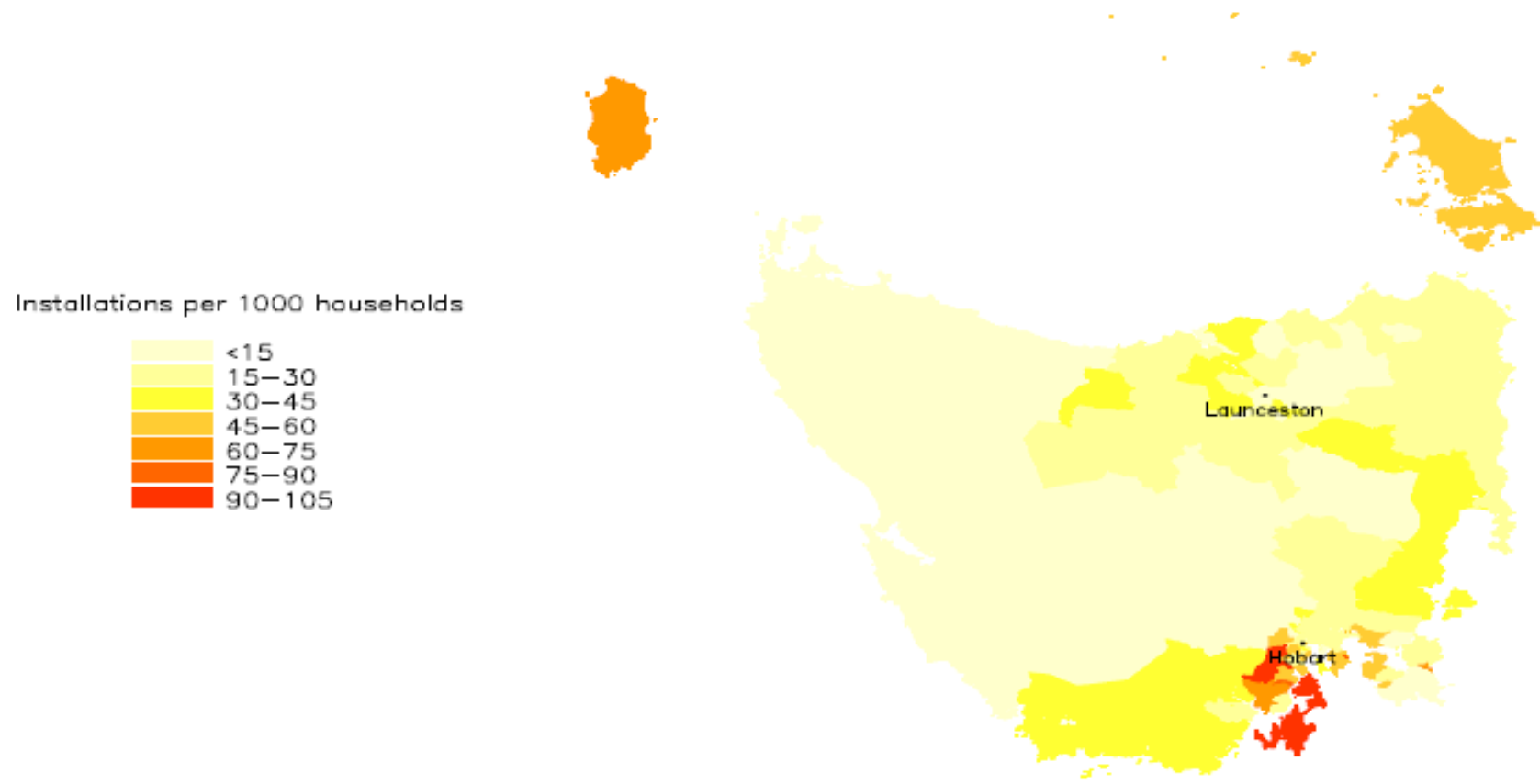






Figure 3.15: Penetration of Solar PV by Postcode, Tasmania, installations per 1,000 dwellings





## 4 Further Directions for Research

A number of previously published studies have analysed and identified relationships with subsets of the ORER data and specific demographic variables, but these have been generally narrowly focused and investigated a specific relationship type. This study has the advantage of using ORER's national data from the inception of the first program and has combined it with a wide range of demographic variables to identify a broader set of relationships.

In preparing this report and our discussions with the AEMC, we have identified a number of areas where potential additional analysis could leverage off the findings of this report and develop further, more targeted and useful insights. The following is a brief discussion of key areas where we believe additional work could be undertaken to benefit from our understanding of the impact of programs designed to increase the penetration of small scale renewable energy technologies.

### 4.1 Comparisons between uptake by States and Territories

The data supplied by ORER covers a range of state based additional incentives to encourage uptake of small scale renewable energy technologies. The differences and similarities in uptake from state to state could provide additional insight into the overall results. Given the relatively recent introduction of the Western Australian Feed In Tariff Scheme, then, appropriately controlled for industry composition and density, the Western Australian results may provide the best basis for considering the impact of the Federal programs in isolation from other state based incentive programs.

In addition, at the individual state or territory level, identifying the characteristics of areas with higher uptake may be helpful in future versions of the current programs or, as is required in the ACT, in the annual reset of the level of the Feed In Tariff.

### 4.2 Non-linear Relationships and Correlations: Further Work

Our interpretation of the non-linear variables discussed in this report has been based on a high level of judgement. Additional work to look at the significance of these variables and their interpretation – particularly in the areas of wealth and social advantage – could improve the ability to interpret and rely on the results.

We have not looked at questions of causality in the data sets or correlations between the variables. Exploring these relationships should add value to the analysis and future policy directions.



### 4.3 Wealth and Social Advantage

In the absence of a direct wealth variable at the postcode level, we have used imputation credits, drawing on earlier work by BITRE<sup>28</sup>. Both BITRE's work and the Melbourne Institute's HILDA Survey indicate that the value of owner occupied housing is dominant in households' wealth portfolios in Australia. BITRE uses Australian Property Monitor's data on property values at the local government level to estimate house values. In a similar way, this data could be purchased and our results restated on a local government area basis to more directly explore the relationship between wealth and penetration of small scale renewable energy technologies.

### 4.4 Comparing the Results to Findings on Incidence and Disadvantage

Our results provide no insight into the incidence of the costs of the Federal and state schemes to electricity consumers. However, IPART has identified a number of local government areas where the incidence of the costs of the schemes is likely to particularly disadvantage consumers. To compare penetration and the characteristics of the disadvantaged areas, our results would need to be recalibrated to local government areas consistent with IPART's data and compared with IPART's findings on the characteristics of customers in these areas<sup>29</sup>.

### 4.5 Moving towards a Predictive Model

In other similar work in other industries, predictive models with strong explanatory performance have been built using a similar process to that used in the truncated multivariate analysis. In pursuing this objective, which we believe could be significant in evaluating the statistical models of penetration being built for the AEMC, our next steps would be to remove variables which are likely to be similar in their contribution to the underlying performance – for example, the net cost of the relevant technology as a share of income and the net cost of technology – and to remove from the data set variables that have little or no explanatory value so as to identify the effect on the contribution of the remaining variables. As a result of a process of testing and retesting as we narrow the data set, we believe a predictive model can be developed for small scale renewable technology penetration to supplement the insights from other models of potential uptake.

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<sup>28</sup> BITRE's results were based on local government areas, but, for the purposes of our analysis we have assumed that the relationship between wealth and imputation credits received was consistent at a postcode level.

<sup>29</sup> We cannot provide any insight into the incidence of the costs of the various schemes to consumers because we have no information on energy consumption. The census data and other publicly available data do not provide a detailed small area breakdown of household energy consumption that could be used to supplement our existing results. IPART's survey data, from which their results are drawn, includes energy consumption by household.



#### 4.6 **Social Attitudes and Program Participation**

In discussing the results of the occupational variables – for example, the behaviour of community sector workers – we believe the data available in publicly available datasets at the postcode or small area level may be insufficient to understand the behaviour identified. Desirably, we would supplement the public domain data with data on social attitudes from people who have participated in the various Federal and state programs and from a control group who haven't participated. In order to do this, whatever data source is used to identify program participants – ORER's data, that from the relevant state or territory regulator, or the retailers administering the Feed In Tariff programs – participants' consent to being contacted would be required. With that consent, modern polling techniques would allow an appropriately structured survey of attitudes to be undertaken within a relatively short period of time, supplementing our understanding of the different uptake of the available programs across groups in the community.



## A. Variables used in the Analyses

Table	Page Number
<b>Table A 1: Variables included in the analysis, by source and rationale</b>	61
<b>Table A 2: ORER Data Variables, Small Generating Units and Solar Hot Water Systems, by treatment and rationale,</b>	66



Table A 1: Variables included in the analysis, by source and rationale

Category	Variables	Rationale
<b>Age and Population Distribution (census)</b>	<ul style="list-style-type: none"> <li>• Proportion of persons in most likely age range (35 – 74)</li> <li>• Proportion of younger persons (20 – 34)</li> <li>• Proportion of older persons (75+)</li> <li>• Median age</li> </ul>	<ul style="list-style-type: none"> <li>• Age may be a useful variable and provide some insights</li> <li>• Most likely age range for persons installing SRES related technology is 35 – 74 so these have been grouped together</li> </ul>
<b>Australian Taxation Office Variables</b>	<ul style="list-style-type: none"> <li>• Taxable income (excluding losses)</li> <li>• Total imputation credits</li> <li>• Net tax</li> <li>• Gross tax</li> <li>• Gross interest</li> <li>• Net capital gain</li> <li>• Total income or loss</li> <li>• Average salary or wages</li> </ul>	<ul style="list-style-type: none"> <li>• May provide additional insights into income and potential wealth proxies and uptake of technologies</li> <li>• Variables calculated and provided at postcode level which aligns with census variable calculation.</li> </ul>
<b>Childcare (census)</b>	<ul style="list-style-type: none"> <li>• Proportion of people caring for their own children</li> </ul>	<ul style="list-style-type: none"> <li>• May provide insights into relationship between ‘stay at home’ families and uptake of technologies</li> </ul>
<b>Children (census)</b>	<ul style="list-style-type: none"> <li>• Proportion of children under 15 to total population</li> <li>• Proportion of children over 15 to total population</li> </ul>	<ul style="list-style-type: none"> <li>• May provide insights into characteristic of household type</li> </ul>
<b>Citizenship (census)</b>	<ul style="list-style-type: none"> <li>• Proportion of Australian citizens</li> </ul>	<ul style="list-style-type: none"> <li>• Australian citizenship is a possible criteria for obtaining consumer finance and therefore may be a relevant variable</li> </ul>
<b>Dwellings (census)</b>	<ul style="list-style-type: none"> <li>• Proportion of most likely dwellings to install solar PV (house, semi-detached etc.)</li> <li>• Proportion of most likely dwellings including flats</li> <li>• Proportion of most likely dwellings including flats and other dwellings (caravan, houseboat)</li> </ul>	<ul style="list-style-type: none"> <li>• Important to understand the dwelling type i.e. separate house, semi-detached.</li> </ul>



Category	Variables	Rationale
<b>Derived variables (ABS)</b>	<ul style="list-style-type: none"> <li>• Socio economic indices               <ul style="list-style-type: none"> <li>— Index of relative social advantage or disadvantage (IRSAD)</li> <li>— Index of educational opportunities</li> <li>— Index of economic resources</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Calculated and provided by the Australian Bureau of Statistics</li> <li>• Composite of many relevant census variables and a measure of socio-economic advantage / disadvantage</li> <li>• Enables a comparison of results with Australia Institute paper on the Australian Government's solar PV rebate program published November 2010</li> </ul>
<b>Derived variables (other)</b>	<ul style="list-style-type: none"> <li>• Average mortgage stress</li> <li>• Average rent stress</li> </ul>	<ul style="list-style-type: none"> <li>• May provide further insights beyond current income variables</li> </ul>
<b>Educational Attainment (census)</b>	<ul style="list-style-type: none"> <li>• Proportion with schooling year 11 or higher within most likely age range (35 – 74)</li> <li>• Proportion with post school qualifications</li> </ul>	<ul style="list-style-type: none"> <li>• May provide insights into characteristics of purchasers of relevant technologies</li> </ul>
<b>Employment (census)</b>	<ul style="list-style-type: none"> <li>• Proportion unemployed</li> <li>• Proportion employment</li> </ul>	<ul style="list-style-type: none"> <li>• May provide insights into relationship between employment statistics and uptake of technologies</li> </ul>
<b>Employment by Industry (census)</b>	<ul style="list-style-type: none"> <li>• Proportion of persons in most likely age range (35 – 74) employed in various industries (as % of total employed persons):               <ul style="list-style-type: none"> <li>— Agriculture, forestry &amp; fishing</li> <li>— Mining</li> <li>— Manufacturing</li> <li>— Electricity, gas, water &amp; waste services</li> <li>— Construction</li> <li>— Wholesale trade</li> <li>— Retail trade</li> <li>— Accommodation &amp; food services</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• May provide insights into more typical employment industries of households that take up technologies</li> </ul>



Category	Variables	Rationale
	<ul style="list-style-type: none"> <li>— Transport, postal &amp; warehousing</li> <li>— Information media &amp; telecommunications</li> <li>— Financial &amp; insurance services</li> <li>— Rental, hiring &amp; real estate services</li> <li>— Professional, scientific &amp; technical services</li> <li>— Administrative &amp; support services</li> <li>— Public administration &amp; safety</li> <li>— Education &amp; training</li> <li>— Health care &amp; social assistance</li> <li>— Arts &amp; recreation services</li> <li>— Other services</li> </ul>	
<b>Home Ownership (census)</b>	<ul style="list-style-type: none"> <li>• Proportion of houses and semi-detached that are fully owned or being purchased</li> </ul>	<ul style="list-style-type: none"> <li>• Will be important drivers of disposable income and a potential proxy for wealth</li> <li>• May provide insights into ability to access consumer finance given equity in home ownership</li> </ul>
<b>Hours Worked (census)</b>	<ul style="list-style-type: none"> <li>• Proportion of full time employment</li> </ul>	<ul style="list-style-type: none"> <li>• May provide insights into relationship between hours worked and uptake of technologies</li> </ul>
<b>Household Characteristics (census)</b>	<ul style="list-style-type: none"> <li>• Average household size</li> <li>• Average number of bedrooms</li> <li>• Proportion who lived at same address one year ago</li> <li>• Proportion who lived at same address 5 years ago</li> <li>• Proportion of households that are families</li> </ul>	<ul style="list-style-type: none"> <li>• Household size could be a driver for energy usage and hence benefit of installing new technology</li> </ul>
<b>Housing Costs (census)</b>	<ul style="list-style-type: none"> <li>• Median individual income</li> <li>• Measure of mortgage stress (housing loan repayment / individual income)</li> </ul>	<ul style="list-style-type: none"> <li>• Will be important drivers of disposable income</li> </ul>





Category	Variables	Rationale
<b>Housing Rental (census)</b>	<ul style="list-style-type: none"> <li>• Median individual income</li> <li>• Measure of rent stress (rental repayment / individual income)</li> </ul>	<ul style="list-style-type: none"> <li>• Will be important in identifying whether rented housing significantly less likely to have an installation than housing where owner in residence</li> <li>• Will be important drivers of disposable income and a potential proxy for wealth</li> </ul>
<b>Income Personal Family and Household (census)</b>	<ul style="list-style-type: none"> <li>• Proportion of family or households with weekly gross income between \$1,000 - \$1,699 (below means test threshold but sufficient incomes)</li> <li>• Proportion of family or households with weekly gross income \$1,700 and above (higher incomes)</li> <li>• Proportion of family or households with weekly gross income over \$1,000 (sufficient incomes)</li> <li>• Proportion of family or households with weekly gross income \$250 - \$649 (very low incomes)</li> <li>• Median family gross income</li> <li>• Median household gross income</li> <li>• Median individual gross income</li> </ul>	<ul style="list-style-type: none"> <li>• Will be important drivers of disposable income and a potential proxy for wealth</li> </ul>
<b>Indigenous Population Size and Distribution (census)</b>	<ul style="list-style-type: none"> <li>• Proportion of indigenous persons</li> </ul>	<ul style="list-style-type: none"> <li>• May provide insights into proportion of high indigenous areas taking up technologies</li> </ul>
<b>Language (census)</b>	<ul style="list-style-type: none"> <li>• Proportion of people with poor English</li> </ul>	<ul style="list-style-type: none"> <li>• May provide insights into the impact of language barriers (if any) on uptake of technologies</li> </ul>
<b>Motor Vehicles (census)</b>	<ul style="list-style-type: none"> <li>• Proportion of dwellings with three or more vehicles</li> </ul>	<ul style="list-style-type: none"> <li>• May be a proxy for wealth</li> <li>• May relate to location</li> </ul>
<b>Occupation (census)</b>	<ul style="list-style-type: none"> <li>• Proportion of persons in most likely age range (35 – 74) by various occupation type:</li> </ul>	<ul style="list-style-type: none"> <li>• May provide insights into relationship between types of occupation (managers,</li> </ul>



Category	Variables	Rationale
	<ul style="list-style-type: none"> <li>— Managers</li> <li>— Professionals</li> <li>— Technicians and trade workers</li> <li>— Community and personal service workers</li> <li>— Clerical and administrative workers</li> <li>— Sales workers</li> <li>— Machinery operators and drivers</li> <li>— Labourers</li> </ul>	self-employed etc.) and uptake of technologies
<b>Type of Internet Connection (census)</b>	<ul style="list-style-type: none"> <li>• Proportion of separate and / or semi-detached houses etc. with broadband connection</li> </ul>	<ul style="list-style-type: none"> <li>• Whilst potentially out of date information, this may be a signal of which suburbs were relatively 'early adopters' of internet technologies and therefore may be early adopters of solar technologies</li> </ul>



Table A 2: ORER Data Variables, Small Generating Units and Solar Hot Water Systems, by treatment and rationale,

Variable	Interpretation	Proposed Treatment	Rationale
<b>SGU File</b>			
<b>Fuel Source</b>	Type of technology Hydro, Solar or Wind	<ul style="list-style-type: none"> <li>Will use this variable</li> <li>Used to split data, but no analysis done on Hydro and only very high level analysis on Wind</li> </ul>	<ul style="list-style-type: none"> <li>13 Hydro record insufficient for any conclusions</li> <li>338 Wind records insufficient for any trend analysis but have developed analysis of overall 'averages' with Solar</li> </ul>
<b>Installation Date</b>	When the system was installed	<ul style="list-style-type: none"> <li>Will use this variable</li> <li>Will not adjust for time lag between purchase date and installation date</li> <li>Used to create time groups e.g. in years, to compare uptake analysis for varying policy periods</li> </ul>	<ul style="list-style-type: none"> <li>Date of installation most closely relates to the decision to purchase</li> <li>Will also link this data to net cost at time of installation</li> </ul>
<b>Grid Connected</b>	Is system connected to a main grid	<ul style="list-style-type: none"> <li>Will not use this variable</li> </ul>	<ul style="list-style-type: none"> <li>Values N (8125) and Y (276,253)</li> <li>Likely to be different drivers to purchasing decision, but numbers of "N" not very large, especially when split by state and therefore may not produce meaningful results</li> <li>However, may provide insights into number of off grid connections</li> </ul>
<b>Deeming Years</b>	Number of deeming years. This period can be 1, 5, 15 years	<ul style="list-style-type: none"> <li>Will not use this variable</li> </ul>	<ul style="list-style-type: none"> <li>Values 1 (51), 5 (4,916), 15(279,262) and NULL (149)</li> <li>Numbers of "1 year" and NULL too small to analyse</li> </ul>



Variable	Interpretation	Proposed Treatment	Rationale
			<ul style="list-style-type: none"> <li>Numbers of “5 years” not very large, especially when split by state</li> <li>So not likely to produce meaningful results</li> </ul>
<b>kW capacity</b>	Capacity of installed technology in kW	<ul style="list-style-type: none"> <li>Will use this variable.</li> <li>Will also be used in conjunction with STCs registered to determine the multiplier for those records that do not contain the multiplier information</li> </ul>	<ul style="list-style-type: none"> <li>Census variables only make sense when combined with domestic installations, however there is no variable to accurately identify commercial vs. domestic installations, therefore we will use the entire data set</li> <li>933 records out of 284,378 (0.3%) are greater than 10kW</li> </ul>
<b>STCs Registered</b>	Number of STCs created from installation	<ul style="list-style-type: none"> <li>Will use this variable</li> <li>Will split in those STCs created with the solar multiplier and those without.</li> </ul>	<ul style="list-style-type: none"> <li>Used to determine if installation was under solar multiplier scheme</li> </ul>
<b>Zone</b>	Indicates the postcode where the installation is installed. For a complete list of zones please see <a href="http://www.orer.gov.au/swh/register.html">http://www.orer.gov.au/swh/register.html</a>	<ul style="list-style-type: none"> <li>Will use this variable</li> </ul>	<ul style="list-style-type: none"> <li>Relevant to the net cost</li> </ul>
<b>Installation Town/Suburb</b>	Town/ suburb of installation	<ul style="list-style-type: none"> <li>Will not use this variable</li> </ul>	<ul style="list-style-type: none"> <li>Postcode is used to indicate location</li> </ul>
<b>Installation State</b>	State of installation	<ul style="list-style-type: none"> <li>Will use this variable</li> </ul>	<ul style="list-style-type: none"> <li>Analysis will be split by state</li> </ul>
<b>Installation</b>	Postcode of installation	<ul style="list-style-type: none"> <li>Will use this variable</li> </ul>	<ul style="list-style-type: none"> <li>This variable is key linkage to census</li> </ul>



Variable	Interpretation	Proposed Treatment	Rationale
<b>Postcode</b>			data
<b>Create Date</b>	When the STCs were created	<ul style="list-style-type: none"> <li>Will not use this variable</li> </ul>	<ul style="list-style-type: none"> <li>Is largely affected by decisions of the installer to register / create STCs</li> <li>This is unrelated to the census data and therefore the demographics of the household</li> </ul>
<b>SGU Brand</b>	Brand of SGU	<ul style="list-style-type: none"> <li>Will not use this variable</li> </ul>	<ul style="list-style-type: none"> <li>Brand of SGU is not relevant</li> </ul>
<b>SGU Model</b>	Model of SGU installation	<ul style="list-style-type: none"> <li>Will not use this variable</li> </ul>	<ul style="list-style-type: none"> <li>Model of SGU is not relevant</li> </ul>
<b>RECs Multiplier</b>	Eligible solar multiplier	<ul style="list-style-type: none"> <li>Will use this variable</li> </ul>	<ul style="list-style-type: none"> <li>Is unreliable from 9 June 2010 to Sep 2010.</li> <li>Will infer multiplier from the kW and STCs for each installation within this period</li> </ul>
<b>SWH File</b>			
<ul style="list-style-type: none"> <li><b>System Brand</b></li> </ul>	<ul style="list-style-type: none"> <li>Brand of SWH</li> </ul>	<ul style="list-style-type: none"> <li>Will not use this variable</li> </ul>	<ul style="list-style-type: none"> <li>There would have been some use in allowing heat pumps to be distinguished from SWH or domestic from commercial but 14% of records could not match brand so we are not able to use this field without introducing bias in our analysis</li> </ul>
<b>System Model</b>	Model of SWH	<ul style="list-style-type: none"> <li>Will not use this variable</li> </ul>	<ul style="list-style-type: none"> <li>Refer discussion above (system brand)</li> </ul>
<b>Number of Panels</b>	Number of panels on SWH	<ul style="list-style-type: none"> <li>Will not use this variable</li> </ul>	<ul style="list-style-type: none"> <li>158,411 values are 0 (25% of the total)</li> </ul>
<b>Installation Date</b>	Date of installation	<ul style="list-style-type: none"> <li>Will use this variable</li> <li>Will not make allowance for time lag between date of</li> </ul>	<ul style="list-style-type: none"> <li>Date of installation most closely relates to the decision to purchase</li> <li>Will also link this data to net cost at</li> </ul>



Variable	Interpretation	Proposed Treatment	Rationale
		<p>purchase and date of installation</p> <ul style="list-style-type: none"> <li>Used to create time groups e.g. in years, to compare uptake analysis for varying policy periods</li> </ul>	<p>time of installation</p>
<b>Installation Type</b>	Type of installation, e.g. new building, first heater in existing building, replace electric, replace gas, replace solar, other	<ul style="list-style-type: none"> <li>Will use this variable</li> <li>Will only split by new vs. replacement</li> </ul>	<ul style="list-style-type: none"> <li>New and existing buildings may have different demographic drivers</li> <li>Inadequate record counts in some of the sub types of replacements to split further than new vs. replacement</li> </ul>
<b>Previous STCs</b>	Existence of previous STCs at installation Y/N/U/blank	<ul style="list-style-type: none"> <li>Will not use this variable</li> </ul>	<ul style="list-style-type: none"> <li>Not relevant</li> <li>Only 1061 values are “Y”</li> </ul>
<b>Number of Previous STCs</b>	Previous number of STCs	<ul style="list-style-type: none"> <li>Will not use this variable</li> </ul>	<ul style="list-style-type: none"> <li>Not relevant</li> <li>Many values are inconsistent with the previous variable</li> </ul>
<b>Volume capacity &gt;700</b>	The capacity of the panels is not stored in the ORER system, only the number of RECs the system is eligible to receive. The system and model can be used to determine the volumetric capacity. This variable indicates if the capacity is greater than 700 litres and is a reasonably new requirement (which is why it is not populated historically)	<ul style="list-style-type: none"> <li>Will not use this variable</li> <li>This variable is an indicator of domestic vs. commercial installations but SWH Type is a better indicator of domestic/commercial and we will use this variable instead</li> </ul>	<ul style="list-style-type: none"> <li>Only 1739 values are “Y”</li> </ul>
<b>Statutory</b>	Statutory declaration supplied for SWH capacity	<ul style="list-style-type: none"> <li>Will not use this variable</li> </ul>	<ul style="list-style-type: none"> <li>Not relevant</li> <li>Only 1739 values are “Y” – similar</li> </ul>



Variable	Interpretation	Proposed Treatment	Rationale
	Y/N/blank		information to the previous variable
<b>Second Hand</b>	Is the installed technology second hand Y/N/blank	<ul style="list-style-type: none"> <li>Will not use this variable</li> </ul>	<ul style="list-style-type: none"> <li>Only 20 Y values, insufficient for any conclusions</li> </ul>
<b>STCs Registered</b>	Number of STCs registered due to the installation	<ul style="list-style-type: none"> <li>Will use this variable</li> <li>Will use &gt;50 STCs as the indicator of commercial systems if SWH Type is Unknown</li> </ul>	<ul style="list-style-type: none"> <li>Indicates part of the rebate received and so the net cost</li> <li>Census variables only make sense when combined with domestic installations, so need to filter out most of the commercial installations</li> <li>10,084 out of 635,796 (1.6%) have greater than 50 STCs. Higher than that, there is only a gradual drop-off till 330 STCs – 1.3% have greater than 325 STCs.</li> </ul>
<b>Creation Date</b>	Date STCs created	<ul style="list-style-type: none"> <li>Will not use this variable</li> </ul>	<ul style="list-style-type: none"> <li>Is largely affected by decisions of the installer to register / create STCs</li> <li>This is unrelated to the census data and therefore the demographics of the household</li> </ul>
<b>Installation Town/Suburb</b>	Town/ suburb of installation	<ul style="list-style-type: none"> <li>Will not use this variable</li> </ul>	<ul style="list-style-type: none"> <li>Postcode is used to indicate location</li> </ul>
<b>Installation State</b>	State of installation	<ul style="list-style-type: none"> <li>Will use this variable</li> </ul>	<ul style="list-style-type: none"> <li>Analysis will be split by state where there is sufficient data</li> </ul>
<b>Installation Postcode</b>	Postcode of installation	<ul style="list-style-type: none"> <li>Will use this variable</li> </ul>	<ul style="list-style-type: none"> <li>This variable is the key link to census data</li> </ul>
<b>Deeming Period</b>	Deeming period	<ul style="list-style-type: none"> <li>Will not use this variable</li> </ul>	<ul style="list-style-type: none"> <li>All values are 10 years</li> </ul>
<b>Zone</b>	Zone of installation	<ul style="list-style-type: none"> <li>Will use this variable</li> </ul>	<ul style="list-style-type: none"> <li>714 values that are -1 will be ignored</li> </ul>



Variable	Interpretation	Proposed Treatment	Rationale
<b>SWH Type</b>	Domestic or commercial	<ul style="list-style-type: none"> <li>Will use this variable</li> </ul>	<ul style="list-style-type: none"> <li>There is a high proportion of “Unknown” in early years, reducing from 2007.</li> <li>3 Domestic type have more than 50 STCs (0.0006%)</li> <li>11 Commercial type have less than 50 STCs (0.1%)</li> <li>For the 87,097 Unknown, suggest &gt;50 STCs be used as the indicator of Commercial.</li> <li>Matching Brand and Model to the list of more/less than 700l brands and models does not give any additional information as only 1 of the Unknown is matched.</li> </ul>
<b>Fuel Source</b>	Solar or Heat Pump	<ul style="list-style-type: none"> <li>Will not use this variable</li> </ul>	<ul style="list-style-type: none"> <li>Only used for creation date in 2011</li> <li>2,922 Heat pump, 13,999 solar, 618,875 unclassified</li> <li>Given missing data before 2011 this variable cannot be used for our analysis</li> </ul>





## B. Results for Solar PV Installations

Table	Page
<b>Table B. 1: Solar PV, Variables used by category and geographic area, linear relationship type</b>	73
<b>Table B. 2: Solar PV, Explanatory Variables by Linear Relationship Type and Geographic Area, number of variables</b>	79
<b>Table B. 3: Solar PV, Variables by category and national regulatory regime, linear relationship type</b>	80
<b>Table B. 4: Solar PV, Linear Relationship Type by National Regulatory Regime, number of relationships</b>	87
<b>Table B. 5: Penetration of Solar PV by Variable and Regulatory Period, NSW, linear relationship type</b>	88
<b>Table B. 6: Solar PV, Linear Relationship Type by NSW Regulatory Treatment, Number of Variables, NSW</b>	95
<b>Table B. 7: Penetration of Solar PV, average size of installation by variable, Australia and states, linear relationship type</b>	96
<b>Table B. 8: Penetration of Solar PV, Average Size of Installation and Linear Relationship Types, Australian and states, Number of Relationships</b>	103



Table B. 1: Solar PV, Variables used by category and geographic area, linear relationship type

Category	Variable	Geographic Area						
		National	NSW	Vic	QLD	SA	WA	TAS
<b>Age and population distribution</b>	Median age	-	-	-	-	-	-	-
	Proportion of people in most likely age range (35-74)	Positive	-	-	Positive	Positive	-	-
	Proportion of people in younger age range (20-34)	Strong Negative	Strong Negative	Negative	Strong Negative	Negative	-	-
	Proportion of older persons (75+)	-	-	-	-	-	-	-
<b>Australian Taxation Office</b>	Average taxable income (excluding losses)	-	-	-	-	-	-	-
	Average imputation credits	-	-	-	-	-	-	-
	Average net tax	-	-	-	-	-	-	-
	Average gross interest	-	-	-	-	-	-	-
	Average gross tax	-	-	-	-	-	-	-
	Average net capital gain	-	-	-	-	-	-	-
	Average income or loss	-	-	-	-	-	-	-
<b>Calculated Indices</b>	Average salary or wages	Negative	Strong Negative	-	Negative	-	-	-
	Index of Education and Occupation	-	-	-	-	-	-	-
	Index of economic resources	-	-	-	-	-	Positive	-
<b>Childcare</b>	Index of relative socio-economic advantage and disadvantage	-	-	-	-	-	-	-
	Proportion of people caring for their own children	Positive	-	Positive	-	-	-	-
<b>Children</b>	Proportion of young children (age < 15)	Positive	-	Positive	-	-	-	-



Category	Variable	Geographic Area						
		National	NSW	Vic	QLD	SA	WA	TAS
	Proportion of older children (age >=15)	-	-	-	-	-	-	-
<b>Citizenship</b>	Proportion of Australian citizens	-	Strong Positive	-	-	Positive	-	-
<b>Dwellings</b>	Number of dwellings	-	-	-	-	-	-	-
	Persons per sq km	Negative	Strong Negative	Strong Negative	-	-	-	-
	Proportion of most likely dwellings to install solar PV (house, semi-detached etc.)	Positive	-	Strong Positive	-	Positive	Strong Positive	-
	Proportion of most likely dwellings including flats	-	-	-	-	-	-	-
	Proportion of most likely dwellings including flats and caravans	-	-	Strong Positive	-	-	Positive	-
<b>Educational attainment</b>	Proportion with schooling year 11 or higher aged (35-74)	-	Negative	-	-	-	-	Strong Positive
	Proportion with post-school qualifications	-	-	-	-	-	-	Strong Positive
<b>Employment</b>	% Unemployment	-	Positive	-	Positive	-	-	-
	% Employment	-	-	-	-	-	-	-
<b>Employment by industry</b>	Proportion of people employed in agriculture, forestry and fishing and in the likely age range (35-74)	Positive	-	Positive	-	-	-	-
	Proportion of people employed in mining and in the likely age range (35-74)	Positive	-	-	-	-	-	-
	Proportion of people employed in manufacturing and in the likely age range (35-74)	-	-	Positive	-	-	Strong Positive	-



Category	Variable	Geographic Area						
		National	NSW	Vic	QLD	SA	WA	TAS
<b>Employment by industry</b>	Proportion of people employed in electricity/gas/water/waste services and in the likely age range (35-74)	Positive	Positive	Positive	-	-	-	-
	Proportion of people employed in construction and in the likely age range (35-74)	Strong Positive	Strong Positive	Positive	Positive	-	Strong Positive	-
	Proportion of people employed in wholesale trade and in the likely age range (35-74)	-	-	-	Positive	-	-	-
	Proportion of people employed in retail trade and in the likely age range (35-74)	Positive	Strong Positive	-	Positive	Positive	-	-
	Proportion of people employed in accommodation and food services and in the likely age range (35-74)	-	-	-	-	-	-	-
	Proportion of people employed in transport/postal/warehousing and in the likely age range (35-74)	-	-	-	-	-	-	-
	Proportion of people employed in information, media or telecommunications and in the likely age range (35-74)	-	-	-	-	-	-	-
	Proportion of people employed in financial and insurance services and in the likely age range (35-74)	-	-	Negative	-	-	-	-
	Proportion of people employed in rental, hiring and real estate services and in the likely age range (35-74)	Positive	-	-	Positive	-	-	-
	<b>Employment</b>	Proportion of people employed in professional, technical and scientific services and in the likely age range (35-74)	-	-	-	-	-	-



Category	Variable	Geographic Area						
		National	NSW	Vic	QLD	SA	WA	TAS
<b>by industry</b>	Proportion of people employed in administrative and support services and in the likely age range (35-74)	-	-	-	-	-	-	-
	Proportion of people employed in public administration and safety and in the likely age range (35-74)	-	Positive	-	-	-	-	-
	Proportion of people employed in education and training services and in the likely age range (35-74)	-	Positive	-	-	-	-	-
	Proportion of people employed in health care and social assistance and in the likely age range (35-74)	Positive	Strong Positive	-	-	-	-	-
	Proportion of people employed in arts and recreation services and in the likely age range (35-74)	-	-	-	-	-	-	-
	Proportion of people employed in other services and in the likely age range (35-74)	Positive	Positive	-	Positive	-	-	-
<b>Home ownership</b>	Proportion of houses that are separate or semi-detached and are owned or being purchased	Positive	-	Strong Positive	Strong Positive	Strong Positive	Strong Positive	-
<b>Hours worked</b>	Proportion of people who are employed fulltime	-	-	-	-	-	-	-
<b>Household characteristics</b>	Average household size	-	-	Positive	-	-	-	-
	Proportion of households that are families	Positive	-	Positive	Positive	Positive	Positive	-
	Proportion who live at same address one year ago	-	-	-	-	-	-	-
	Proportion who live at same address five years ago	-	-	-	Negative	-	-	-



Category	Variable	Geographic Area						
		National	NSW	Vic	QLD	SA	WA	TAS
	Average number of bedrooms per dwelling	Positive	-	Positive	-	Flat	Positive	-
<b>Housing costs</b>	Average mortgage stress (mortgage/income)	-	-	-	Positive	-	-	-
<b>Housing rental</b>	Average rent stress (rent/income)	Flat	-	-	Positive	-	-	-
<b>Income personal, family and household</b>	Median individual income	-	-	-	Negative	-	-	-
	Median family income	Negative	Negative	-	Negative	-	-	-
	Median household income	Flat	Negative	-	-	-	-	Strong Positive
	Proportion of family or households with weekly gross income between \$1,000 - \$1,699 (below means test threshold but sufficient incomes)	Positive	-	Positive	Positive	Positive	-	-
	Proportion of family or households with weekly gross income \$1,700 and above (higher incomes)	Flat	Negative	-	-	-	-	-
	Proportion of family or households with weekly gross income over \$1,000 (sufficient incomes)	-	-	-	-	-	-	-
	Proportion of family or households with weekly gross income \$250 - \$649 (very low incomes)	Positive	Positive	-	Positive	-	-	-
<b>Indigenous population size and distribution</b>	Proportion of Aboriginal & Torres strait islanders	-	Positive	-	-	-	-	-
<b>Language</b>	Proportion of people with poor English	Strong Negative	Strong Negative	Negative	-	-	-	-



Category	Variable	Geographic Area						
		National	NSW	Vic	QLD	SA	WA	TAS
<b>Motor vehicles</b>	Proportion of dwellings with 3 or more cars	Positive	-	Positive	Positive	-	-	-
<b>Occupation</b>	Proportion of managers in mostly likely age range (35 - 74)	-	-	-	-	-	-	-
	Proportion of professionals in mostly likely age range (35 - 74)	-	-	Flat	-	-	-	-
	Proportion of technical and trade workers in mostly likely age range (35 - 74)	Strong Positive	Strong Positive	Positive	Strong Positive	Positive	Positive	-
	Proportion of community and personal service workers in mostly likely age range (35 - 74)	Positive	Strong Positive	-	Positive	Positive	-	-
	Proportion of clerical and administrative workers in mostly likely age range (35 - 74)	-	-	-	-	-	-	-
	Proportion of sales workers in mostly likely age range (35 - 74)	Positive	Strong Positive	-	Positive	-	Strong Positive	-
	Proportion of machinery operators and drivers in mostly likely age range (35 - 74)	-	-	-	-	-	Positive	-
	Proportion of labourers in mostly likely age range (35 - 74)	-	-	-	Positive	-	-	-
<b>Type of internet connection</b>	Proportion of people with separate and semidetached houses and broadband	-	-	-	-	-	-	-



**Table B. 2: Solar PV, Explanatory Variables by Linear Relationship Type and Geographic Area, number of variables**

Relationship type	Geographic Area						
	Aust	NSW	Vic	QLD	SA	WA	Tas
<b>Strong Positive</b>	2	7	3	2	1	5	4
<b>Positive</b>	19	7	12	16	8	6	0
<b>Flat</b>	3	0	1	0	1	0	0
<b>Negative</b>	3	4	3	4	1	0	0
<b>Strong Negative</b>	2	4	1	1	0	0	0
<b>Total Relationships</b>	29	22	20	23	11	11	4
<b>No Relationship</b>	46	53	55	52	64	64	71
<b>Total Variables</b>	75	75	75	75	75	75	75





Table B. 3: Solar PV, Variables by category and national regulatory regime, linear relationship type

Category	Variable	Regulatory Period			
		PVRP	SHCP	Solar Credits	All time periods
<b>Age and population distribution</b>	Median age	Strong Positive	Positive	-	-
	Proportion of people in most likely age range (35-74)	-	Positive	Positive	Positive
	Proportion of people in younger age range (20-34)	-	Strong Negative	Negative	Strong Negative
	Proportion of older persons (75+)	-	-	-	-
<b>Australian Taxation Office</b>	Average taxable income (excluding losses)	-	-	-	-
	Average imputation credits	-	-	-	-
	Average net tax	-	-	-	-
	Average gross interest	-	-	-	-
	Average gross tax	-	-	-	-
	Average net capital gain	-	-	-	-
	Average income or loss	-	-	-	-
	Average salary or wages	-	Negative	-	Negative
<b>Calculated Indices</b>	Index of Education and Occupation	-	-	-	-
	Index of economic resources	Negative	-	-	-
	Index of relative socio-economic advantage and disadvantage	Strong Negative	-	-	-
<b>Childcare</b>	Proportion of people caring for their own children	-	-	Positive	Positive



Category	Variable	Regulatory Period			
		PVRP	SHCP	Solar Credits	All time periods
<b>Children</b>	Proportion of young children (age < 15)	-	-	Positive	Positive
	Proportion of older children (age >=15)	Strong Negative	-	-	-
<b>Citizenship</b>	Proportion of Australian citizens	Strong Positive	-	-	-
<b>Dwellings</b>	number of dwellings	-	-	-	-
	Persons per sq. km	-	-	-	Negative
	Proportion of most likely dwellings to install solar PV (house, semi-detached etc.)	-	Strong Positive	Positive	Positive
	Proportion of most likely dwellings including flats	-	-	-	-
	Proportion of most likely dwellings including flats and caravans	-	Positive	-	-
<b>Educational attainment</b>	Proportion with schooling year 11 or higher aged (35-74)	-	-	Negative	-
	Proportion with post-school qualifications	-	-	-	-
<b>Employment</b>	% Unemployment	-	-	-	-
	% Employment	-	-	-	-
<b>Employment by industry</b>	Proportion of people employed in agriculture, forestry and fishing and in the likely age range (35-74)	Strong Positive	Positive	-	Positive
	Proportion of people employed in mining and in the likely age range (35-74)	-	Positive	Positive	Positive



Category	Variable	Regulatory Period			
		PVRP	SHCP	Solar Credits	All time periods
<b>Employment by industry</b>	Proportion of people employed in manufacturing and in the likely age range (35-74)	-	-	-	-
	Proportion of people employed in electricity/gas/water/waste services and in the likely age range (35-74)	-	Positive	Positive	Positive
	Proportion of people employed in construction and in the likely age range (35-74)	-	Strong Positive	Strong Positive	Strong Positive
	Proportion of people employed in wholesale trade and in the likely age range (35-74)	Strong Negative	-	-	-
	Proportion of people employed in retail trade and in the likely age range (35-74)	-	Positive	Strong Positive	Positive
	Proportion of people employed in accommodation and food services and in the likely age range (35-74)	-	-	-	-
	Proportion of people employed in transport/postal/warehousing and in the likely age range (35-74)	-	-	-	-
	Proportion of people employed in information, media or telecommunications and in the likely age range (35-74)	-	-	-	-
	Proportion of people employed in financial and insurance services and in the likely age range (35-74)	-	-	-	-



Category	Variable	Regulatory Period			
		PVRP	SHCP	Solar Credits	All time periods
<b>Employment by industry</b>	Proportion of people employed in rental, hiring and real estate services and in the likely age range (35-74)	-	Positive	Positive	Positive
	Proportion of people employed in professional, technical and scientific services and in the likely age range (35-74)	-	-	-	-
	Proportion of people employed in administrative and support services and in the likely age range (35-74)	-	Flat	-	-
	Proportion of people employed in public administration and safety and in the likely age range (35-74)	-	-	-	-
	Proportion of people employed in education and training services and in the likely age range (35-74)	-	-	-	-
	Proportion of people employed in health care and social assistance and in the likely age range (35-74)	-	Positive	-	Positive
	Proportion of people employed in arts and recreation services and in the likely age range (35-74)	-	-	-	-
	Proportion of people employed in other services and in the likely age range (35-74)	-	Positive	Positive	Positive
<b>Home ownership</b>	Proportion of houses that are separate or semi-detached and are owned or being purchased	Positive	Strong Positive	-	Positive
<b>Hours worked</b>	Proportion of people who are employed	Negative	-	-	-



Category	Variable	Regulatory Period			
		PVRP	SHCP	Solar Credits	All time periods
	fulltime				
<b>Household characteristics</b>	average household size	-	-	Positive	-
	Proportion of households that are families	-	-	Positive	Positive
	Proportion who live at same address one year ago	-	-	-	-
	Proportion who live at same address five years ago	-	-	-	-
	Average number of bedrooms per dwelling	-	-	Positive	Positive
<b>Housing costs</b>	Average mortgage stress (mortgage/income)	Strong Negative	-	-	-
<b>Housing rental</b>	Average rent stress (rent/income)	-	-	Positive	Flat
<b>Income personal, family and household</b>	Median individual income	-	-	-	-
	Median family income	-	-	Negative	Negative
	Median household income	Strong Negative	-	-	Flat
	Proportion of family or households with weekly gross income between \$1,000 - \$1,699 (below means test threshold but sufficient incomes)	-	Positive	Positive	Positive
	Proportion of family or households with weekly gross income \$1,700 and above (higher incomes)	-	-	-	Flat



Category	Variable	Regulatory Period			
		PVRP	SHCP	Solar Credits	All time periods
	Proportion of family or households with weekly gross income over \$1,000 (sufficient incomes)	Negative	-	-	-
	Proportion of family or households with weekly gross income \$250 - \$649 (very low incomes)	-	Positive	Positive	Positive
<b>Indigenous population size and distribution</b>	Proportion of Aboriginal & Torres strait islanders	-	-	-	-
<b>Language</b>	Proportion of people with poor English	Strong Negative	Strong Negative	Negative	Strong Negative
<b>Motor vehicles</b>	Proportion of dwellings with 3 or more cars	-	Positive	-	Positive
<b>Occupation</b>	Proportion of managers in mostly likely age range (35 - 74)	Strong Positive	-	-	-
	Proportion of professionals in mostly likely age range (35 - 74)	-	-	-	-
	Proportion of technical and trade workers in mostly likely age range (35 - 74)	-	Strong Positive	Strong Positive	Strong Positive
	Proportion of community and personal service workers in mostly likely age range (35 - 74)	-	Strong Positive	Positive	Positive
	Proportion of clerical and administrative workers in mostly likely age range (35 - 74)	Strong Negative	-	-	-
	Proportion of sales workers in mostly likely age range (35 - 74)	-	Positive	Positive	Positive
	Proportion of machinery operators and drivers in mostly likely age range (35 - 74)	-	-	-	-



Category	Variable	Regulatory Period			
		PVRP	SHCP	Solar Credits	All time periods
	Proportion of labourers in mostly likely age range (35 - 74)	-	-	-	-
<b>Type of internet connection</b>	Proportion of people with separate and semidetached houses and broadband	Strong Negative	-	-	-



Table B. 4: Solar PV, Linear Relationship Type by National Regulatory Regime, number of relationships

Relationship type	Regulatory Period			
	PVRP	SHCP	Solar Credits	All Time Periods
<b>Strong Positive</b>	4	5	3	2
<b>Positive</b>	1	14	16	19
<b>Flat</b>	0	1	0	3
<b>Negative</b>	3	1	4	3
<b>Strong Negative</b>	8	2	0	2
<b>Total Relationships</b>	16	23	23	29
<b>No Relationship</b>	59	52	52	46
<b>Total Variables</b>	75	75	75	75





Table B. 5: Penetration of Solar PV by Variable and Regulatory Period, NSW, linear relationship type

Category	Variable	Regulatory Period (NSW)		
		Pre PFIT	During PFIT	All time periods
<b>Age and population distribution</b>	Median age	Strong Positive	-	-
	Proportion of people in most likely age range (35-74)	-	-	-
	Proportion of people in younger age range (20–34)	Strong Negative	Strong Negative	Strong Negative
	Proportion of older persons (75+)	-	-	-
<b>Australian Taxation Office</b>	Average taxable income (excluding losses)	Strong Negative	-	-
	Average imputation credits	-	-	-
	Average net tax	Strong Negative	-	-
	Average gross interest	-	-	-
	Average gross tax	Negative	-	-
	Average net capital gain	-	-	-
	Average income or loss	Negative	-	-
	Average salary or wages	-	Strong Negative	Strong Negative
<b>Calculated Indices</b>	Index of Education and Occupation	-	-	-
	Index of economic resources	-	-	-
	Index of relative socio-economic advantage and disadvantage	Negative	-	-
<b>Childcare</b>	Proportion of people caring for their own children	-	Positive	-
<b>Children</b>	Proportion of young children (age < 15)	-	-	-



Category	Variable	Regulatory Period (NSW)		
		Pre PFIT	During PFIT	All time periods
	Proportion of older children (age >=15)	-	-	-
<b>Citizenship</b>	Proportion of Australian citizens	Strong Positive	Strong Positive	Strong Positive
<b>Dwellings</b>	Number of dwellings	-	-	-
	Persons per sq. km	Strong Negative	-	Strong Negative
	Proportion of most likely dwellings to install solar PV (house, semi-detached etc.)	-	Strong Positive	-
	Proportion of most likely dwellings including flats	-	-	-
	Proportion of most likely dwellings including flats and caravans	-	Strong Positive	-
<b>Educational attainment</b>	Proportion with schooling year 11 or higher aged (35-74)	-	Negative	Negative
	Proportion with post-school qualifications	-	-	-
<b>Employment</b>	% Unemployment	Positive	Positive	Positive
	% Employment	-	-	-
<b>Employment by industry</b>	Proportion of people employed in agriculture, forestry and fishing and in the likely age range (35-74)	Strong Positive	-	-
	Proportion of people employed in mining and in the likely age range (35-74)	-	-	-
	Proportion of people employed in manufacturing and in the likely age range (35-74)	-	-	-



Category	Variable	Regulatory Period (NSW)		
		Pre PFIT	During PFIT	All time periods
<b>Employment by industry</b>	Proportion of people employed in electricity/gas/water/waste services and in the likely age range (35-74)	-	Strong Positive	Positive
	Proportion of people employed in construction and in the likely age range (35-74)	Strong Positive	Strong Positive	Strong Positive
	Proportion of people employed in wholesale trade and in the likely age range (35-74)	-	-	-
	Proportion of people employed in retail trade and in the likely age range (35-74)	Strong Positive	Strong Positive	Strong Positive
	Proportion of people employed in accommodation and food services and in the likely age range (35-74)	-	-	-
	Proportion of people employed in transport/postal/warehousing and in the likely age range (35-74)	-	-	-
	Proportion of people employed in information, media or telecommunications and in the likely age range (35-74)	-	-	-
	Proportion of people employed in financial and insurance services and in the likely age range (35-74)	Strong Negative	-	-
	Proportion of people employed in rental, hiring and real estate services and in the likely age range (35-74)	-	-	-



Category	Variable	Regulatory Period (NSW)		
		Pre PFIT	During PFIT	All time periods
<b>Employment by industry</b>	Proportion of people employed in professional, technical and scientific services and in the likely age range (35-74)	-	-	-
	Proportion of people employed in administrative and support services and in the likely age range (35-74)	-	-	-
	Proportion of people employed in public administration and safety and in the likely age range (35-74)	-	Positive	Positive
	Proportion of people employed in education and training services and in the likely age range (35-74)	-	Positive	Positive
	Proportion of people employed in health care and social assistance and in the likely age range (35-74)	Strong Positive	Strong Positive	Strong Positive
	Proportion of people employed in arts and recreation services and in the likely age range (35-74)	-	-	-
	Proportion of people employed in other services and in the likely age range (35-74)	Positive	Positive	Positive
<b>Home ownership</b>	Proportion of houses that are separate or semi-detached and are owned or being purchased	-	Strong Positive	-
<b>Hours worked</b>	Proportion of people who are employed fulltime	Strong Negative	-	-
<b>Household characteristics</b>	Average household size	-	-	-
	Proportion of households that are families	-	-	-



Category	Variable	Regulatory Period (NSW)		
		Pre PFIT	During PFIT	All time periods
	Proportion who live at same address one year ago	-	-	-
	Proportion who live at same address five years ago	-	-	-
	Average number of bedrooms per dwelling	-	-	-
<b>Housing costs</b>	Average mortgage stress (mortgage/income)	-	-	-
<b>Housing rental</b>	Average rent stress (rent/income)	-	-	-
	Median individual income	-	-	-
	Median family income	Strong Negative	Negative	Negative
	Median household income	Strong Negative	Negative	Negative
<b>Income personal, family and household</b>	Proportion of family or households with weekly gross income between \$1,000 - \$1,699 (below means test threshold but sufficient incomes)	-	Positive	-
	Proportion of family or households with weekly gross income \$1,700 and above (higher incomes)	-	-	Negative
	Proportion of family or households with weekly gross income over \$1,000 (sufficient incomes)	-	-	-
	Proportion of family or households with weekly gross income \$250 - \$649	Strong Positive	Positive	Positive



Category	Variable	Regulatory Period (NSW)		
		Pre PFIT	During PFIT	All time periods
	(very low incomes)			
<b>Indigenous population size and distribution</b>	Proportion of Aboriginal & Torres strait islanders	Positive	Positive	Positive
<b>Language</b>	Proportion of people with poor English	Strong Negative	Strong Negative	Strong Negative
<b>Motor vehicles</b>	Proportion of dwellings with 3 or more cars	-	-	-
<b>Occupation</b>	Proportion of managers in mostly likely age range (35 - 74)	Positive	-	-
	Proportion of professionals in mostly likely age range (35 - 74)	-	-	-
	Proportion of technical and trade workers in mostly likely age range (35 - 74)	Strong Positive	Strong Positive	Strong Positive
	Proportion of community and personal service workers in mostly likely age range (35 - 74)	Strong Positive	Strong Positive	Strong Positive
	Proportion of clerical and administrative workers in mostly likely age range (35 - 74)	-	-	-
	Proportion of sales workers in mostly likely age range (35 - 74)	Strong Positive	Strong Positive	Strong Positive
	Proportion of machinery operators and drivers in mostly likely age range (35 - 74)	-	-	-
	Proportion of labourers in mostly likely age range (35 - 74)	-	-	-



Category	Variable	Regulatory Period (NSW)		
		Pre PFIT	During PFIT	All time periods
<b>Type of internet connection</b>	Proportion of people with separate and semidetached houses and broadband	-	-	-



Table B. 6: Solar PV, Linear Relationship Type by NSW Regulatory Treatment, Number of Variables, NSW

Relationship type	Regulatory Period (NSW)		
	Pre PFIT	During PFIT	All Time Periods
<b>Strong Positive</b>	10	11	7
<b>Positive</b>	4	8	7
<b>Flat</b>	0	0	0
<b>Negative</b>	3	3	4
<b>Strong Negative</b>	9	3	4
<b>Total Relationships</b>	26	25	22
<b>No Relationship</b>	49	50	53
<b>Total Variables</b>	75	75	75





Table B. 7: Penetration of Solar PV, average size of installation by variable, Australia and states, linear relationship type

Category	Variable	Geographic Area						
		National	NSW	Vic	QLD	SA	WA	TAS
<b>Age and population distribution</b>	Median age	-	-	-	-	-	-	-
	Proportion of people in most likely age range (35-74)	-	-	-	-	-	-	-
	Proportion of people in younger age range (20-34)	-	-	-	-	-	-	-
	Proportion of older persons (75+)	-	-	-	-	-	-	-
<b>Australian Taxation Office</b>	Average taxable income (excluding losses)	-	-	-	-	-	-	-
	Average imputation credits	-	-	-	-	-	-	-
	Average net tax	-	-	-	-	-	-	-
	Average gross interest	-	-	-	-	-	-	-
	Average gross tax	-	-	-	-	-	-	-
	Average net capital gain	-	-	-	-	-	-	-
	Average income or loss	-	-	-	-	-	-	-
	Average salary or wages	-	-	-	-	-	-	-
<b>Calculated Indices</b>	Index of Education and Occupation	-	-	-	-	-	-	-
	Index of economic resources	-	-	-	-	-	-	-
	Index of relative socio-economic advantage and disadvantage	-	-	-	-	-	-	-
<b>Childcare</b>	Proportion of people caring for their	-	-	-	-	-	-	-



Category	Variable	Geographic Area						
		National	NSW	Vic	QLD	SA	WA	TAS
	own children							
<b>Children</b>	Proportion of young children (age < 15)	-	-	-	-	-	-	-
	Proportion of older children (age >=15)	Negative	Negative	-	-	-	-	-
<b>Citizenship</b>	Proportion of Australian citizens	-	-	Positive	-	-	-	-
<b>Dwellings</b>	Number of dwellings	-	-	-	-	-	-	-
	Persons per sq. km	-	-	-	-	-	-	-
	Proportion of most likely dwellings to install solar PV (house, semi-detached etc.)	-	-	-	-	-	-	-
	Proportion of most likely dwellings including flats	Negative	-	-	-	-	-	-
	Proportion of most likely dwellings including flats and caravans	-	-	-	-	-	-	-
<b>Educational attainment</b>	Proportion with schooling year 11 or higher aged (35-74)	-	-	-	-	-	-	-
	Proportion with post-school qualifications	-	-	-	-	-	-	-
<b>Employment</b>	% Unemployment	-	-	Negative	-	-	-	-
	% Employment	-	-	-	-	-	-	-
<b>Employment by industry</b>	Proportion of people employed in agriculture, forestry and fishing and in the likely age range (35-74)	-	-	-	-	-	-	-



Category	Variable	Geographic Area						
		National	NSW	Vic	QLD	SA	WA	TAS
<b>Employment by industry</b>	Proportion of people employed in mining and in the likely age range (35-74)	-	-	Positive	-	-	-	-
	Proportion of people employed in manufacturing and in the likely age range (35-74)	Negative	-	-	-	-	-	-
	Proportion of people employed in electricity/gas/water/waste services and in the likely age range (35-74)	-	-	-	-	-	-	-
	Proportion of people employed in construction and in the likely age range (35-74)	-	-	-	-	-	-	-
	Proportion of people employed in wholesale trade and in the likely age range (35-74)	-	-	-	-	-	-	-
	Proportion of people employed in retail trade and in the likely age range (35-74)	-	-	-	-	-	-	-
	Proportion of people employed in accommodation and food services and in the likely age range (35-74)	Positive	-	-	-	-	-	-
	Proportion of people employed in transport/postal/warehousing and in the likely age range (35-74)	-	-	-	-	-	-	-
	Proportion of people employed in information, media or telecommunications and in the likely age range (35-74)	-	-	-	-	-	-	-



Category	Variable	Geographic Area						
		National	NSW	Vic	QLD	SA	WA	TAS
<b>Employment by industry</b>	Proportion of people employed in financial and insurance services and in the likely age range (35-74)	-	-	-	-	-	-	-
	Proportion of people employed in rental, hiring and real estate services and in the likely age range (35-74)	-	-	-	-	-	-	-
	Proportion of people employed in professional, technical and scientific services and in the likely age range (35-74)	-	-	-	-	-	-	Negative
	Proportion of people employed in administrative and support services and in the likely age range (35-74)	-	-	-	-	-	-	-
	Proportion of people employed in public administration and safety and in the likely age range (35-74)	-	-	-	-	-	-	-
	Proportion of people employed in education and training services and in the likely age range (35-74)	-	-	-	-	-	-	-
	Proportion of people employed in health care and social assistance and in the likely age range (35-74)	-	-	-	-	-	-	-
	Proportion of people employed in arts and recreation services and in the likely age range (35-74)	-	-	-	-	-	-	-
	Proportion of people employed in other services and in the likely age range (35-74)	-	-	-	-	-	-	-



Category	Variable	Geographic Area						
		National	NSW	Vic	QLD	SA	WA	TAS
<b>Home ownership</b>	Proportion of houses that are separate or semi-detached and are owned or being purchased	-	-	-	-	-	-	-
<b>Hours worked</b>	Proportion of people who are employed fulltime	-	-	-	-	-	-	-
<b>Household characteristics</b>	Average household size	-	-	-	-	-	-	-
	Proportion of households that are families	-	-	-	-	-	-	-
	Proportion who live at same address one year ago	-	-	-	-	-	-	-
	Proportion who live at same address five years ago	-	-	-	-	-	-	-
	Average number of bedrooms per dwelling	-	-	-	-	-	-	-
<b>Housing costs</b>	Average mortgage stress (mortgage/income)	-	Strong Negative	Negative	-	-	-	-
<b>Housing rental</b>	Average rent stress (rent/income)	-	Strong Negative	Negative	-	-	-	-
<b>Income personal, family and household</b>	Median individual income	-	-	-	-	-	-	-
	Median family income	-	-	-	-	-	-	-
	Median household income	-	-	-	-	-	-	-



Category	Variable	Geographic Area						
		National	NSW	Vic	QLD	SA	WA	TAS
<b>Income personal, family and household</b>	Proportion of family or households with weekly gross income between \$1,000 - \$1,699 (below means test threshold but sufficient incomes)	-	-	-	-	-	-	-
	Proportion of family or households with weekly gross income \$1,700 and above (higher incomes)	-	-	-	-	-	-	-
	Proportion of family or households with weekly gross income over \$1,000 (sufficient incomes)	-	-	-	-	-	-	-
	Proportion of family or households with weekly gross income \$250 - \$649 (very low incomes)	-	-	-	-	-	-	-
<b>Indigenous population size and distribution</b>	Proportion of Aboriginal & Torres strait islanders	-	-	-	-	-	-	-
<b>Language</b>	Proportion of people with poor English	-	Negative	Flat	-	-	-	-
<b>Motor vehicles</b>	Proportion of dwellings with 3 or more cars	-	Positive	-	-	-	-	-
<b>Occupation</b>	Proportion of managers in mostly likely age range (35 - 74)	Positive	Positive	-	Positive	-	-	-
	Proportion of professionals in mostly likely age range (35 - 74)	-	-	-	-	-	-	-
	Proportion of technical and trade workers in mostly likely age range (35 -	-	-	-	-	-	-	-



Category	Variable	Geographic Area						
		National	NSW	Vic	QLD	SA	WA	TAS
<b>Occupation</b>	74)							
	Proportion of community and personal service workers in mostly likely age range (35 - 74)	-	-	-	-	-	-	-
	Proportion of clerical and administrative workers in mostly likely age range (35 - 74)	-	-	-	-	-	-	-
	Proportion of sales workers in mostly likely age range (35 - 74)	-	-	-	-	-	-	-
	Proportion of machinery operators and drivers in mostly likely age range (35 - 74)	-	-	-	-	-	-	-
	Proportion of labourers in mostly likely age range (35 - 74)	-	-	-	-	-	-	-
<b>Type of internet connection</b>	Proportion of people with separate and semidetached houses and broadband	Negative	-	-	-	-	-	-



**Table B. 8: Penetration of Solar PV, Average Size of Installation and Linear Relationship Types, Australian and states, Number of Relationships**

Relationship type	Geographic Area						
	National	NSW	Vic	QLD	SA	WA	Tas
<b>Strong Positive</b>	0	0	0	0	0	0	0
<b>Positive</b>	2	2	2	1	0	0	0
<b>Flat</b>	0	0	1	0	0	0	0
<b>Negative</b>	4	2	3	0	0	0	1
<b>Strong Negative</b>	0	2	0	0	0	0	0
<b>Total Relationships</b>	6	6	6	1	0	0	1
<b>No Relationship</b>	69	69	69	74	75	75	74
<b>Total Variables</b>	75	75	75	75	75	75	75





## C. Results for Solar Hot Water Systems

Table	Page Number
<b>Table C. 1: Penetration of Solar Hot Water Systems, Variables used by category and geographic area, linear relationship type</b>	105
<b>Table C. 2: Penetration of Solar Hot Water Systems, Explanatory Variables by Linear Relationship Type and Geographic Area, number of variables</b>	112
<b>Table C. 3: Penetration of Solar Hot Water Systems, Variables by category and national regulatory regime, linear relationship type</b>	113
<b>Table C. 4: Solar Hot Water Systems, Linear Relationship Type by National Regulatory Regime, number of relationships</b>	120
<b>Table C. 5: Penetration of Solar Hot Water Systems, by variable and Installation Type, Linear Relationship Type</b>	121
<b>Table C. 6: Penetration of Solar Hot Water System Installations by New Building or Replacement and Linear Relationship Type, Australia, number of variables</b>	129
<b>Table C. 7: Penetration of Solar Hot Water Systems, average size by variable, Australia, linear relationship type.</b>	130
<b>Table C. 8: Penetration of Solar Hot Water Systems, average size by Linear Relationship Types, Australia, Number of Relationships</b>	134



Table C. 1: Penetration of Solar Hot Water Systems, Variables used by category and geographic area, linear relationship type

Category	Variable	Geographic Area						
		National	NSW	Vic	QLD	SA	WA	TAS
<b>Age and population distribution</b>	Median age	-	Strong Positive	-	-	-	-	-
	Proportion of people in most likely age range (35-74)	-	Strong Positive	-	Positive	-	-	-
	Proportion of people in younger age range (20-34)	Strong Negative	Strong Negative	-	Negative	Strong Negative	-	-
	Proportion of older persons (75+)	-	-	-	-	-	Negative	-
<b>Australian Taxation Office</b>	Average taxable income (excluding losses)	-	Strong Negative	-	-	-	-	-
	Average imputation credits	-	-	-	-	-	-	-
	Average net tax	-	Strong Negative	-	-	-	-	-
	Average gross interest	-	-	-	Negative	-	-	-
	Average gross tax	-	Strong Negative	-	-	-	-	-
	Average net capital gain	-	-	-	-	-	-	-
	Average income or loss	-	Strong Negative	-	-	-	-	-
	Average salary or wages	-	Strong Negative	-	-	-	-	-
<b>Calculated Indices</b>	Index of Education and Occupation	-	Strong Negative	-	Negative	-	-	-
	Index of economic resources	-	-	-	-	-	-	-



Category	Variable	Geographic Area						
		National	NSW	Vic	QLD	SA	WA	TAS
	Index of relative socio-economic advantage and disadvantage	-	Strong Negative	-	-	-	-	-
<b>Childcare</b>	Proportion of people caring for their own children	Positive	-	-	-	-	Strong Positive	-
<b>Children</b>	Proportion of young children (age < 15)	Strong Positive	-	Strong Positive	Positive	Positive	Strong Positive	-
	Proportion of older children (age >=15)	-	-	-	-	-	-	-
<b>Citizenship</b>	Proportion of Australian citizens	Positive	Strong Positive	Strong Positive	-	-	-	-
<b>Dwellings</b>	Number of dwellings	-	-	-	-	-	-	-
	Persons per sq. km	Strong Negative	Strong Negative	Strong Negative	Strong Negative	Strong Negative	Strong Negative	-
	Proportion of most likely dwellings to install solar PV (house, semi-detached etc.)	Strong Positive	-	Strong Positive	Positive	-	Strong Positive	-
	Proportion of most likely dwellings including flats	-	-	-	-	-	-	-
	Proportion of most likely dwellings including flats and caravans	-	-	Strong Positive	Positive	-	-	-
<b>Educational attainment</b>	Proportion with schooling year 11 or higher aged (35-74)	Negative	Strong Negative	-	-	-	-	-
<b>Educational attainment</b>	Proportion with post-school qualifications	-	-	-	-	-	-	Positive
<b>Employment</b>	% Unemployment	-	Strong Positive	-	-	-	-	-
	% Employment	-	Strong Negative	-	-	-	-	Strong Positive



Category	Variable	Geographic Area						
		National	NSW	Vic	QLD	SA	WA	TAS
<b>Employment by industry</b>	Proportion of people employed in agriculture, forestry and fishing and in the likely age range (35-74)	Strong Positive	-	Strong Positive	-	-	Strong Positive	-
	Proportion of people employed in mining and in the likely age range (35-74)	Strong Positive	Strong Positive	-	-	-	-	-
	Proportion of people employed in manufacturing in the likely age range (35-74)	-	-	-	-	-	-	-
	Proportion of people employed in electricity/gas/water/waste services and in the likely age range (35-74)	Positive	Strong Positive	Strong Positive	-	-	-	-
	Proportion of people employed in construction and in the likely age range (35-74)	Strong Positive	Strong Positive	-	Positive	-	-	-
	Proportion of people employed in wholesale trade and in the likely age range (35-74)	Negative	Strong Negative	-	Positive	-	-	-
	Proportion of people employed in retail trade and in the likely age range (35-74)	Strong Positive	Strong Positive	-	-	-	Positive	-
	Proportion of people employed in accommodation and food services and in the likely age range (35-74)	-	-	-	-	-	-	-
	Proportion of people employed in transport/postal/warehousing and in the likely age range (35-74)	-	-	Strong Positive	-	-	Positive	-
	Proportion of people employed in information, media or telecommunications and in the likely age range (35-74)	Strong Negative	-	Strong Negative	-	-	-	-



Category	Variable	Geographic Area						
		National	NSW	Vic	QLD	SA	WA	TAS
<b>Employment by industry</b>	Proportion of people employed in financial and insurance services and in the likely age range (35-74)	Strong Negative	-	Strong Negative	-	-	-	-
	Proportion of people employed in rental, hiring and real estate services and in the likely age range (35-74)	Positive	-	-	-	-	-	-
	Proportion of people employed in professional, technical and scientific services and in the likely age range (35-74)	-	-	-	-	-	-	Strong Positive
	Proportion of people employed in administrative and support services and in the likely age range (35-74)	-	-	-	-	-	-	-
	Proportion of people employed in public administration and safety and in the likely age range (35-74)	Flat	Positive	-	-	-	-	-
	Proportion of people employed in education and training services and in the likely age range (35-74)	-	Strong Positive	-	-	-	-	-
	Proportion of people employed in health care and social assistance and in the likely age range (35-74)	-	Strong Positive	-	-	-	-	-
	Proportion of people employed in arts and recreation services and in the likely age range (35-74)	-	-	-	-	-	-	-
	Proportion of people employed in other services and in the likely age range (35-74)	Positive	Strong Positive	-	-	-	Flat	-
	<b>Home ownership</b>	Proportion of houses that are separate or semi-detached and are owned or being	Positive	-	Strong Positive	Strong Positive	Positive	-



Category	Variable	Geographic Area						
		National	NSW	Vic	QLD	SA	WA	TAS
	purchased							
<b>Hours worked</b>	Proportion of people who are employed fulltime	-	-	-	-	-	-	-
<b>Household characteristics</b>	Average household size	-	-	-	Positive	-	Positive	-
	Proportion of households that are families	Positive	-	Strong Positive	Strong Positive	-	Strong Positive	-
	Proportion who live at same address one year ago	-	-	-	-	-	-	-
	Proportion who live at same address five years ago	Negative	-	-	-	-	-	-
	Average number of bedrooms per dwelling	Positive	-	-	Positive	-	-	-
<b>Housing costs</b>	Average mortgage stress (mortgage/income)	-	-	-	-	-	-	-
<b>Housing rental</b>	Average rent stress (rent/income)	-	Positive	-	Positive	-	-	-
<b>Income personal, family and household</b>	Median individual income	-	Strong Negative	-	-	-	-	Strong Positive
	Median family income	Negative	Strong Negative	-	Flat	-	-	-
	Median household income	-	Strong Negative	-	-	-	-	Strong Positive
<b>Income personal, family and household</b>	Proportion of family or households with weekly gross income between \$1,000 - \$1,699 (below means test threshold but sufficient incomes)	Strong Positive	-	Strong Positive	Positive	-	Positive	-
	Proportion of family or households with weekly gross income \$1,700 and above	Negative	Strong Negative	-	-	-	-	Strong Positive



Category	Variable	Geographic Area						
		National	NSW	Vic	QLD	SA	WA	TAS
	(higher incomes)							
	Proportion of family or households with weekly gross income over \$1,000 (sufficient incomes)	-	-	-	-	-	-	Strong Positive
	Proportion of family or households with weekly gross income \$250 - \$649 (very low incomes)	Positive	Strong Positive	-	Positive	-	Strong Positive	-
<b>Indigenous population size and distribution</b>	Proportion of Aboriginal & Torres strait islanders	Strong Positive	Strong Positive	-	-	-	-	-
<b>Language</b>	Proportion of people with poor English	Strong Negative	Strong Negative	Strong Negative	-	-	Strong Negative	-
<b>Motor vehicles</b>	Proportion of dwellings with 3 or more cars	Positive	-	Strong Positive	Strong Positive	Strong Positive	Strong Positive	-
<b>Occupation</b>	Proportion of managers in mostly likely age range (35 - 74)	-	-	-	-	-	-	Strong Positive
	Proportion of professionals in mostly likely age range (35 - 74)	-	-	Strong Negative	-	-	-	-
	Proportion of technical and trade workers in mostly likely age range (35 - 74)	Strong Positive	Strong Positive	-	Strong Positive	-	Positive	-
<b>Occupation</b>	Proportion of community and personal service workers in mostly likely age range (35 - 74)	Strong Positive	Strong Positive	Strong Positive	Positive	-	Positive	-
	Proportion of clerical and administrative workers in mostly likely age range (35 - 74)	-	-	-	-	-	-	-



Category	Variable	Geographic Area						
		National	NSW	Vic	QLD	SA	WA	TAS
	Proportion of sales workers in mostly likely age range (35 - 74)	Positive	Strong Positive	-	-	-	-	-
	Proportion of machinery operators and drivers in mostly likely age range (35 - 74)	-	-	-	Positive	-	Strong Positive	-
	Proportion of labourers in mostly likely age range (35 - 74)	-	Strong Positive	-	Positive	-	-	-
<b>Type of internet connection</b>	Proportion of people with separate and semidetached houses and broadband	-	-	-	-	-	-	-





**Table C. 2: Penetration of Solar Hot Water Systems, Explanatory Variables by Linear Relationship Type and Geographic Area, number of variables**

Relationship type	Geographic Area						
	Aust	NSW	Vic	QLD	SA	WA	Tas
<b>Strong Positive</b>	10	17	12	4	1	8	7
<b>Positive</b>	11	2	0	14	2	6	1
<b>Flat</b>	1	0	0	1	0	1	0
<b>Negative</b>	5	0	0	3	0	1	0
<b>Strong Negative</b>	5	17	5	1	2	2	0
<b>Total Relationships</b>	32	36	17	23	5	18	8
<b>No Relationship</b>	43	39	58	52	70	57	67
<b>Total Variables</b>	75	75	75	75	75	75	75



**Table C. 3: Penetration of Solar Hot Water Systems, Variables by category and national regulatory regime, linear relationship type**

Category	Variable	Regulatory Period			
		Pre Federal rebate	Federal rebate (\$1,600, no means test)	Federal rebate (\$1,000 and means tested)	All time periods
<b>Age and population distribution</b>	Median age	-	-	-	-
	Proportion of people in most likely age range (35-74)	-	-	-	-
	Proportion of people in younger age range (20-34)	Negative	Strong Negative	-	Strong Negative
	Proportion of older persons (75+)	-	-	-	-
<b>Australian Taxation Office</b>	Average taxable income (excluding losses)	-	Negative	-	-
	Average imputation credits	-	-	-	-
	Average net tax	-	Negative	-	-
	Average gross interest	-	-	-	-
	Average gross tax	-	-	-	-
	Average net capital gain	-	-	-	-
	Average income or loss	-	-	-	-
	Average salary or wages	-	-	-	-
<b>Calculated Indices</b>	Index of Education and Occupation	-	-	-	-
	Index of economic resources	-	-	-	-
	Index of relative socio-economic advantage and disadvantage	-	-	-	-
<b>Childcare</b>	Proportion of people caring for their own	Strong	Positive	Strong	Positive



Category	Variable	Regulatory Period			
		Pre Federal rebate	Federal rebate (\$1,600, no means test)	Federal rebate (\$1,000 and means tested)	All time periods
	children	Positive		Positive	
<b>Children</b>	Proportion of young children (age < 15)	Strong Positive	Strong Positive	Strong Positive	Strong Positive
	Proportion of older children (age >=15)	Negative	-	-	-
<b>Citizenship</b>	Proportion of Australian citizens	-	Strong Positive	-	Positive
<b>Dwellings</b>	number of dwellings	-	-	-	-
	Persons per sq. km	Strong Negative	Strong Negative	Strong Negative	Strong Negative
	Proportion of most likely dwellings to install solar PV (house, semi-detached etc.)	Strong Positive	Positive	Strong Positive	Strong Positive
	Proportion of most likely dwellings including flats	-	-	-	-
	Proportion of most likely dwellings including flats and caravans	-	-	-	-
<b>Educational attainment</b>	Proportion with schooling year 11 or higher aged (35-74)	-	Negative	Negative	Negative
	Proportion with post-school qualifications	-	-	-	-
<b>Employment</b>	% Unemployment	-	-	-	-
	% Employment	-	-	-	-



Category	Variable	Regulatory Period			
		Pre Federal rebate	Federal rebate (\$1,600, no means test)	Federal rebate (\$1,000 and means tested)	All time periods
<b>Employment by industry</b>	Proportion of people employed in agriculture, forestry and fishing and in the likely age range (35-74)	Strong Positive	Strong Positive	Strong Positive	Strong Positive
	Proportion of people employed in mining and in the likely age range (35-74)	Strong Positive	Positive	Positive	Strong Positive
	Proportion of people employed in manufacturing and in the likely age range (35-74)	-	-	-	-
	Proportion of people employed in electricity/gas/water/waste services and in the likely age range (35-74)	Positive	Positive	Positive	Positive
	Proportion of people employed in construction and in the likely age range (35-74)	Strong Positive	Strong Positive	Strong Positive	Strong Positive
	Proportion of people employed in wholesale trade and in the likely age range (35-74)	Negative	Negative	-	Negative
	Proportion of people employed in retail trade and in the likely age range (35-74)	Positive	Strong Positive	Positive	Strong Positive
	Proportion of people employed in accommodation and food services and in the likely age range (35-74)	-	-	-	-
	<b>Employment by</b>	Proportion of people employed in transport/postal/warehousing and in the likely age range (35-74)	-	-	-



Category	Variable	Regulatory Period			
		Pre Federal rebate	Federal rebate (\$1,600, no means test)	Federal rebate (\$1,000 and means tested)	All time periods
<b>industry</b>	Proportion of people employed in information, media or telecommunications and in the likely age range (35-74)	Strong Negative	Strong Negative	Strong Negative	Strong Negative
	Proportion of people employed in financial and insurance services and in the likely age range (35-74)	Strong Negative	Strong Negative	Strong Negative	Strong Negative
	Proportion of people employed in rental, hiring and real estate services and in the likely age range (35-74)	Strong Positive	Flat	Flat	Positive
	Proportion of people employed in professional, technical and scientific services and in the likely age range (35-74)	-	-	-	-
	Proportion of people employed in administrative and support services and in the likely age range (35-74)	-	-	-	-
	Proportion of people employed in public administration and safety and in the likely age range (35-74)	Positive	-	-	Flat
	Proportion of people employed in education and training services and in the likely age range (35-74)	-	Flat	-	-
	Proportion of people employed in health care and social assistance and in the likely age range (35-74)	-	-	-	-



Category	Variable	Regulatory Period			
		Pre Federal rebate	Federal rebate (\$1,600, no means test)	Federal rebate (\$1,000 and means tested)	All time periods
<b>Employment by industry</b>	Proportion of people employed in arts and recreation services and in the likely age range (35-74)	-	-	-	-
	Proportion of people employed in other services and in the likely age range (35-74)	Positive	Positive	Positive	Positive
<b>Home ownership</b>	Proportion of houses that are separate or semi-detached and are owned or being purchased	Positive	Positive	Positive	Positive
<b>Hours worked</b>	Proportion of people who are employed fulltime	-	-	-	-
<b>Household characteristics</b>	Average household size	Positive	-	Positive	-
	Proportion of households that are families	Positive	-	Positive	Positive
	Proportion who live at same address one year ago	Strong Negative	-	-	-
	Proportion who live at same address five years ago	Strong Negative	-	-	Negative
	Average number of bedrooms per dwelling	Positive	-	Positive	Positive
<b>Housing costs</b>	Average mortgage stress (mortgage/income)	-	-	-	-
<b>Housing rental</b>	Average rent stress (rent/income)	-	-	Flat	-
<b>Income personal, family and household</b>	Median individual income	-	Negative	-	-
	Median family income	-	Negative	-	Negative



Category	Variable	Regulatory Period			
		Pre Federal rebate	Federal rebate (\$1,600, no means test)	Federal rebate (\$1,000 and means tested)	All time periods
	Median household income	-	-	-	-
	Proportion of family or households with weekly gross income between \$1,000 - \$1,699 (below means test threshold but sufficient incomes)	Strong Positive	Positive	Strong Positive	Strong Positive
	Proportion of family or households with weekly gross income \$1,700 and above (higher incomes)	-	Negative	Negative	Negative
	Proportion of family or households with weekly gross income over \$1,000 (sufficient incomes)	-	-	-	-
	Proportion of family or households with weekly gross income \$250 - \$649 (very low incomes)	Positive	Strong Positive	Positive	Positive
<b>Indigenous population size and distribution</b>	Proportion of Aboriginal & Torres strait islanders	Strong Positive	Strong Positive	Positive	Strong Positive
<b>Language</b>	Proportion of people with poor English	Strong Negative	Strong Negative	Strong Negative	Strong Negative
<b>Motor vehicles</b>	Proportion of dwellings with 3 or more cars	Strong Positive	Positive	Strong Positive	Positive
<b>Occupation</b>	Proportion of managers in mostly likely age range (35 - 74)	-	-	-	-
<b>Occupation</b>	Proportion of professionals in mostly likely age range (35 - 74)	-	-	Negative	-



Category	Variable	Regulatory Period			
		Pre Federal rebate	Federal rebate (\$1,600, no means test)	Federal rebate (\$1,000 and means tested)	All time periods
	Proportion of technical and trade workers in mostly likely age range (35 - 74)	Strong Positive	Strong Positive	Strong Positive	Strong Positive
	Proportion of community and personal service workers in mostly likely age range (35 - 74)	Strong Positive	Strong Positive	Strong Positive	Strong Positive
	Proportion of clerical and administrative workers in mostly likely age range (35 - 74)	-	-	-	-
	Proportion of sales workers in mostly likely age range (35 - 74)	-	Positive	Positive	Positive
	Proportion of machinery operators and drivers in mostly likely age range (35 - 74)	-	-	-	-
	Proportion of labourers in mostly likely age range (35 - 74)	-	-	-	-
<b>Type of internet connection</b>	Proportion of people with separate and semidetached houses and broadband	-	-	-	-





Table C. 4: Solar Hot Water Systems, Linear Relationship Type by National Regulatory Regime, number of relationships

Relationship type	Regulatory Period			
	Pre Federal rebate	Federal Rebate (\$1,600, no means test)	Federal rebate (\$1,000 and means tested)	All Time Periods
<b>Strong Positive</b>	12	9	9	10
<b>Positive</b>	9	9	11	11
<b>Flat</b>	0	2	2	1
<b>Negative</b>	3	7	3	5
<b>Strong Negative</b>	6	5	4	5
<b>Total Relationships</b>	30	32	29	32
<b>No Relationship</b>	45	43	46	43
<b>Total Variables</b>	75	75	75	75



Table C. 5: Penetration of Solar Hot Water Systems, by variable and Installation Type, Linear Relationship Type

Category	Variable	Installation Type		
		New Buildings	Replacements	All Installation Types
<b>Age and population distribution</b>	Median age	-	Positive	-
	Proportion of people in most likely age range (35-74)	-	Strong Positive	-
	Proportion of people in younger age range (20-34)	-	Strong Negative	Strong Negative
	Proportion of older persons (75+)	-	-	-
<b>Australian Taxation Office</b>	Average taxable income (excluding losses)	-	-	-
	Average imputation credits	Negative	-	-
	Average net tax	-	-	-
	Average gross interest	Strong Negative	-	-
	Average gross tax	-	-	-
	Average net capital gain	-	-	-
	Average income or loss	-	-	-
<b>Calculated Indices</b>	Index of Education and Occupation	-	-	-
	Index of economic resources	-	-	-
	Index of relative socio-economic advantage and disadvantage	-	-	-
<b>Childcare</b>	Proportion of people caring for their own children	-	-	Positive



Category	Variable	Installation Type		
		New Buildings	Replacements	All Installation Types
<b>Children</b>	Proportion of young children (age < 15)	Strong Positive	-	Strong Positive
	Proportion of older children (age >=15)	-	-	-
<b>Citizenship</b>	Proportion of Australian citizens	-	Positive	Positive
<b>Dwellings</b>	Number of dwellings	-	-	-
	Persons per sq. km	Strong Negative	Strong Negative	Strong Negative
	Proportion of most likely dwellings to install solar PV (house, semi-detached etc.)	Strong Positive	-	Strong Positive
	Proportion of most likely dwellings including flats	-	-	-
	Proportion of most likely dwellings including flats and caravans	Strong Positive	-	-
<b>Educational attainment</b>	Proportion with schooling year 11 or higher aged (35-74)	-	Negative	Negative
	Proportion with post-school qualifications	-	-	-
<b>Employment</b>	% Unemployment	-	-	-
	% Employment	-	-	-
<b>Employment by industry</b>	Proportion of people employed in agriculture, forestry and fishing and in the likely age range (35-74)	-	Strong Positive	Strong Positive



Category	Variable	Installation Type		
		New Buildings	Replacements	All Installation Types
<b>Employment by industry</b>	Proportion of people employed in mining and in the likely age range (35-74)	Positive	Strong Positive	Strong Positive
	Proportion of people employed in manufacturing and in the likely age range (35-74)	-	-	-
	Proportion of people employed in electricity/gas/water/waste services and in the likely age range (35-74)	-	Positive	Positive
	Proportion of people employed in construction and in the likely age range (35-74)	Strong Positive	Strong Positive	Strong Positive
	Proportion of people employed in wholesale trade and in the likely age range (35-74)	-	Negative	Negative
	Proportion of people employed in retail trade and in the likely age range (35-74)	Positive	Strong Positive	Strong Positive
	Proportion of people employed in accommodation and food services and in the likely age range (35-74)	-	-	-
	Proportion of people employed in transport/postal/warehousing and in the likely age range (35-74)	Positive	-	-



Category	Variable	Installation Type		
		New Buildings	Replacements	All Installation Types
<b>Employment by industry</b>	Proportion of people employed in information, media or telecommunications and in the likely age range (35-74)	Strong Negative	Negative	Strong Negative
	Proportion of people employed in financial and insurance services and in the likely age range (35-74)	Strong Negative	Strong Negative	Strong Negative
	Proportion of people employed in rental, hiring and real estate services and in the likely age range (35-74)	-	Positive	Positive
	Proportion of people employed in professional, technical and scientific services and in the likely age range (35-74)	-	-	-
	Proportion of people employed in administrative and support services and in the likely age range (35-74)	-	-	-
	Proportion of people employed in public administration and safety and in the likely age range (35-74)	-	Positive	Flat
	Proportion of people employed in education and training services and in the likely age range (35-74)	Flat	Positive	-



Category	Variable	Installation Type		
		New Buildings	Replacements	All Installation Types
	Proportion of people employed in health care and social assistance and in the likely age range (35-74)	-	Positive	-
	Proportion of people employed in arts and recreation services and in the likely age range (35-74)	-	-	-
	Proportion of people employed in other services and in the likely age range (35-74)	-	Positive	Positive
<b>Home ownership</b>	Proportion of houses that are separate or semi-detached and are owned or being purchased	Strong Positive	-	Positive
<b>Hours worked</b>	Proportion of people who are employed fulltime	-	-	-
<b>Household characteristics</b>	Average household size	Strong Positive	-	-
	Proportion of households that are families	Strong Positive	-	Positive
	Proportion who live at same address one year ago	Strong Negative	-	-
	Proportion who live at same address five years ago	Strong Negative	-	Negative
	Average number of bedrooms per dwelling	Strong Positive	-	Positive
<b>Housing costs</b>	Average mortgage stress (mortgage/income)	-	-	-



Category	Variable	Installation Type		
		New Buildings	Replacements	All Installation Types
<b>Housing rental</b>	Average rent stress (rent/income)	-	-	-
<b>Income personal, family and household</b>	Median individual income	-	Negative	-
	Median family income	-	Negative	Negative
	Median household income	-	Negative	-
	Proportion of family or households with weekly gross income between \$1,000 - \$1,699 (below means test threshold but sufficient incomes)	Strong Positive	-	Strong Positive
	Proportion of family or households with weekly gross income \$1,700 and above (higher incomes)	-	Negative	Negative
	Proportion of family or households with weekly gross income over \$1,000 (sufficient incomes)	-	-	-
	Proportion of family or households with weekly gross income \$250 - \$649 (very low incomes)	-	Positive	Positive
<b>Indigenous population size and distribution</b>	Proportion of Aboriginal & Torres strait islanders	-	Strong Positive	Strong Positive



Category	Variable	Installation Type		
		New Buildings	Replacements	All Installation Types
<b>Language</b>	Proportion of people with poor English	Strong Negative	Strong Negative	Strong Negative
<b>Motor vehicles</b>	Proportion of dwellings with 3 or more cars	Strong Positive	-	Positive
<b>Occupation</b>	Proportion of managers in mostly likely age range (35 - 74)	-	-	-
	Proportion of professionals in mostly likely age range (35 - 74)	Strong Negative	-	-
	Proportion of technical and trade workers in mostly likely age range (35 - 74)	Strong Positive	Strong Positive	Strong Positive
	Proportion of community and personal service workers in mostly likely age range (35 - 74)	Strong Positive	Strong Positive	Strong Positive
	Proportion of clerical and administrative workers in mostly likely age range (35 - 74)	-	-	-
	Proportion of sales workers in mostly likely age range (35 - 74)	-	Positive	Positive
	Proportion of machinery operators and drivers in mostly likely age range (35 - 74)	Strong Positive	-	-
	Proportion of labourers in mostly likely age range (35 -	-	-	-





Category	Variable	Installation Type		
		New Buildings	Replacements	All Installation Types
	74)			
<b>Type of internet connection</b>	Proportion of people with separate and semidetached houses and broadband	-	-	-



Table C. 6: Penetration of Solar Hot Water System Installations by New Building or Replacement and Linear Relationship Type, Australia, number of variables

Relationship type	Installation Type		
	New Buildings	Replacements	All Installations
<b>Strong Positive</b>	13	8	10
<b>Positive</b>	3	10	11
<b>Flat</b>	1	0	1
<b>Negative</b>	1	7	5
<b>Strong Negative</b>	8	4	5
<b>Total Relationships</b>	26	29	32
<b>No Relationship</b>	49	46	43
<b>Total Variables</b>	75	75	75



**Table C. 7: Penetration of Solar Hot Water Systems, average size by variable, Australia, linear relationship type.**

Category	Variable	Geographic Area
		National
<b>Age and population distribution</b>	Median age	-
	Proportion of people in most likely age range (35-74)	-
	Proportion of people in younger age range (20-34)	Negative
	Proportion of older persons (75+)	Positive
<b>Australian Taxation Office</b>	Average taxable income (excluding losses)	-
	Average imputation credits	-
	Average net tax	Negative
	Average gross interest	-
	Average gross tax	-
	Average net capital gain	-
	Average income or loss	-
	Average salary or wages	-
<b>Calculated Indices</b>	Index of Education and Occupation	-
	Index of economic resources	-
	Index of relative socio-economic advantage and disadvantage	-
<b>Childcare</b>	Proportion of people caring for their own children	-
<b>Children</b>	Proportion of young children (age < 15)	-
	Proportion of older children (age >=15)	-
<b>Citizenship</b>	Proportion of Australian citizens	Positive
<b>Dwellings</b>	Number of dwellings	-
	Persons per sq. km	-
	Proportion of most likely dwellings to install solar PV (house, semi-detached etc.)	-
	Proportion of most likely dwellings including flats	-
	Proportion of most likely dwellings including flats and caravans	-
<b>Educational attainment</b>	Proportion with schooling year 11 or higher aged (35-74)	-
	Proportion with post-school qualifications	-
<b>Employment</b>	% Unemployment	Positive
	% Employment	-



Category	Variable	Geographic Area
		National
<b>Employment by industry</b>	Proportion of people employed in agriculture, forestry and fishing and in the likely age range (35-74)	-
	Proportion of people employed in mining and in the likely age range (35-74)	-
	Proportion of people employed in manufacturing and in the likely age range (35-74)	-
<b>Employment by industry</b>	Proportion of people employed in electricity/gas/water/waste services and in the likely age range (35-74)	-
	Proportion of people employed in construction and in the likely age range (35-74)	-
	Proportion of people employed in wholesale trade and in the likely age range (35-74)	-
	Proportion of people employed in retail trade and in the likely age range (35-74)	Positive
	Proportion of people employed in accommodation and food services and in the likely age range (35-74)	-
	Proportion of people employed in transport/postal/warehousing and in the likely age range (35-74)	-
	Proportion of people employed in information, media or telecommunications and in the likely age range (35-74)	-
	Proportion of people employed in financial and insurance services and in the likely age range (35-74)	-
	Proportion of people employed in rental, hiring and real estate services and in the likely age range (35-74)	-
	Proportion of people employed in professional, technical and scientific services and in the likely age range (35-74)	-
	Proportion of people employed in administrative and support services and in the likely age range (35-74)	-
	Proportion of people employed in public administration and safety and in the likely age range (35-74)	-
	Proportion of people employed in education and training services and in the likely age range (35-74)	-
	Proportion of people employed in health care and social assistance and in the likely age range (35-74)	-
<b>Employment by industry</b>		



Category	Variable	Geographic Area
		National
	Proportion of people employed in arts and recreation services and in the likely age range (35-74)	-
	Proportion of people employed in other services and in the likely age range (35-74)	Positive
<b>Home ownership</b>	Proportion of houses that are separate or semi-detached and are owned or being purchased	-
<b>Hours worked</b>	Proportion of people who are employed fulltime	-
<b>Household characteristics</b>	Average household size	-
	Proportion of households that are families	-
	Proportion who live at same address one year ago	Positive
	Proportion who live at same address five years ago	-
	Average number of bedrooms per dwelling	-
<b>Housing costs</b>	Average mortgage stress (mortgage/income)	Positive
<b>Housing rental</b>	Average rent stress (rent/income)	Positive
<b>Income personal, family and household</b>	Median individual income	-
	Median family income	-
	Median household income	-
<b>Income personal, family and household</b>	Proportion of family or households with weekly gross income between \$1,000 - \$1,699 (below means test threshold but sufficient incomes)	-
	Proportion of family or households with weekly gross income \$1,700 and above (higher incomes)	-
	Proportion of family or households with weekly gross income over \$1,000 (sufficient incomes)	-
	Proportion of family or households with weekly gross income \$250 - \$649 (very low incomes)	-
	<b>Indigenous population size and distribution</b>	Proportion of Aboriginal & Torres strait islanders
<b>Language</b>	Proportion of people with poor English	-
<b>Motor vehicles</b>	Proportion of dwellings with 3 or more cars	-



Category	Variable	Geographic Area
		National
<b>Occupation</b>	Proportion of managers in mostly likely age range (35 - 74)	-
	Proportion of professionals in mostly likely age range (35 - 74)	-
	Proportion of technical and trade workers in mostly likely age range (35 - 74)	-
	Proportion of community and personal service workers in mostly likely age range (35 - 74)	-
<b>Occupation</b>	Proportion of clerical and administrative workers in mostly likely age range (35 - 74)	-
	Proportion of sales workers in mostly likely age range (35 - 74)	Positive
	Proportion of machinery operators and drivers in mostly likely age range (35 - 74)	-
<b>Type of internet connection</b>	Proportion of labourers in mostly likely age range (35 - 74)	-
	Proportion of people with separate and semidetached houses and broadband	-



**Table C. 8: Penetration of Solar Hot Water Systems, average size by Linear Relationship Types, Australia, Number of Relationships**

Relationship type	Geographic Area
	National
Strong Positive	0
Positive	9
Flat	0
Negative	2
Strong Negative	0
Total Relationships	11
No Relationship	64
Total Variables	75



## D. Results for Small Wind Generation Units

In the case of the wind data, the number of installations was too small to split the data, so a single average was compared with the average for the solar data. The standard error for each of the averages was used to calculate a standard error of the difference between the averages. Dividing the difference by its standard error gives a rough measure of significance – if the value is greater than two, the difference is judged to be significant, i.e. that variable is significantly different for wind and solar.

The table contains those variables where the difference between the average value for wind was statistically significantly different to the average value for solar. The key differences in average variable values are largely explainable by the location of wind installations vs. solar installations: the wind installations are primarily in remoter areas than solar which drives many of the differences in the average values.





Table D. 1: Penetration of SGU Wind and Solar PV, comparison of variable averages, significant variations

Variable	Average value (wind)	Standard Error (wind)	Average value (solar)	Standard Error (solar)	Significance
Persons per sq. km	91.5	25.6	856.8	2.5	29.8
Proportion of people with poor English	2.38%	0.22%	5.48%	0.02%	14.0
Number of dwellings per postcode	3,605.1	321.7	7,705.7	18.1	12.7
Proportion of people with separate and semidetached houses and broadband	25.52%	1.51%	36.37%	0.07%	7.2
Proportion of family or households with weekly gross income \$1,700 and above (higher incomes)	15.57%	0.96%	21.17%	0.04%	5.9
Proportion of people in younger age range (20 – 34)	14.26%	0.81%	18.31%	0.04%	5.0
Proportion of older children (age >=15)	8.88%	0.50%	11.04%	0.02%	4.3
Average rent stress (rent / income)	13.64%	0.78%	16.73%	0.03%	4.0
Proportion of Aboriginal & Torres strait islanders	3.75%	0.47%	2.13%	0.01%	3.5
Median household income (\$ / week)	853.5	48.0	1,007.4	2.0	3.2
Proportion of dwellings with 3 or more cars	20.29%	1.16%	16.78%	0.03%	3.0
Proportion of family or households with weekly gross income \$250 - \$649 (low but not very low incomes)	18.80%	1.07%	15.56%	0.03%	3.0
Median family income (\$/week)	1,024.9	57.1	1,191.5	2.3	2.9
Average salary or wages (\$)	32,075.2	1,804.7	37,301.5	71.1	2.9
Average net tax (\$)	9,285.9	529.4	10,794.4	21.7	2.8
Proportion of family or households with weekly gross income over \$1,000 (sufficient incomes)	38.24%	2.16%	44.03%	0.09%	2.7
Average gross tax (\$)	9,483.0	538.7	10,838.7	21.7	2.5
Median individual income (\$/week)	411.4	22.8	465.3	0.9	2.4