A report from the GREEN Grid Project
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Photovoltaic (PV) Uptake in NZ
The story so far


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Disclaimer

The work presented in this report is an early stage indication of some of the high-level findings coming out of the GREEN Grid research project to date. There is still more analysis to be done and more information to be released at a later date, including an extension to this report, which we intend to release in November 2014, as well as reports and papers relating to each of the individual pieces of research undertaken.

1. PV Uptake in New Zealand to Date

New Zealand’s electricity infrastructure was designed to support the flow of energy from large centralised power stations toward end users, including households and businesses. However, a shift to a more distributed supply may be beginning with the growing interest in small-scale photovoltaic (PV) solar generation. In the last 2 years alone the quantity of grid-connected small-scale PV systems in NZ has grown by at least 330\(^2\). Although PV installations to date are relatively few, such that the current installed capacity is about one-tenth that of Meridian’s West Wind power station near Wellington, a continuation of the growth that can be seen in this market (Figure 1) could have substantial impact.

Figure 1: Cumulative PV Capacity by Applications (MW) - GREEN Grid Survey (9 major EDBs, ~80% of NZ’s population)

\(^1\) See http://energycultures.org/ for more information.

While the current installed PV capacity per capita is still relatively low compared to some other countries\(^3\) (most likely due to the subsidies through attractive feed-in tariffs), the rate of uptake is of great interest given the absence of Government incentives for small-scale PV installations, along with the relatively high cost to implement\(^4\). It is important to understand the drivers of PV uptake (i.e. the reasons for the rapid increase in PV installations), and whether PV is likely to remain niche or become even more widespread.

To investigate these issues we have undertaken three separate research streams. We have carried out interviews\(^5\) with people who have already purchased (or who have a strong interest to purchase) PV systems both nationally (20 people) and within Blueskin Bay (18 people), a small region of the country with relatively high interest in PV. We have run an online questionnaire and choice modelling experiment\(^6\) with 2000 people (1000 of whom we questioned about PV), and we have responses to a national household energy survey of 2700 households around New Zealand. This report draws from all three studies to provide an update of our high-level findings to date. This is an early-stage report and further detailed analysis and reporting will follow.

### 2. Contextualising the Research: Participant Demographics

Our samples were generally biased toward older people with higher income (see Table 1 and Table 2). This was a result of self-selection, and can be corrected for in our later analysis. However this demographic (older people with higher net worth and disposable cash flow) is the most likely market for PV under current market conditions.

**Table 1: Age distribution of research participants**

<table>
<thead>
<tr>
<th>Age range</th>
<th>National interviews</th>
<th>Blueskin Bay interviews</th>
<th>Choice experiment</th>
<th>National survey</th>
<th>2013 Census Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-24</td>
<td>0%</td>
<td>0%</td>
<td>6%</td>
<td>10%</td>
<td>13%</td>
</tr>
<tr>
<td>25-34</td>
<td>6%</td>
<td>6%</td>
<td>9%</td>
<td>12%</td>
<td>17%</td>
</tr>
<tr>
<td>35-44</td>
<td>6%</td>
<td>17%</td>
<td>18%</td>
<td>16%</td>
<td>17%</td>
</tr>
<tr>
<td>45-54</td>
<td>29%</td>
<td>39%</td>
<td>23%</td>
<td>21%</td>
<td>19%</td>
</tr>
<tr>
<td>55-64</td>
<td>29%</td>
<td>17%</td>
<td>23%</td>
<td>19%</td>
<td>15%</td>
</tr>
<tr>
<td>65+</td>
<td>29%</td>
<td>22%</td>
<td>21%</td>
<td>22%</td>
<td>19%</td>
</tr>
</tbody>
</table>

Most people who were interviewed (i.e. already purchased PV or seriously considering purchasing) also reported that they owned their own homes; 69% owned their home debt-free and 28% with a mortgage. Only one person rented their home. Most current PV business models involve householders owning their own PV system, and, amongst some interviewees, PV is seen to add to the value of their home. However other business models exist internationally (Vector in NZ is currently trialling a lease system) which could offer options for people who do not have upfront cash to invest and/or do not own their own home.

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\(^3\) New Zealand currently has an installed PV capacity of about 2.7 Watts per capita (up from 1.9 Watts per capita in 2013), compared with 440 Watts per capita in Germany and 293 Watts per capita in Italy in 2013.

\(^4\) Approx. $10,000 for a 3kW system; see http://www.level.org.nz/energy/renewable-electricity-generation/photovoltaic-pv-systems


\(^6\) Choice modelling attempts to model the decision process of an individual in a particular context. Our work included a choice experiment in which individuals had to make trade-offs between levels of attributes, e.g. lower installation cost vs. greater grid independence.
Table 2: Average income

<table>
<thead>
<tr>
<th>Household income</th>
<th>National interviews</th>
<th>Blueskin Bay interviews</th>
<th>Choice experiment</th>
<th>National survey</th>
<th>2013 Census Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than $30,000</td>
<td>6.2%</td>
<td>29.6%</td>
<td>28.8%</td>
<td>18.3%</td>
<td>51.9%</td>
</tr>
<tr>
<td>$30,001 - $50,000</td>
<td>18.8%</td>
<td>17.7%</td>
<td>18.6%</td>
<td>16.7%</td>
<td>21.4%</td>
</tr>
<tr>
<td>$50,001 - $70,000</td>
<td>25.1%</td>
<td>23.5%</td>
<td>19.0%</td>
<td>16.6%</td>
<td>12.9%</td>
</tr>
<tr>
<td>$70,001 - $100,000</td>
<td>12.4%</td>
<td>23.5%</td>
<td>16.6%</td>
<td>20.9%</td>
<td>7.8%</td>
</tr>
<tr>
<td>Over $100,000</td>
<td>37.5%</td>
<td>5.8%</td>
<td>17.1%</td>
<td>27.5%</td>
<td>5.9%</td>
</tr>
<tr>
<td>Prefer not to say</td>
<td>27.2%</td>
<td>5.5%</td>
<td>12.8%</td>
<td>23.9%</td>
<td>9.7%</td>
</tr>
</tbody>
</table>

a Groupings used in the Blueskin Bay interviews are slightly different: < $29K; $30K-$49K; $50K-$79K; $80K-$120K; >$120K; prefer not to say.

3. Drivers and Enablers of PV Uptake

A scan of the international literature suggests that some of the largest drivers or enablers of uptake are environmental concern, saving money and energy, interest in trialling new technologies, as well as being able to afford the units. However, following a set of 38 interviews around the country (20 nationally and 18 in Blueskin Bay) it appears that the drivers within New Zealand are somewhat different in nature. Whilst financial considerations were a very important enabler of PV uptake, particularly because of the high initial outlay and uncertainty on returns and buyback rates from power companies, issues such as a desire to be independent and self-sufficient appear to be powerful drivers for our those people who have already adopted PV.

Households lacked trust in their power companies and wanted some protection against future rises in power prices. “Why wouldn’t you want to have an extra something that would make your [electricity] payments less in the future? You’re creating your own power, and power’s really expensive, so you can’t go wrong. It’s a saving for that person, so I can’t see it [having PV installed] as a disadvantage really.”

The national household survey backs up these interview findings, revealing that only 30% of people are happy with getting their electricity from their power company. 58% would like to generate their own electricity; 38% of these while remaining connected to the national grid, and 20% being independent of it. These are aspirational responses but give an indication of a very widespread desire for independence.

Those interviewed also expressed a desire for greater financial control over their own outgoings; “You know, we’re in our fifties and they’re probably not even going to give us a pension when we get old. So we have to have as much happening as possible. Because electricity is a huge cost.” The concern over future electricity prices and financial expenditure was similarly reinforced by the national household survey. The majority (approx. two thirds) of the national household survey respondents indicated that they were fairly or very concerned that in the next 5-10 years electricity and gas will become unaffordable for them. A number of the interviewees were also thinking about their retirement, and the benefit that PV would afford them in terms of reduced outgoings when they stopped working. “If you are faced with a future where you are on a fixed income, it pays to organise yourself to minimise the costs that can be avoided”.

7 Income is measured as personal income for choice modelling survey and census data, and household income for both interview sets and the national survey

8 This sample is most definitely not representative of the typical household, and no inferences should be drawn from sample to population.
As well as the lack of trust in power companies and a desire for greater power price insulation and financial control, **grid independence** was perceived as being important by some, particularly in providing **resilience in the face of power cuts** and/or natural disasters. It is also interesting to note that there seems to be a belief amongst at least some interviewees that grid-connected PV systems still operate when the grid is down. This is not necessarily the case, unless their system has been set up to achieve this – however this does indicate a market opportunity to provide this service.

A PV owner who was fully off grid said: “It's nice to be off the grid. I actually find that my power supply is more reliable than the network anyway. So when I hear that my neighbours have a power cut, I haven't noticed there’s a power cut, of course, because I live off the grid. And the other thing is, occasionally I'll read in the paper that the price of electricity has gone up every now and then. And even though it sounds selfish, it always makes me smile.”

For some, the installation of PV was the **next step in a journey to a more energy efficient home**. As one interview participant states, “I built my home myself 8 years ago and it has been designed to catch the sun and insulation was done at the highest rating available that time”. PV was the next stage of development for this household. For others, the **ease with which they could install PV** and the **ease of maintaining** it was a real draw.

Most participants mentioned that they were **concerned about the environment**, and wanted to have a greener and more sustainable lifestyle, and supported **renewable energy technologies**. Comments such as “I definitely see it as possibly the only way forward for humanity in general, seeing as we’re using so much energy at this point” and “It is the only way to make a sustainable society in the future” were common amongst our participants, though this was not the main reason for most people to choose to install PV.

These stated preferences from the interviewees are consistent with the evidence of stated preference from the choice modelling survey. These results show that the attribute of PV systems that delivers the most value from installing solar was the resulting **reductions in power bills**, with independence from the national grid and contributing the NZ’s sustainable energy supply be of secondary (and approximately equal) importance (see Figure 2).

**Figure 2: Relative importance of different incentives for PV uptake**

![Figure 2: Relative importance of different incentives for PV uptake](image)

The **reducing costs of PV units and installation**, as well as the **potential increase in property value**, is triggering much more serious consideration of PV. The upfront costs can definitely be a barrier to entry, but as one interview participant states: “more and more people are looking at it because the prices are dropping rapidly”. 
4. Barriers Preventing PV Uptake

For some of the interviewees, one of the main barriers to uptake was the high upfront cost of the PV units. Allied to this was the lack of financial incentives in New Zealand: “Basically, I’m loath to progress [with the PV installation] until I’m in a situation where I have a feed-in tariff. Otherwise I’m faced with either capital expenditure [on batteries] which is difficult to do, or a situation where most of the power that’s generated, I can’t use, because I’m away from the house most of the day.”

The uncertainty around return on investment due to the lack of certainty about buy-back rates was also a cause for concern for some, although others did not appear to be concerned about these matters.

A few people suggested that some form of government intervention should be used to encourage or mandate PV to be installed on new builds.

Some people also talked about uncertainty about changes in PV technology. The rate at which the technology is improving and costs are dropping made some people question whether now was the right time to invest; “Is the technology going to be so much better in a few years time? So is it worth waiting a bit longer and saving up the money?”

These findings are reflected in the choice modelling experiment, as shown in Figure 3. When asked what the biggest problem people thought they would face when deciding to install solar, financial cost was reported as the largest barrier to entry, above the effort involved with choosing the right system, the difficulty of accurately estimating the financial returns, or safety and security concerns.

However, whilst upfront cost of installation was considered to be more important that the other issues, it also has the biggest spread in the data (‘cost’ in Figure 3); for some it may be a great deal more important than effort, risk, or safety, but for others the relative importance of cost over these other attributes may be less.

Figure 3: Relative importance of different barriers preventing PV uptake

Those interviewees who had adopted PV reported having a positive experience overall. Whilst some were biding their time hoping for the introduction of incentives and/or improvements in price and technologies, overall expectations were that PV’s time had come and that NZ would start to see more and more PV going up on households’ roofs.
5. Factors Affecting Uptake of PV

When considering the factors that may drive (or prevent) a widespread uptake of PV, it is useful to refer to the diffusion of innovations theory\(^9\) as an underlying conceptual model to explain how new technologies spread through a social system. This theory suggests that people move through a 5-stage decision process, as illustrated in Figure 4.

**Figure 4: Diffusion of Innovation Pathway**

![Diffusion of Innovation Pathway Diagram]

This process suggests that before people are able to make a decision about whether or not to purchase PV, they must have some knowledge about the system. In the survey administered alongside the choice modelling exercise, we asked about knowledge levels about PV. This revealed that a bi-modal distribution; while 33% felt they had poor knowledge about PV, 43% claimed to know as much as others or more than others, as illustrated in Figure 5.

**Figure 5: Knowledge levels about PV, EV, and HEMS**

![Knowledge Levels Chart]

Despite a third of respondents claiming to be largely ignorant of PV, the national household survey revealed that 60% of people felt positive about PV panels on the roof of their dwelling. 60% also would be willing to purchase PV *in the future*, and if the costs of buying and running PV became significantly less than the cost of power from the grid, this rose to 70%.

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Both the surveys asked about readiness to purchase PV\textsuperscript{10}. In both, 4% of respondents claimed to already own PV, and a further 8% show intent to purchase. A further quarter of the choice modelling survey respondents indicated that they are still thinking about it (this question was not asked in the national household survey). It is worth recalling that this sample is somewhat biased; in addition to being wealthier and older, more, on average, own PV than is nationally representative (less than 1%). However, these figures still demonstrate a growing interest and intention to purchase PV.

**Table 3: Interest in purchasing PV (National Household Survey results)**

<table>
<thead>
<tr>
<th>Interest in purchasing PV</th>
<th>% of survey respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Currently own</td>
<td>4</td>
</tr>
<tr>
<td>Intend to purchase within 12 months</td>
<td>2</td>
</tr>
<tr>
<td>Intend to purchase within 5 years</td>
<td>6</td>
</tr>
</tbody>
</table>

**Table 4: Interest in purchasing PV (Choice Modelling Survey results)**

<table>
<thead>
<tr>
<th>Interest in purchasing PV</th>
<th>% of survey respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>I've never considered purchase</td>
<td>43</td>
</tr>
<tr>
<td>I've thought about it but rejected the idea</td>
<td>19</td>
</tr>
<tr>
<td>I'm still thinking about it</td>
<td>26</td>
</tr>
<tr>
<td>I'm almost ready to buy</td>
<td>5</td>
</tr>
<tr>
<td>I'm ready to buy</td>
<td>3</td>
</tr>
<tr>
<td>I already have one</td>
<td>3</td>
</tr>
<tr>
<td>I've got one, and am thinking of buying another</td>
<td>1</td>
</tr>
</tbody>
</table>

Of those people who own or are intending to purchase PV, a substantial proportion has higher than average income (Figure 6). Whilst people who currently own PV tend to come from a considerably older demographic, those who intend to purchase do not (Figure 7).

**Figure 6: Intention to purchase PV split by income**

\textsuperscript{10} Note: in the national household survey, a similar question was asked about solar hot water systems and the results show a lesser future interest in these than in PV.
Aspects of the technology itself may also affect widespread uptake. The choice modelling survey provides an indication of the relative importance of one attribute of PV systems over another. The attributes investigated are shown in Figure 8.

Figure 8: Attributes investigated in choice-modelling experiment

- **Upfront cost of PV system**
  - $4000
  - $8000
  - $16000

- **Level of grid independence**
  - Completely disconnected
  - Disconnected most days each year
  - Disconnected a few days each year

- **Payback period**
  - 5 years
  - 10 years
  - 15 years

- **Ownership of PV system**
  - Owned by customer
  - Leased from electricity company
  - Owned by electricity company

- **Aesthetics of PV panels**
  - Small and discrete
  - Big and highly visible
The results suggest that the upfront cost of the system, payback period, and grid dependence are relatively more important than ownership, which is relatively more important than aesthetics, as indicated in Figure 9 (note: the attributes are colour-coded such that all those with the same colour are not statistically significantly different from each other).

**Figure 9: Relative utility of different attributes of PV systems**

If enhanced uptake was desired, the three most important utilities - *upfront cost, payback period and independence* - should be addressed.

Within the Blueskin community, for example, a **bulk purchase scheme** reduced the price per unit, which thus reduced one of the largest barriers to PV uptake. Vector’s lease scheme, which also provided some battery storage, addressed the upfront cost and desire for independence.

Over time, **improvements in the technology** and declining prices for PV units may reduce payback periods.

### 6. Implications and Conclusions

From interviews with early adopters and from two national surveys, we find high levels of knowledge and interest in PV, and a substantial proportion either owning or expecting to purchase within five years. If 12% of households were generating, this could see an increase to around 90 Watts per capita from the current value of about 2.7\(^1\). Although this would still be far less than countries with very high levels of uptake like Germany and Italy, 90 Watts per capita equates to about 400MW across NZ, which is the equivalent of a large power station, distributed throughout the network.

This level of interest currently exists with no support from the Government via subsidies and feed-in tariffs, and mostly under business models that require a large upfront investment. **New types of business model** such as that currently being trialled by Vector may remove some significant barriers to entry and increase the level of interest in installing PV.

High levels of grid-connected PV would contribute to renewable generation and **may require new approaches to the management of the electricity grid** to ensure that New Zealanders continue to have access to safe, reliable, and affordable energy.

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\(^1\) Assuming an average installation of 3.8kW, and an additional 8% of private dwellings purchase PV within 5 years.