Understanding Australian householders’ willingness to participate in the solar distributed energy market

Peta Ashworth, Lygia M Romanach and Zaida Contreras-Castro

Energy Systems in Transition: Inter-and Trans-disciplinary Contributions | October 9-11th 2013
Introduction

• Since 2010 feed-in-tariffs have stimulated investment in solar PV in Australia

• Financial incentives have been substantially wound back in most Australian states. Concerns include:
  - Rapid increase of solar PV installations
  - Associated cost in electricity tariffs to recover the subsidy

• Understand what business models are needed to sustain investment in solar PV technologies in Australia
Research objectives

- Investigate Australian householders’ willingness to participate in the solar and distributed energy market
  - Demographics
  - Knowledge
  - Risks and benefits perceptions
  - Pro-environmental behaviour: VBN Theory
  - Energy security
  - Financial incentive

- Preferences for finance options
Technology and finance options explored

**Six technology options:**

1. Solar hot water systems (SHW)
2. Grid connected solar PV systems (SPV)
3. Grid connected solar PV systems with battery (SPVB)
4. Battery alone systems (BA)
5. Off-grid PV solar systems (OGPV)
6. Community PV systems (CPV)

**Four finance options:**

1. Buying upfront
2. Buying with finance
3. Leasing
4. Energy Service Companies (ESCOs): Demand Control
Methodology

• Survey developed from relevant literature and focus group findings
• Online survey with panel participants
  • February 2013: Pilot survey with over 200 responses
  • March 2013: Final survey with 2,500 people (2,463 usable responses)
• Quotas by state, gender and age to ensure a representative sample
• Surveys presented 2 technology options (out of 6):
  • Technology options were randomly assigned
  • Brief description of each technology was provided
Sample demographics

- Representative sample of Australian population
  - Gender: 54% females and 46% males
  - Age: from 18 to 75 plus
  - Capital cities 71% and Regional 29%
  - Home-ownership:
    - 69% own home
    - 25% are tenants
    - 2% living in public housing
    - 2% living in shared accommodation
  - Property type:
    - 73% live in houses
    - 18% live in units/apartments
    - 9% live in townhouses/semi-detached houses
Support for technology options

Mean=3.9
Mean=3.9
Mean=3.9
Mean=3.6
Mean=3.5
Mean=3.6
Support for technologies and demographics

• Support for all technologies similar across
  • Age groups (18-39, 40-59, and 60+)
  • Gender
  • Income groups (Below $60K, $60-100K, Above $100K)

• Support SHW, SPV and SPVB
  • Higher: living in houses

• Support SPVB
  • Higher: home owners
Attitudinal variables: Power bill

- **Current SPV owners**
  - Negative association between power bills cost and support for SPV
  - SPV systems owners have lower bill perception

- **BA**
  - Weak positive correlation between power bills cost and support for BA
  - Households with a perception of higher than average bills could be more supportive of BA systems
## Multiple regression

<table>
<thead>
<tr>
<th>MODEL:</th>
<th>BENEFITS (1)</th>
<th>SHW (2)</th>
<th>SPV (3)</th>
<th>SPVB (4)</th>
<th>OGPV (5)</th>
<th>BA (6)</th>
<th>CPV (7)</th>
<th>ESCO (8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>-0.03 (0.03)</td>
<td>0.01 (0.06)</td>
<td>-0.09 (0.07)</td>
<td>-0.05 (0.06)</td>
<td>-0.02 (0.07)</td>
<td>-0.03 (0.07)</td>
<td>-0.12 (0.06)</td>
<td>-0.21** (0.04)</td>
</tr>
<tr>
<td>Age</td>
<td>-0.01 (0.00)</td>
<td>-0.04*** (0.01)</td>
<td>-0.01 (0.01)</td>
<td>-0.03** (0.01)</td>
<td>-0.02 (0.01)</td>
<td>-0.04*** (0.01)</td>
<td>-0.02 (0.01)</td>
<td>-0.02** (0.01)</td>
</tr>
<tr>
<td>Income</td>
<td>0.00 (0.01)</td>
<td>0.02 (0.02)</td>
<td>0.00 (0.02)</td>
<td>0.02 (0.01)</td>
<td>-0.02 (0.02)</td>
<td>0.02 (0.02)</td>
<td>0.00 (0.02)</td>
<td>-0.03** (0.01)</td>
</tr>
<tr>
<td>House</td>
<td>0.06 (0.04)</td>
<td>0.41*** (0.08)</td>
<td>0.26** (0.09)</td>
<td>0.21** (0.08)</td>
<td>0.07 (0.09)</td>
<td>0.10 (0.09)</td>
<td>0.03 (0.08)</td>
<td>0.04 (0.06)</td>
</tr>
<tr>
<td>Home owner</td>
<td>-0.01 (0.03)</td>
<td>0.02 (0.07)</td>
<td>-0.03 (0.08)</td>
<td>0.08 (0.07)</td>
<td>0.07 (0.08)</td>
<td>0.04 (0.08)</td>
<td>-0.04 (0.07)</td>
<td>-0.04 (0.05)</td>
</tr>
<tr>
<td>Household with children</td>
<td>-0.03 (0.03)</td>
<td>0.06 (0.08)</td>
<td>-0.11 (0.08)</td>
<td>-0.02 (0.07)</td>
<td>-0.05 (0.09)</td>
<td>-0.06 (0.09)</td>
<td>-0.18* (0.07)</td>
<td>-0.04 (0.05)</td>
</tr>
<tr>
<td>Capital cities</td>
<td>-0.12*** (0.03)</td>
<td>-0.08 (0.06)</td>
<td>-0.01 (0.07)</td>
<td>-0.09 (0.06)</td>
<td>-0.07 (0.07)</td>
<td>0.03 (0.07)</td>
<td>-0.00 (0.06)</td>
<td>-0.03 (0.04)</td>
</tr>
<tr>
<td>Number people</td>
<td>0.02 (0.01)</td>
<td>-0.05 (0.03)</td>
<td>0.05 (0.03)</td>
<td>0.00 (0.03)</td>
<td>0.01 (0.03)</td>
<td>-0.00 (0.03)</td>
<td>0.09** (0.03)</td>
<td>0.05** (0.02)</td>
</tr>
<tr>
<td>Have SPV</td>
<td>0.30*** (0.04)</td>
<td>-0.04 (0.10)</td>
<td>-0.23 (0.38)</td>
<td>0.14 (0.08)</td>
<td>-0.08 (0.10)</td>
<td>-0.04 (0.09)</td>
<td>-0.12 (0.09)</td>
<td>-0.05 (0.06)</td>
</tr>
<tr>
<td>Have SHW</td>
<td>-0.04 (0.05)</td>
<td>-0.01 (0.40)</td>
<td>-0.09 (0.17)</td>
<td>0.06 (0.11)</td>
<td>-0.10 (0.14)</td>
<td>0.17 (0.13)</td>
<td>-0.12 (0.12)</td>
<td>-0.07 (0.08)</td>
</tr>
<tr>
<td>Energy bill</td>
<td>-0.02 (0.01)</td>
<td>-0.02 (0.03)</td>
<td>0.01 (0.04)</td>
<td>0.06 (0.03)</td>
<td>0.11** (0.04)</td>
<td>0.08* (0.04)</td>
<td>0.03 (0.03)</td>
<td>0.11*** (0.02)</td>
</tr>
<tr>
<td>VBN_AC</td>
<td>0.16*** (0.02)</td>
<td>0.20*** (0.05)</td>
<td>0.16** (0.06)</td>
<td>0.22*** (0.05)</td>
<td>0.04 (0.06)</td>
<td>0.01 (0.06)</td>
<td>0.21*** (0.05)</td>
<td>0.06 (0.04)</td>
</tr>
<tr>
<td>VBN_AR</td>
<td>0.08*** (0.02)</td>
<td>-0.01 (0.05)</td>
<td>-0.01 (0.06)</td>
<td>-0.05 (0.05)</td>
<td>-0.03 (0.06)</td>
<td>0.12* (0.06)</td>
<td>-0.10 (0.05)</td>
<td>-0.00 (0.04)</td>
</tr>
<tr>
<td>VBN_PN</td>
<td>0.20*** (0.02)</td>
<td>-0.07 (0.05)</td>
<td>-0.05 (0.06)</td>
<td>-0.06 (0.05)</td>
<td>0.01 (0.06)</td>
<td>0.04 (0.06)</td>
<td>0.03 (0.05)</td>
<td>0.09* (0.04)</td>
</tr>
<tr>
<td>Energy security</td>
<td>0.11*** (0.01)</td>
<td>0.00 (0.03)</td>
<td>-0.00 (0.04)</td>
<td>-0.04 (0.03)</td>
<td>-0.01 (0.04)</td>
<td>0.08* (0.04)</td>
<td>-0.03 (0.03)</td>
<td>0.02 (0.02)</td>
</tr>
<tr>
<td>Financial incentive</td>
<td>0.05*** (0.01)</td>
<td>0.00 (0.03)</td>
<td>0.05 (0.03)</td>
<td>0.07** (0.03)</td>
<td>0.02 (0.03)</td>
<td>0.06 (0.03)</td>
<td>0.02 (0.03)</td>
<td>-0.00 (0.02)</td>
</tr>
<tr>
<td>Objective knowledge</td>
<td>0.00 (0.01)</td>
<td>0.02 (0.03)</td>
<td>-0.00 (0.03)</td>
<td>0.01 (0.02)</td>
<td>-0.04 (0.03)</td>
<td>0.06 (0.03)</td>
<td>-0.01 (0.03)</td>
<td>0.01 (0.02)</td>
</tr>
<tr>
<td>Subjective knowledge</td>
<td>0.13*** (0.01)</td>
<td>0.07* (0.03)</td>
<td>0.11** (0.04)</td>
<td>0.14*** (0.03)</td>
<td>0.10** (0.04)</td>
<td>0.01 (0.04)</td>
<td>0.10** (0.03)</td>
<td>-0.00 (0.02)</td>
</tr>
<tr>
<td>BENEFITS</td>
<td>0.40*** (0.05)</td>
<td>0.46*** (0.06)</td>
<td>0.41*** (0.05)</td>
<td>0.43*** (0.06)</td>
<td>0.18** (0.06)</td>
<td>0.44*** (0.05)</td>
<td>0.23*** (0.03)</td>
<td></td>
</tr>
<tr>
<td>_cons</td>
<td>1.12*** (0.11)</td>
<td>1.76*** (0.26)</td>
<td>1.08*** (0.27)</td>
<td>1.08*** (0.25)</td>
<td>1.49*** (0.33)</td>
<td>1.43*** (0.28)</td>
<td>1.06*** (0.26)</td>
<td>1.55*** (0.18)</td>
</tr>
<tr>
<td>N</td>
<td>2020</td>
<td>601</td>
<td>541</td>
<td>657</td>
<td>677</td>
<td>659</td>
<td>661</td>
<td>2020</td>
</tr>
<tr>
<td>F-value</td>
<td>82.76</td>
<td>12.30</td>
<td>12.20</td>
<td>17.35</td>
<td>6.65</td>
<td>6.31</td>
<td>16.53</td>
<td>14.12</td>
</tr>
<tr>
<td>R²</td>
<td>0.43</td>
<td>0.29</td>
<td>0.31</td>
<td>0.34</td>
<td>0.16</td>
<td>0.16</td>
<td>0.33</td>
<td>0.12</td>
</tr>
<tr>
<td>Adj. R²</td>
<td>0.42</td>
<td>0.26</td>
<td>0.28</td>
<td>0.32</td>
<td>0.14</td>
<td>0.13</td>
<td>0.31</td>
<td>0.11</td>
</tr>
</tbody>
</table>
Payment preferences

![Bar chart showing payment preferences]

- **Buying upfront**: First preference (1,300 respondents)
- **Buying with finance**: Second preference (600 respondents)
- **Leasing**: Third preference (800 respondents)
- **ESCO**: Fourth preference (500 respondents)
- **Not ranked**: 200 respondents

**Legend**:
- Blue: First preference
- Dark blue: Second preference
- Green: Third preference
- Olive green: Fourth preference
- Light blue: Not ranked
Payment preferences and demographics

• Buying upfront:
  • Higher: older respondents

• Buying with finance:
  • Lower: older male respondents

• Leasing:
  • Higher: younger respondents
  • Higher: respondents’ income below $60k

• ESCO:
  • Higher: older respondents
  • Higher: respondents’ income below $60k
## Demand control

### Reasons for agreeing to demand control such as allowing ESCO to manage certain household appliances

<table>
<thead>
<tr>
<th>Reason</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>To save money on my power bill</td>
<td>1443</td>
<td>58%</td>
</tr>
<tr>
<td>So I don’t need to worry about how I use electricity at home</td>
<td>116</td>
<td>5%</td>
</tr>
<tr>
<td>To reduce the use of energy at peak demand</td>
<td>89</td>
<td>4%</td>
</tr>
<tr>
<td>To reduce my household carbon emissions</td>
<td>152</td>
<td>6%</td>
</tr>
<tr>
<td>Other</td>
<td>25</td>
<td>1%</td>
</tr>
<tr>
<td>Not at all</td>
<td>638</td>
<td>26%</td>
</tr>
</tbody>
</table>
Acknowledgements

Funding

This work was contracted by the Australian PV Association (APVA) through funding from the Australian Renewable Energy Agency (ARENA)

Further information

Thank you

CSIRO
Earth Science and Resource Engineering
Peta Ashworth
Group Leader, Science into Society Group

+61 7 3327 4145
Peta.Ashworth@csiro.au

CSIRO
Earth Science and Resource Engineering
Lygia M Romanach
Postdoctoral Research Fellow, Science into Society Group

+61 7 3327 4006
Lygia.Romanach@csiro.au

ENERGY FLAGSHIP
www.csiro.au