Attitudes toward Electricity Alternatives: Results from a Survey of Australian Organisations

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## Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXECUTIVE SUMMARY</td>
<td>4</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>5</td>
</tr>
<tr>
<td>METHOD</td>
<td>5</td>
</tr>
<tr>
<td>SAMPLE</td>
<td>6</td>
</tr>
<tr>
<td>Organisational Characteristics</td>
<td>7</td>
</tr>
<tr>
<td>RESULTS</td>
<td>8</td>
</tr>
<tr>
<td>Demand Management</td>
<td>9</td>
</tr>
<tr>
<td>Acceptance of Demand Management Technology</td>
<td>9</td>
</tr>
<tr>
<td>Perceived Importance of Demand Management Features</td>
<td>11</td>
</tr>
<tr>
<td>Barriers and Other Issues</td>
<td>12</td>
</tr>
<tr>
<td>Distributed Generation Technology</td>
<td>12</td>
</tr>
<tr>
<td>Acceptance of Distributed Generation Technology</td>
<td>12</td>
</tr>
<tr>
<td>Perceived Importance of Distributed Generation Features</td>
<td>14</td>
</tr>
<tr>
<td>Barriers and Other Issues</td>
<td>15</td>
</tr>
<tr>
<td>Paths to adoption</td>
<td>16</td>
</tr>
<tr>
<td>CONCLUSION</td>
<td>17</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>18</td>
</tr>
<tr>
<td>APPENDIX A: SURVEY</td>
<td>19</td>
</tr>
<tr>
<td>APPENDIX B: EMAILED SURVEY INVITATION</td>
<td>27</td>
</tr>
<tr>
<td>APPENDIX C: RESPONDENT CHARACTERISTICS</td>
<td>28</td>
</tr>
</tbody>
</table>
EXECUTIVE SUMMARY

A web-based survey of organisations’ attitudes towards energy alternatives was conducted as part of the Intelligent Grid project. The survey assessed general characteristics of the organisations and respondents, as well as their attitudes towards and acceptance of detailed examples of distributed generation and demand management technology.

Completed surveys were received from 462 people in organisations from New South Wales, Queensland, South Australia and Victoria. Although the sample was too small to be considered representative of Australian organisations as a whole, it reflected a broad cross-section of organisational characteristics, including organisational classification, staff numbers and level of electricity consumption. The survey was designed to assess three research questions, which are outlined below along with their principal findings.

What types of organisations are prepared to adopt demand management and distributed generation technologies?

In general, larger organisations (median staff numbers between 180-235, median annual turnover of $60 million, and median annual electricity costs of $132,000 - $225,000) rated the acceptability of demand management and distributed generation technologies higher than smaller organisations. For distributed generation technology in particular, acceptance was also higher for electricity intensive organisations, in which electricity cost was a larger percentage of their annual turnover (median 0.6%).

In terms of organisational classification, acceptance of demand management appeared higher for mining, construction, and health and community service organisations, and lower for accommodation, cafes and restaurants, personal and other services, and agriculture, forestry and fishing. Acceptance of distributed generation appeared higher for mining, health and community services, and manufacturing, and lower for construction, finance and insurance, and personal and other service organisations.

What are these organisation’s preferences in relation to these technologies?

For both technologies, improved efficiency, safety, and reliability/durability were all identified as important features, while ease of installation, and potential government incentives were seen as relatively unimportant. Interruptions to supply were also rated as an important concern for demand management. Respondents with higher acceptance of both distributed generation and demand management rated energy efficiency as more important and cost to install as less important than did those with lower acceptance of the technologies.

What are the barriers and drivers for the adoption of these technologies by organisations?

Written comments about barriers and important issues relating to adoption were provided with regard to both technologies. The comments were summarised and can be organised into contextual issues (external to the organisation), organisational issues (drivers and barriers related to the nature of the organisation itself) and product issues (drivers and barriers related to the product).

Contextual issues included requirements for support (in the form of government incentives), approval from relevant gatekeepers (notably building owners for leased sites), and proof of claims (in the form of demonstrations and guarantees of savings).

Organisational issues included matches between the technology and the organisational characteristics, in terms of suitability for the site and appropriateness for the scale and constraints of the organisation. Interruptions to supply were seen as a major barrier to acceptance of demand management.

In terms of product issues, cost was a major barrier for both technologies. Performance and
compatibility with existing systems were important requirements for demand management. Energy source and environmental impacts were important for distributed generation. A range of actions to promote drivers and reduce barriers are identified.

INTRODUCTION

This report describes the results of a questionnaire survey of Australian organisations. The survey was designed to inform the Intelligent Grid Project within the Energy Transformed Flagship. Part of the aim of the Intelligent Grid project is to develop an understanding of the attitudes of Australian organisations towards demand management (DM) and distributed generation (DG) technologies. The aim of the survey was to address the following research questions:

- What types of organisations are prepared to adopt demand management and distributed generation technologies?
- What are the organisation’s preferences in relation to demand management and distributed generation technologies?
- What are the barriers and drivers for the uptake of demand management and distributed generation technologies by organisations in Australia?

The Intelligent Grid project aims to produce a large-scale simulation of the potential uptake of distributed energy in Australia. Within this project, the concept of distributed energy incorporates the application of demand management technology and local energy generation into a variety of organisations, as well as domestic households. The findings from this survey are intended to inform the development of the Intelligent Grid simulation.

Note that the term “organisation”, as used throughout this report, is a general term that includes local government and not-for-profit groups as well as commercial businesses.

METHOD

The questionnaire was designed to be comparable in content and structure to the Intelligent Grid survey used for individual households (see Gardner & Ashworth, 2007), and was tested in focus groups with business representatives. As a result of this feedback some adjustments were made to improve clarity of content. Survey questions used a range of numerical response (Likert) scales, menus and check boxes. Respondents from organisations with more than one site were asked (and reminded throughout the survey) to reply for one specific site only.

The questionnaire (see Appendix A) contained five sections:

- Section One assessed reactions to an “automatic energy manager”, an example of demand management technology.
- Section Two assessed reactions to a “local electricity generator”, an example of distributed generation technology.
- Section Three measured details of electricity and water use for the particular site.
- Section Four measured characteristics of the responding organisation (type, staff numbers, location, etc).
- Section Five assessed demographic details of the individual responding to the survey (age, gender, education, etc).

Questionnaire recipients were identified in three ways:

1. A commercially-available mailing list of approximately 7100 business decision makers
was purchased; invitations to these people were sent via e-mail.

2. A list of email contacts (for the mayor or council manager) for 443 local councils in Queensland, NSW, Victoria and South Australia was created from government websites; invitations were sent via email.

3. A list of approximately 3000 large electricity consumers (those with annual electricity bills greater than $10,000) was accessed from Origin Energy (Queensland), in return for providing feedback to Origin on the survey outcomes; these invitations were sent via post.

The questionnaire was provided online and invitations were sent to recipients in July and August, 2007. Email invitations (see Appendix B) included a hyperlink within the message text to take recipients directly to the survey website. To comply with anti-spam legislation, email invitations also included a link to automatically remove the recipient’s email from the mailing list. Posted invitations directed recipients to a simple web address which linked to the survey. Survey returns began in July and have continued up to the time of writing this report, although very few new responses have been received since mid-November.

Web surveying of this sort involves several potential biases and problems. A major issue is attrition, as respondents drop out of the survey before completing it. Methods to minimise attrition include keeping the survey short and tightly focussed on important issues, convincing participants of the value of the research, and removing or reducing irrelevant questions. The survey used funnelling to ensure that only relevant questions were seen – e.g. if respondent said that a technology had no potential in their organisation, the next question asked why not, and questions asking them to rate importance of features of that technology were not displayed.

Several other steps were taken to improve the quality of responses to the survey. Potential participants were sent a personalised email or letter highlighting the importance of the survey and asking for their participation. Participants were assured of the anonymity of their responses, and were offered the chance to win one of five $100 shopping vouchers if they completed the survey. Potential bias due to order of presentation was addressed by randomising the order of response options between surveys.

The nature of this survey assumes that the individual responding is capable of responding on behalf of the organisation, and has a sufficient understanding of their organisation’s needs. However, it is recognised that it is difficult for individuals to be completely objective in their answers, and some response bias is possible. The survey instructions outlined the sort of information required to answer the questions, and suggested that the survey link be passed on to the appropriate person if the recipient did not have the required information/expertise.

**SAMPLE**

A total of 462 usable surveys were completed. As is typical for web-completed surveys, later questions in the survey had more missing data: as people progressed through the survey they were increasingly likely to stop, leaving the rest of the survey unanswered. Incomplete responses were included where there were sufficient answers to allow some analysis, as the sample was judged too small to allow for the valid replacement of missing data.

The sample, although not large enough to be judged truly representative of Australian organisations as a whole, does reflect a broad cross-section of organisational characteristics, including staff numbers, type of organisation, and electricity consumption. Detailed characteristics of the organisations in the sample are reported in more detail below. Characteristics of individual respondents are summarised in Appendix C.
Organisational Characteristics

The State where each organisation operated was identified via postcode, and is summarised in Table 1 below. The majority of completed surveys were received from NSW/ACT (39%) and Victoria (36%). Seventeen percent of the survey sample came from Queensland and 7% from South Australia. The single respondent from Western Australia was excluded from the sample for statistical analysis.

Table 1: State where the organisation’s site is located

<table>
<thead>
<tr>
<th>State</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSW/ACT</td>
<td>144</td>
<td>38.9</td>
</tr>
<tr>
<td>Victoria</td>
<td>135</td>
<td>36.5</td>
</tr>
<tr>
<td>Queensland</td>
<td>63</td>
<td>17.0</td>
</tr>
<tr>
<td>South Australia</td>
<td>27</td>
<td>7.3</td>
</tr>
<tr>
<td>Western Australia</td>
<td>1</td>
<td>.3</td>
</tr>
<tr>
<td>Total</td>
<td>370</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Note: 92 people did not provide a postcode.

Organisational Classification was assessed via a menu of options; results are displayed in Table 2. Government and manufacturing organisations represent the largest groups in the sample, although a wide range of other organisational types are represented. The nine organisations listed as “other” included trade unions, conservation organisations and research institutions.

Table 2: Organisational Classification (ANZSIC Code)

<table>
<thead>
<tr>
<th>How would you classify your organisation?</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accommodation, cafes and restaurants</td>
<td>16</td>
<td>4.3</td>
</tr>
<tr>
<td>Agriculture, forestry and fishing</td>
<td>9</td>
<td>2.4</td>
</tr>
<tr>
<td>Communication services</td>
<td>8</td>
<td>2.2</td>
</tr>
<tr>
<td>Construction</td>
<td>2</td>
<td>.5</td>
</tr>
<tr>
<td>Cultural and recreational services</td>
<td>10</td>
<td>2.7</td>
</tr>
<tr>
<td>Education</td>
<td>19</td>
<td>5.1</td>
</tr>
<tr>
<td>Electricity, gas and water supply</td>
<td>7</td>
<td>1.9</td>
</tr>
<tr>
<td>Finance and insurance</td>
<td>30</td>
<td>8.1</td>
</tr>
<tr>
<td>Government administration and defence</td>
<td>83</td>
<td>22.5</td>
</tr>
<tr>
<td>Health and community services</td>
<td>19</td>
<td>5.1</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>76</td>
<td>20.6</td>
</tr>
<tr>
<td>Mining</td>
<td>6</td>
<td>1.6</td>
</tr>
<tr>
<td>Personal and other services</td>
<td>13</td>
<td>3.5</td>
</tr>
<tr>
<td>Property and organisation services</td>
<td>17</td>
<td>4.6</td>
</tr>
<tr>
<td>Retail trade</td>
<td>13</td>
<td>3.5</td>
</tr>
<tr>
<td>Transport and storage</td>
<td>15</td>
<td>4.1</td>
</tr>
<tr>
<td>Wholesale trade</td>
<td>17</td>
<td>4.6</td>
</tr>
<tr>
<td>Other</td>
<td>9</td>
<td>2.4</td>
</tr>
<tr>
<td>Total</td>
<td>369</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Note: 93 people did not answer.

Number of Employees was used to classify organisations into small, medium and large as per the cut-offs used by the Australian Bureau of Statistics (2007), and these categories are
displayed in Table 3. The median staff size was 140, and responses ranged from 2 (an accounting firm) to 5,000 (a university). Two responses listed staff numbers higher than this figure, but it was apparent that the respondent had listed staff from multiple sites, rather than just a single site, so these responses were excluded from the variable before analysis. Because the variable was substantially positively skewed, it was log transformed for statistical analysis.

Table 3: Organisation Size

<table>
<thead>
<tr>
<th>How many people does your organisation employ at this location?</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small (up to 19 staff)</td>
<td>30</td>
<td>8.2</td>
</tr>
<tr>
<td>Medium (20 to 199 staff)</td>
<td>194</td>
<td>52.7</td>
</tr>
<tr>
<td>Large (200+ staff)</td>
<td>144</td>
<td>39.1</td>
</tr>
<tr>
<td>Total</td>
<td>368</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Note: 94 people did not answer.

Annual turnover ranged from $100,000 (a hospitality business) to $3 billion (an oil refinery). Some respondents listed company-wide turnover rather than specific site turnover, and where this was obviously the case, these values were excluded before analysis. The median turnover value was $30 million. Because of the highly skewed distribution of this variable, it was log transformed for statistical analysis.

Annual cost of grid-supplied electricity ranged from $123 (local council chambers) to $37 million (a mining company). The median annual cost was $109,000. Because of the highly skewed distribution of this variable, it was log transformed for statistical analysis.

Electricity Intensity was calculated as grid-based electricity costs as a proportion of the organisation’s total turnover. This measure was created to reflect the relative importance of grid-supplied electricity to each organisation. The median value of this measure was 3.5%, and values ranged from 0.01% (a state government treasury) to 11.45% (a glass and metal manufacturing plant). One value of 27.5% for this variable was assumed to reflect an error in reporting of either turnover or electricity cost, and was excluded from analysis. Because of the highly skewed distribution of this variable, it was log transformed for statistical analysis.

Other power sources were assessed. In particular, respondents identified if their site had a backup power generator (true for 111 respondents) and if they usually provided some of their own electricity (true for 19 respondents).

RESULTS

Analyses were designed to provide a descriptive evaluation of organisations that were more likely to adopt the demand management and distributed generation technologies, and so statistical tests were conducted on pairwise relationships, rather than more complex multivariate relationships. Pairwise analyses used bivariate correlations, chi-squared tests and one-way analyses of variance as appropriate. A conservative significance level of $p < .01$ was adopted, to counteract the increased error rate caused by conducting multiple tests across the same group of variables.

Results of these analyses are presented in separate sections for demand management and distributed generation technologies. In both sections, predictors of acceptance are described, followed by ratings of the importance of specific features, and written comments regarding issues relevant to adoption.
Demand Management

Acceptance of Demand Management Technology

Overall, 91.6% of respondents said that an automatic energy manager had the potential to be used in their organisation. These respondents provided a further rating of the likelihood that their organisation would be prepared to use this technology. The combined results of these two questions are summarised in Table 4 below. A total of 51.0% of respondents thought that uptake by their organisation was likely or very likely. To simplify the descriptive analyses, organisations were classified into one of three groups:

- no potential (those that identified no potential for the use of an automatic energy manager),
- low potential (those that gave ratings of “very unlikely”, “unlikely” or “possible”), and
- high potential (those that considered their organisation “likely” or “very likely” to adopt an automatic energy manager).

Table 4. Acceptance of demand management technology

<table>
<thead>
<tr>
<th>Overall, how likely is it that your organisation would be prepared to use this sort of automatic energy manager?</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>No potential</td>
<td>38</td>
<td>8.4</td>
</tr>
<tr>
<td>Very unlikely</td>
<td>20</td>
<td>4.4</td>
</tr>
<tr>
<td>Unlikely</td>
<td>14</td>
<td>3.1</td>
</tr>
<tr>
<td>Possible</td>
<td>150</td>
<td>33.1</td>
</tr>
<tr>
<td>Likely</td>
<td>136</td>
<td>30.0</td>
</tr>
<tr>
<td>Very likely</td>
<td>95</td>
<td>21.0</td>
</tr>
<tr>
<td>Total</td>
<td>453</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Note: 9 people did not answer.

Both respondent characteristics and organisational characteristics were tested as potential predictors of acceptance of demand management technology. Respondent characteristics included age, gender and education. There were no differences in acceptance of demand management technology related to respondent age, education level, or gender. This result is encouraging, suggesting that individual respondents were not providing biased reactions to the survey based on their own characteristics.

Continuous-scaled organisational characteristics included: number of employees, annual turnover, annual electricity costs, and the electricity intensity measure described above. Summaries of these variables for the three levels of acceptance of demand management technology are provided in Table 5.

Statistical testing of the relationship between these characteristics was based on the original acceptance measure and the log transformed version of the characteristics above. Test showed significant positive associations between acceptance and number of employees, annual turnover and annual electricity cost. Since these measures all reflect organisational size, a general conclusion to be drawn here is that larger organisations are more likely to report acceptance of demand management technology. However, it must be noted that some smaller organisations also appear in the high potential group – organisational size is not the only predictor of acceptance.
Table 5: Characteristics of organisations described according to acceptance of demand management.

<table>
<thead>
<tr>
<th>Acceptance of DM technology</th>
<th>Statistic</th>
<th>Number of Employees</th>
<th>Annual Turnover ($M)</th>
<th>Annual Electricity Cost ($k)</th>
<th>Electricity intensity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No potential</td>
<td>Mean</td>
<td>170.6</td>
<td>251.29</td>
<td>698.00</td>
<td>1.25</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>55.0</td>
<td>16.00</td>
<td>50.00</td>
<td>0.30</td>
</tr>
<tr>
<td></td>
<td>Range</td>
<td>2 to 1500</td>
<td>0.35 to 3000</td>
<td>1 to 9000</td>
<td>0.01 to 5.86</td>
</tr>
<tr>
<td>Low potential</td>
<td>Mean</td>
<td>257.6</td>
<td>76.64</td>
<td>276.88</td>
<td>0.93</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>95.5</td>
<td>20.00</td>
<td>58.50</td>
<td>0.33</td>
</tr>
<tr>
<td></td>
<td>Range</td>
<td>2 to 3000</td>
<td>0.1 to 1000</td>
<td>0.6 to 2600</td>
<td>0.01 to 8.64</td>
</tr>
<tr>
<td>High potential</td>
<td>Mean</td>
<td>358.5</td>
<td>151.70</td>
<td>953.22</td>
<td>0.94</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>180.0</td>
<td>60.00</td>
<td>132.00</td>
<td>0.40</td>
</tr>
<tr>
<td></td>
<td>Range</td>
<td>5 to 5000</td>
<td>0.6 to 1734</td>
<td>0.12 to 3700</td>
<td>0.01 to 11.45</td>
</tr>
</tbody>
</table>

Note: Because these variables were all positively skewed, the median is a more informative measure than the mean.

Categorical organisational characteristics included state, classification, and access to other power sources. There were no differences apparent in the acceptance of demand management technology for organisations across states, or for those with and without access to other power sources. Acceptance of demand management appeared to differ markedly across organisational classification, but many specific classifications had small sample sizes which precluded a statistical analysis of these differences. Acceptance of demand management appeared to be highest for mining, construction, and health and community service organisations, and lowest for accommodation, cafes and restaurants, personal and other services, and agriculture, forestry and fishing organisations (see Fig. 1).

Figure 1. Acceptance of demand management for different organisational classifications (rated from 0 = no potential to 5 = very likely to adopt).
Perceived Importance of Demand Management Features

To understand the relative importance that people placed on various features of demand management technology, 12 features were assessed using Likert scales. The features, which were developed via a review of technical features and focus group work, were:

- Cost to install
- Ease of installation
- Ease of use
- Improved energy efficiency
- Interruptions to electricity supply
- Level of control over the device
- Potential government incentives
- Reduction in overall emissions
- Reliability and durability
- Safety levels
- Savings over time
- Time until return on investment

Ratings of the relative importance of these features are displayed in Figure 2. Across the sample, improved efficiency, safety, interruptions to supply and reliability/durability were all rated as important, while ease of installation, cost to install, time until return on investment and potential government incentives were rated as least important. Although they prioritised features similarly, respondents with high acceptance attached relatively more importance to energy efficiency and reduction in emissions, whereas respondents with low acceptance attached relatively more importance to cost to install, return on investment and potential government incentives.

![Figure 2. Rated importance of various features of demand management technology (original scale rated from 1 = not at all important to 5 = very important).](image-url)
Barriers and Other Issues

Respondents who reported that there was no potential for demand management in their organisation were asked to explain why. Respondents who reported some potential for acceptance were asked to list other issues that would influence their organisation’s decision (beyond the 12 features listed in the survey). A total of 131 respondents listed one or more issues, which were categorised into themes, and are summarised in Table 6.

Table 6. Themes from written comments about demand management technology.

<table>
<thead>
<tr>
<th>Issue Type</th>
<th>Theme</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contextual issues</td>
<td>Approval</td>
<td>The use of the system would require approval from outside agencies, either government bodies and/or building/site owners in cases where the organisation was leasing</td>
</tr>
<tr>
<td></td>
<td>Support</td>
<td>Would benefit from government incentives, would need to understand how it linked to the NSW state government Energy Savings Action Plan, would like to get recognition from electricity retailer in the form of reduced rates.</td>
</tr>
<tr>
<td></td>
<td>Proof</td>
<td>Would like some guarantee of return on investment, would like to see a demonstration system already running, would like a recommendation from relevant professional associations, would need to see a cost comparison with alternative options.</td>
</tr>
<tr>
<td>Organisational issues</td>
<td>Interruptions to supply</td>
<td>Interruptions to supply are unacceptable given the nature of the organisation</td>
</tr>
<tr>
<td></td>
<td>Relevance</td>
<td>Organisation already has a similar system in place</td>
</tr>
<tr>
<td></td>
<td>Advantages</td>
<td>Would replace a number of separate devices currently used, would promote the organisation as environmentally responsible, would promote community recognition, would link with the organisation’s existing sustainability policy.</td>
</tr>
<tr>
<td></td>
<td>Scale</td>
<td>The organisation’s electricity load is too small to make such a system worthwhile</td>
</tr>
<tr>
<td></td>
<td>Site suitability</td>
<td>The system isn’t suitable for a leased space.</td>
</tr>
<tr>
<td>Product-specific issues</td>
<td>Costs</td>
<td>Upfront installation cost, savings over time, time until return on investment, cost/benefit analysis, ongoing costs of maintenance and upgrading, staff time and training to control/monitor the device.</td>
</tr>
<tr>
<td></td>
<td>Performance</td>
<td>Ease of use, reliability, accuracy, reaction time to changes in environment, need ongoing data on performance, need offsite access and to be able to program operational priorities.</td>
</tr>
<tr>
<td></td>
<td>Compatibility</td>
<td>Capacity to be integrated with old plant equipment and existing building management systems, needs to be transparent to normal operation of the organisation</td>
</tr>
</tbody>
</table>

Distributed Generation Technology

Acceptance of Distributed Generation Technology

Overall, 64.9% of respondents said that a local electricity generator had the potential to be used in their organisation. These respondents provided a further rating of the likelihood that their organisation would be prepared to use this technology. The combined results of these two questions are summarised in Table 7 below. Only 18.9% of respondents thought that uptake by their organisation was likely or very likely. To simplify the descriptive analyses, organisations were classified into one of three groups:
Organisations’ Attitudes towards Electricity Alternatives

- no potential (those that identified no potential for the use of a local electricity generator),
- low potential (those that gave ratings of “very unlikely”, “unlikely” or “possible”), and
- high potential (those that considered their organisation “likely” or “very likely” to adopt a local electricity generator).

Table 7. Acceptance of distributed generation technology.

<table>
<thead>
<tr>
<th>Overall, how likely is it that your organisation would be prepared to use this sort of local generator?</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>No potential</td>
<td>156</td>
<td>35.1</td>
</tr>
<tr>
<td>Very unlikely</td>
<td>18</td>
<td>4.1</td>
</tr>
<tr>
<td>Unlikely</td>
<td>28</td>
<td>6.3</td>
</tr>
<tr>
<td>Possible</td>
<td>158</td>
<td>35.6</td>
</tr>
<tr>
<td>Likely</td>
<td>51</td>
<td>11.5</td>
</tr>
<tr>
<td>Very likely</td>
<td>33</td>
<td>7.4</td>
</tr>
<tr>
<td>Total</td>
<td>444</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Note: 18 people did not answer.

Statistical analyses were carried out to explore whether acceptance of distributed generation technology was related to either respondent or organisational characteristics. There were no differences in acceptance of distributed generation technology related to respondent age or education level. However, male respondents reported higher average acceptance of distributed generation technology than did females. It is possible this finding reflects a bias in individuals’ responses (i.e. males are more accepting of generators than females), or a bias in the gender distribution of employees in certain organisations (i.e. organisations more likely to accept generators also hire more males).

Continuous-scaled organisational characteristics included: number of employees, annual turnover, annual electricity costs, and the electricity intensity measure described above. Summaries of these variables for the three levels of acceptance of distributed generation technology are provided in Table 8.

Table 8. Characteristics of organisations described according to acceptance of distributed generation technology.

<table>
<thead>
<tr>
<th>Acceptance of DG technology</th>
<th>Statistic</th>
<th>Number of Employees</th>
<th>Annual Turnover ($M)</th>
<th>Annual Electricity Cost ($k)</th>
<th>Electricity intensity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No potential</td>
<td>Mean</td>
<td>169.5</td>
<td>108.63</td>
<td>257.98</td>
<td>0.67</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>60.0</td>
<td>20.00</td>
<td>35.00</td>
<td>0.20</td>
</tr>
<tr>
<td></td>
<td>Range</td>
<td>2 to 2400</td>
<td>0.1 to 3000</td>
<td>1 to 9000</td>
<td>0.01 to 6.67</td>
</tr>
<tr>
<td>Low potential</td>
<td>Mean</td>
<td>324.5</td>
<td>152.76</td>
<td>880.17</td>
<td>1.21</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>160.0</td>
<td>47.50</td>
<td>165.00</td>
<td>0.53</td>
</tr>
<tr>
<td></td>
<td>Range</td>
<td>4 to 3000</td>
<td>0.3 to 1734</td>
<td>0.12 to 37000</td>
<td>0.01 to 11.45</td>
</tr>
<tr>
<td>High potential</td>
<td>Mean</td>
<td>541.6</td>
<td>157.98</td>
<td>868.72</td>
<td>1.10</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>235.0</td>
<td>60.00</td>
<td>225.50</td>
<td>0.58</td>
</tr>
<tr>
<td></td>
<td>Range</td>
<td>2 to 5000</td>
<td>0.6 to 1200</td>
<td>1 to 12000</td>
<td>0.01 to 6.42</td>
</tr>
</tbody>
</table>

Note: Because these variables were all positively skewed, the median is a more informative measure than the mean.

Statistical testing of the relationship between these characteristics was based on the original acceptance measure and the log transformed version of the characteristics above. Tests showed significant positive associations between acceptance and number of employees,
annual turnover, annual electricity cost and electricity intensity. As for demand management, acceptance of distributed generation appears to be higher for larger organisations. But in addition, organisations with higher electricity intensity (in which electricity is a larger cost relative to overall turnover) also reported higher levels of acceptance of distributed generation.

Categorical organisational characteristics included state, classification and access to other power sources. There were no differences apparent in the acceptance of distributed generation technology for organisations in different states, or for those with and without access to an emergency generator. However, organisations who already routinely supplied their own power tended to report higher acceptance of distributed generation technology (average acceptance rating 3.9) than those who used grid-supplied power only (average acceptance rating 3.2).

Further, acceptance of distributed generation appeared to differ markedly across organisational classification, but many specific classifications had small sample sizes which precluded a statistical analysis of these differences. Acceptance of distributed generation appeared highest for mining, health and community services, and manufacturing, and lowest for construction, finance and insurance, and personal and other service organisations (see Figure 3).

[Diagram showing acceptance ratings for different organisational classifications]

Figure 3. Acceptance of distributed generation for different organisational classifications (rated from 0 = no potential to 5 = very likely to adopt).

Perceived Importance of Distributed Generation Features

To understand the relative importance that people placed on various features of distributed generation technology, 13 features were assessed using Likert scales. The features, which were developed via a review of technical features and focus group work, were:

- Cost to install
- Ease of installation
- Ease of use
• Improved energy efficiency
• Noise levels
• Potential exhaust fumes
• Potential government incentives
• Reduction in overall emissions
• Reliability and durability
• Safety levels
• Savings over time
• The generator’s energy source
• Time until return on investment

Ratings of the relative importance of these features are displayed in Figure 4. Across the sample, safety levels, improved efficiency, and reliability/durability were all rated as important, while the generator’s energy source, ease of installation, and potential government incentives were rated as least important. Comparing ratings from respondents with high acceptance and those with low acceptance shows some differences: those with high acceptance rated energy efficiency as more important, and cost to install, noise levels, the generator’s energy source and potential government incentives as less important than did those with lower acceptance of the technology.

Figure 4. Rated importance of various features of demand management technology (original scale rated from 1 = not at all important to 5 = very important).

Barriers and Other Issues

Respondents who reported that there was no potential for distributed generation in their organisation were asked to explain why. Respondents who reported some potential for acceptance were asked to list other issues that would influence their organisation’s decision (beyond the 13 features listed in the survey). A total of 84 respondents listed one or more issues, which were categorised into themes and are summarised in Table 9.
Table 9. Themes from written comments about distributed generation technology.

<table>
<thead>
<tr>
<th>Issue Type</th>
<th>Theme</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approval</td>
<td>Installation would require approval from building/site owners in cases where the organisation was leasing</td>
<td></td>
</tr>
<tr>
<td>Support</td>
<td>Would benefit from government incentives.</td>
<td></td>
</tr>
<tr>
<td>Distrust</td>
<td>Not trialled in other areas, uncertainty regarding costs/maintenance, not convinced it would deliver claimed benefits</td>
<td></td>
</tr>
<tr>
<td>Scale</td>
<td>Don’t use enough electricity, base load is too large for this technology, company has minimal budget for energy efficiency initiatives</td>
<td></td>
</tr>
<tr>
<td>Relevance</td>
<td>Organisation already has a similar system in place</td>
<td></td>
</tr>
<tr>
<td>Nature of site</td>
<td>Unsuitable for tenants in shared space, building structure not suitable, CBD location unsuitable, leased site not suitable, residential site not suitable, insufficient space.</td>
<td></td>
</tr>
<tr>
<td>Energy source</td>
<td>Would only be interested if used solar/other renewable power.</td>
<td></td>
</tr>
<tr>
<td>Cost</td>
<td>Cost to install, cost too high relative to benefits, up front capital cost, time to return on investment, savings over time, ongoing maintenance/staffing costs</td>
<td></td>
</tr>
<tr>
<td>Environmental concerns</td>
<td>Potential exhaust fumes, environmental health issues, noise levels, emissions</td>
<td></td>
</tr>
</tbody>
</table>

Paths to adoption

Figure 5 below summarises a range of drivers and barriers to organisational adoption of distributed generation and demand management that have been identified in the current research. From these, we can identify a range of actions that could be undertaken to promote adoption, either removing barriers or strengthening drivers.

In terms of contextual issues, such actions include: implement incentives and advertise them, provide more detailed explanation of technology and potential savings (along with working demonstrations), explore potential permission from building owners, or market these products to building owners directly.

For organisational issues, these actions include: target electricity intensive organisations, organisations moving to new sites, and organisations that own commercial and industrial sites, target organisations that are large enough (but not too large) to benefit from distributed generation and demand management.

For issues associated with distributed generation and demand management products, these actions include: provide more detailed information on performance, explain emissions benefits in more depth, explore compatibility with older systems, promote perceived advantages (environmental responsibility, potential to replace multiple separate control devices), reduce upfront costs (including via incentives), address environmental impacts of DG (noise, exhaust), explain non-intrusive supply interruptions for DM.
CONCLUSION

The results of the present study have identified a number of issues associated with the adoption of distributed generation and demand management technologies by Australian organisations. Specifically, characteristics of organisations that are more likely to adopt the technology have been identified, as well as a range of important issues identified by the survey respondents in written comments. These findings led to the identification of a series of drivers and barriers to technology adoption that fall into three domains of external context, organisational issues and technological or product issues. It is envisaged that the specific drivers and barriers identified in this research can be investigated in more detail through interviews and workshops with a range of organisation representatives, to test the influence each of the factors may have on the overall value proposition for distributed energy in Australia.
REFERENCES


APPENDIX A: SURVEY

Survey of Australian Organisations - LG

Welcome

Energy Consumption and Alternative Energy Sources
Survey of Australian Organisations

This web survey is part of a larger CSIRO project that is investigating the energy use of organisations in Australia. Information we gather will help inform efforts to meet the future energy needs of Australian organisations.

Is your organisation eligible? We are gathering information from all types of organisations (public, private, not-for-profit), especially those that have large energy requirements. Organisations that have smaller energy requirements are also welcome to participate.

What is in the survey? The survey contains questions about your organisation's inputs, outputs and energy consumption, and asks for opinions about some new types of energy technology that CSIRO is investigating. The survey takes about 20 minutes to complete. Note that you can leave the survey at any time, and return to it later - the link will automatically return you to where you left off.

Who should complete the survey? Given the costs of questions we are asking, the best person to complete this survey is probably the Operations Manager or Site Manager, or another person with access to detailed information about the energy requirements of the organisation.

Does your organisation operate at multiple locations? Note that this survey focuses on a single site or location - if your organisation operates at more than one site, then please consider forwarding the link to this survey (www.csiro.au/news/energysurvey) to a suitable staff member at each specific site.

What happens to your responses? Survey response are anonymous and will remain confidential within CSIRO. Reports generated from the survey will involve summaries of organisations only - no individual organisations will be described. Participation is voluntary and organisations are, of course, free to withdraw from the study at any time. If you choose, we will send you a summary of the survey results once the study is complete.

You can win a $100 shopping voucher. We would greatly appreciate your participation, and we recognise that your time is valuable. In return for participating, respondents have a chance to win one of five $100 shopping vouchers for their organisation. If you wish to enter the draw for one of these vouchers, please add your contact details at the end of the survey. These contact details will not be linked to your completed survey responses.

Do you want more information? If you have any questions regarding this study, please contact Dr. John Gardner on (07) 3327 4076 or via email at John.Gardner@csiro.au.

Automatic Energy Manager

In this section, we want to get your opinions about some potential new technology - an automatic energy manager.

Imagine a computing device, an automatic energy manager, installed at your organisation and in communication with the power company. It would measure and model the electricity consumption of your organisation's most significant electrical loads, for example, fixed machinery, HVAC system (heating, ventilation, and air conditioning), and cool/cold stores. Advanced sensing technology, easily retro-fitted, would measure information about room occupancy and temperature, and information about product inventory and condition in the case of cool/cold stores. The energy manager would use this information to interrupt the electricity supply to non-essential loads to reduce your overall electricity consumption (for example, turning off cooling to unoccupied areas). This control would be coordinated with the power company to reduce peaks in overall electricity demand. The energy manager would provide detailed information about energy performance and could be adjusted via a menu interface.

- The energy manager would cost you around $2,000 to $3,000 to install
- Your organisation's greenhouse gas emissions would be reduced by around 10-20%
- Your organisation's electricity bill would be reduced by around 10%
- Your organisation would receive a rebate on its electricity bill whenever the energy manager helped to prevent a peak in overall electricity demand

1. Does this technology have the potential to be used in your organisation?
   - Yes, possibly
   - No, definitely not
Energy Manager Not Suitable

Imagine a computing device, an automatic energy manager, installed at your organisation and in communication with the power company. It would measure and model the electricity consumption of your organisation's most significant electrical loads, for example, fixed machinery, HVAC system (heating, ventilation, and air-conditioning), and cool/cold stores. Advanced sensing technology, easily retro-fitted, would measure information about room occupancy and temperature, and information about product inventory and condition in the case of cool/cold stores. The energy manager would use this information to interrupt the electricity supply to non-essential loads to reduce your overall electricity consumption (for example, turning off cooling in unoccupied areas). This control would be coordinated with the power company to reduce peaks in overall electricity demand. The energy manager would provide detailed information about energy performance and could be adjusted via a menu interface.

- The energy manager would cost you around $2,000 to $3,000 to install
- Your organisation's greenhouse gas emissions would be reduced by around 10-20%
- Your organisation's electricity bill would be reduced by around 10%
- Your organisation would receive a rebate on its electricity bill whenever the energy manager helped to prevent a peak in overall electricity demand

1. Why would an automatic energy manager be unsuitable for your organisation?

Energy Manager Evaluation

Imagine a computing device, an automatic energy manager, installed at your organisation and in communication with the power company. It would measure and model the electricity consumption of your organisation's most significant electrical loads, for example, fixed machinery, HVAC system (heating, ventilation, and air-conditioning), and cool/cold stores. Advanced sensing technology, easily retro-fitted, would measure information about room occupancy and temperature, and information about product inventory and condition in the case of cool/cold stores. The energy manager would use this information to interrupt the electricity supply to non-essential loads to reduce your overall electricity consumption (for example, turning off cooling in unoccupied areas). This control would be coordinated with the power company to reduce peaks in overall electricity demand. The energy manager would provide detailed information about energy performance and could be adjusted via a menu interface.

- The energy manager would cost you around $2,000 to $3,000 to install
- Your organisation's greenhouse gas emissions would be reduced by around 10-20%
- Your organisation's electricity bill would be reduced by around 10%
- Your organisation would receive a rebate on its electricity bill whenever the energy manager helped to prevent a peak in overall electricity demand

1. Overall, how likely is it that your organisation would be prepared to use this sort of automatic energy manager?
   - Very unlikely
   - Unlikely
   - Possible
   - Likely
   - Very likely

2. Please consider the following features of an automatic energy manager. How important would each of these features be in determining whether or not your organisation would use this technology?

<table>
<thead>
<tr>
<th>Not at all important</th>
<th>Moderately important</th>
<th>Very important</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Page 2
Survey of Australian Organisations - LG

<table>
<thead>
<tr>
<th>Ease of installation</th>
<th>Cost to install</th>
<th>Savings over time</th>
<th>Time until return on investment</th>
<th>Potential government incentives</th>
<th>Interruptions to electricity supply</th>
<th>Reduction in overall emissions</th>
<th>Safety levels</th>
<th>Ease of use</th>
<th>Reliability and durability</th>
<th>Level of control over the device</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Are there any other issues that would influence your organisation's decision to use this technology? Please describe them below:

Local Generation Technology

In this section, we want to get your opinions about a second potential new technology - a local electricity generator.

Imagine an electricity generator that could be installed at your organisation, which would be large enough to provide all of the electricity you required. (You may already have such a generator as an emergency backup.) This generator would be powered by diesel, natural gas or biofuel, and would produce lower CO₂ emissions than the emissions produced by a coal- or gas-fired power station. It would turn on automatically when electricity demand was high (for example, in the middle of the day and during the early evening) according to a contractual arrangement with the power company. By making your generator available for automatic operation you would receive a discounted electricity bill. While the generator was running, your business would not draw any power from the electricity grid, further reducing your electricity bills.

- The generator would cost you around $50,000 to $100,000 to install, depending on power requirements
- The generator might produce some exhaust fumes and noise, depending on the fuel source used
- Maintenance of the generator would be an expense for your organisation
- Your organisation’s greenhouse gas emissions would be reduced by around 20%
- Your organisation’s overall energy bill (including the cost of running the generator) would be reduced by around 30%

1. Does this technology have the potential to be used in your organisation?
   - Yes, possibly
   - No, definitely not
Organisations' Attitudes towards Electricity Alternatives

Survey of Australian Organisations - LG

Local Generation Not Suitable

[Repeated from previous page]

Imagine an electricity generator that could be installed at your organisation, which would be large enough to provide all of the electricity you required. (You may already have such a generator as an emergency backup.) This generator would be powered by diesel, natural gas or biofuel, and would produce lower CO₂ emissions than the emissions produced by a coal- or gas-fired power station. It would turn on automatically when electricity demand was high (for example, in the middle of the day and during the early evening) according to a contractual arrangement with the power company. By making your generator available for automatic operation you would receive a discounted electricity bill. While the generator was running, your business would not draw any power from the electricity grid, further reducing your electricity bills.

- The generator would cost you around $50,000 to $100,000 to install, depending on power requirements
- The generator might produce some exhaust fumes and noise, depending on the fuel source used
- Maintenance of the generator would be an expense for your organisation
- Your organisation’s greenhouse gas emissions would be reduced by around 20%
- Your organisation’s overall energy bill (including the cost of running the generator) would be reduced by around 30%

1. Why is this sort of local electricity generator unsuitable for your organisation?

Local Generation Evaluation

[Repeated from previous page]

Imagine an electricity generator that could be installed at your organisation, which would be large enough to provide all of the electricity you required. (You may already have such a generator as an emergency backup.) This generator would be powered by diesel, natural gas or biofuel, and would produce lower CO₂ emissions than the emissions produced by a coal- or gas-fired power station. It would turn on automatically when electricity demand was high (for example, in the middle of the day and during the early evening) according to a contractual arrangement with the power company. By making your generator available for automatic operation you would receive a discounted electricity bill. While the generator was running, your business would not draw any power from the electricity grid, further reducing your electricity bills.

- The generator would cost you around $50,000 to $100,000 to install, depending on power requirements
- The generator might produce some exhaust fumes and noise, depending on the fuel source used
- Maintenance of the generator would be an expense for your organisation
- Your organisation’s greenhouse gas emissions would be reduced by around 20%
- Your organisation’s overall energy bill (including the cost of running the generator) would be reduced by around 30%

1. Overall, how likely is it that your organisation would be prepared to use a local electricity generator?

- Very unlikely
- Unlikely
- Possible
- Likely
- Very likely

2. Please consider the following features of a local electricity generator. How important would each of these features be in determining whether or not your organisation would use this technology?

<table>
<thead>
<tr>
<th>Feature</th>
<th>Not at all important</th>
<th>Moderately important</th>
<th>Very important</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliability and durability</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Ease of installation</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Noise levels</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Improved energy efficiency</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
3. Are there any other issues that would influence your organisation's decision to use this technology? Please describe them below:

Electricity and Water Use

Remember that this survey is focused on a single site or location. If your organisation operates at more than one location, please answer the survey questions with reference to the site where you work.

1. What is the annual electricity usage at this location (in kilowatt-hours)? This information can be found on your electricity account.

From the electricity grid:  
From your own sources:

2. If you produce your own electricity, what power source(s) do you use?

3. Does this location have an emergency power generator?

- Yes  
- No

4. What is the annual water usage at this location (in megalitres)? Please skip this question if your organisation does not track water usage.

From the mains supply:  
From your own sources:

5. If you provide some of your own water, what source(s) do you use?

6. How important to your organisation are issues of sustainability and environmental impact?

- Not at all important
Survey of Australian Organisations - LG

- Somewhat important
- Important
- Very Important

7. Overall, how energy efficient is your organisation, compared to other organisations like yours?
- Much more efficient than similar organisations
- A bit more efficient than similar organisations
- About the same as similar organisations
- A bit less efficient than similar organisations
- Much less efficient than similar organisations

8. If you were shifting your organisation to a new location, would you be prepared to pay extra for a location that was more energy efficient and environmentally friendly?
- Yes, we would pay up to 10% extra for such a location
- Yes, we would pay up to 5% extra
- Yes, we would pay up to 2% extra
- Yes, we would pay up to 1% extra
- No, we would not be prepared to pay more

Background Information - Location

The following questions are designed to allow us to summarise the types of organisations that complete this survey.

1. Please provide a brief description of the type of business conducted at this location.

2. How many people does your organisation employ at this location?

3. What is the postcode at this location?

4. What is the approximate annual turnover (in dollars) at this location?

5. How would you classify your organisation? Please choose the best option from the menu below.

6. What is the annual electricity cost (for grid-supplied electricity) for this location?
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location?

7. Which electricity retailer do you use? That is, the company listed on your electricity account.

Background Information - Personal

The following questions are designed to allow us to summarise the types of people that complete this survey.

1. What is your role within the organisation?

2. What is your age (in years)?

3. What is your gender?
   - Female
   - Male

4. What is the highest level of education you have completed?
   - Primary school only
   - Year 9 or below
   - Year 10 or equivalent
   - Year 11 or equivalent
   - Year 12 or equivalent
   - Trade certificate/apprenticeship
   - Diploma
   - Bachelor/honours degree
   - Postgraduate degree
   - Other (please specify)
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Further Information and Feedback

1. Would you like to receive a summary of the results of this survey?
   - Yes
   - No

2. Would you like to enter the draw to win one of five $100 shopping vouchers for your organisation?
   - Yes
   - No

3. If you answered yes to either of the questions above, please provide a contact name and postal or email address in the space below.

Terms and Conditions: This prize draw is conducted by CSIRO. Entry in the draw is free and is open to all organisations who complete the survey online and who provide their contact details. Five randomly selected winners will each receive a $100 retail gift voucher. The total value of all prizes is $500. The prize draw closes on August 31st, 2007. Prizes will be drawn on September 1st, 2007 at CSIRO: Exploration and Mining, Queensland Centre for Advanced Technologies (QCAT), Technology Court, Pullenvale, Queensland. Winners will be notified by mail. Contact details provided will be kept confidential within CSIRO.

Thankyou for your participation in this project. Click on the "Done" button below to close the survey.
APPENDIX B: EMAILED SURVEY INVITATION

Dear <firstname>

Australia’s Commonwealth Scientific and Industrial Research Organisation (CSIRO) is conducting a study into energy consumption and energy sources for all types of Australian organisations.

**How can you help?** By completing a short web-based survey about your organisation's energy usage, you can provide valuable information that will help inform future efforts to meet the energy needs of Australian organisations. The best person to complete the survey is someone who is responsible for managing payments to your electricity supplier. If this isn't you, we'd appreciate it if you could forward this email to the appropriate person in your organisation.

**What is in the survey?** The survey contains questions about your energy consumption, and asks for opinions about some new energy technologies that CSIRO is investigating. The survey will take only 15-20 minutes to complete. To complete the survey go to:

<survey hyperlink>

**What happens to your responses?** Survey responses are anonymous and will remain confidential within CSIRO. Reports generated from the survey will involve summaries of organisations only - no individual responses will be reported. Participation is voluntary and you are, of course, free to withdraw from the study at any time. If you choose, we will send you a summary of the survey results once the study is complete.

**Do you want more information?** If you have any questions regarding this study, please contact Dr. John Gardner on (07) 3327 4076 or via email at John.Gardner@csiro.au.

Please note: If you do not wish to receive further emails from us, please click the link below, and you will be automatically removed from our mailing list.

<opt-out hyperlink>
APPENDIX C: RESPONDENT CHARACTERISTICS

The following tables present summaries of the characteristics of the respondents.

**Age** was measured in years, and then coded into five categories as shown in the table below.

<table>
<thead>
<tr>
<th>Age Range</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-29</td>
<td>32</td>
<td>9.0</td>
</tr>
<tr>
<td>30-39</td>
<td>89</td>
<td>25.1</td>
</tr>
<tr>
<td>40-49</td>
<td>120</td>
<td>33.9</td>
</tr>
<tr>
<td>50-59</td>
<td>92</td>
<td>26.0</td>
</tr>
<tr>
<td>60+</td>
<td>21</td>
<td>5.9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>354</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Note: 108 people did not answer.

**Gender**: 26.5% of the respondents were female and 73.5% were male. There were 100 people who did not answer this question.

**Education** was measured with a range of options from “year 9 or below” up to “postgraduate degree”. One hundred respondents did not answer this question. For statistical analysis, the original categories were collapsed into three broader categories:

- Year 9 or below up to diploma: 36.5% of the respondents
- Bachelor/honours degree: 37.8% of the respondents
- Postgraduate degree: 27.3% of the respondents
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