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1 Introduction

1.1 Background

Being deeply committed to the development of solar photovoltaic (PV) as a renewable energy technology, the Alternative Technology Association (ATA) launched a study to understand the experiences of PV system owners and how ownership influenced and changed their lives concerning energy use, energy conservation and energy efficiency. ATA was supported by the Australian Greenhouse Office in this study.

Present PV system owners are considered “early adopters”¹. Understanding their experiences will enable future policy designers to incorporate solutions that may improve the experiences with PV systems for future owners. This should foster the spread of a positive image of the technology, as well as empowering the PV system owner to take other measures to lower their electricity consumption.

The Photovoltaic Rebate Programme (PVPR) was launched by the Federal Government in 2000. This programme has recently been extended and changed by the Federal Government to incorporate an increased rebate, as well as an enlarged total budget. This programme is an important incentive to encourage the uptake of photovoltaic systems, by reducing its high upfront cost, making the investment more attractive to consumers. As of June 2007, there were 4,169 PV systems connected to the grid that had taken advantage of the PVPR giving an additional 6.56 MW of capacity to the electric grid².

The Renewable Remote Power Generation Programme (RRPGP) provides rebates for the installation of renewable generation equipment in remote parts of the country which are not serviced by a main electricity grid and rely on fossil fuel for electricity generation. This programme aims to increase the uptake of renewable energy technologies in remote areas of Australia thereby displacing fossil fuels. This programme also started in 2000, and was extended during 2006. As of June 2007, there were 4,547 remote PV systems installed using this programme³.

The result of this study is intended to contribute to the discussion of future government programmes aiming to increase the uptake of PV system installations, as well as its influence over the potential to reduce energy consumption at the household level. In ATA's view, such programmes should not only incorporate pure market incentive instruments (as PVPR and RRPGP programmes currently do), but should address additional key motivational factors in order to drive a much higher PV systems uptake in Australia.

1.2 Research objectives

This research aims to explore PV owners' experiences with their systems, as well as understanding the influence of this ownership's contribution to changes in other “energy attitudes”.

¹ The ones that are more motivated to use new technology and that have the financial capability to invest in PV or have no other alternative

² Source: Australian Greenhouse Office – PVPR programme

³ Source: Australian Greenhouse Office – RRPGP programme



The primary objectives of this research were to:

- understand expectations and the personal satisfaction of PV system owners with their systems, and the resulting economical implications;
- understand influences between PV systems, energy efficiency and conservation, solar hot water systems and GreenPower;
- capture PV system owners' views and suggestions on the best solutions to increase PV system uptake.

This research also enabled the following complementary objectives to be reached:

- understanding environmental and climate change perceptions and concerns of PV system owners;
- understanding the main motivations for PV system acquisition;
- understanding experience with grid connection (when applicable), rebates and Renewable Energy Certificates (RECs).

1.3 Sample population

The population constitutes a mixed population from two sources:

- ATA Membership base of 4000 members, without a specific representation of PV systems.
- 4000 randomly chosen beneficiaries of PVRP and RRPGP rebates (Australian Greenhouse Office (AGO) database).

The ATA membership sample include owners that may not have benefited from any rebates or RECs, while the AGO sample includes only PVRP and RRPGP rebate beneficiaries.

This research portrays no information on the views of the general public on PV systems, being limited to current PV system users.

This research was conducted before the change in PVRP, which saw a doubling of the available rebate, reflecting users' views on the previous situation (prevalent until May 2007).

2 Methodology

This survey was conducted online, using the online survey product "Zoomerang", encompassing 52 predominately multiple choice and ranking questions, together with 6 questions enabling further expansion. The survey was expected to take around 15-20 minutes to complete and was limited to one answer per computer. Paper surveys were dispatched to all respondents that requested them.

The respondents were invited via 2 methods to complete this survey:

- ATA sample - Email notification and website posting.
- AGO sample – Invitation letter with reference to the website.

3 Results

The survey was open from 11 April till 25 May 2007. During this time there were 1306 answers to this survey.

3.1 Geographic data

The respondents' residence, by state is shown in figure 1.

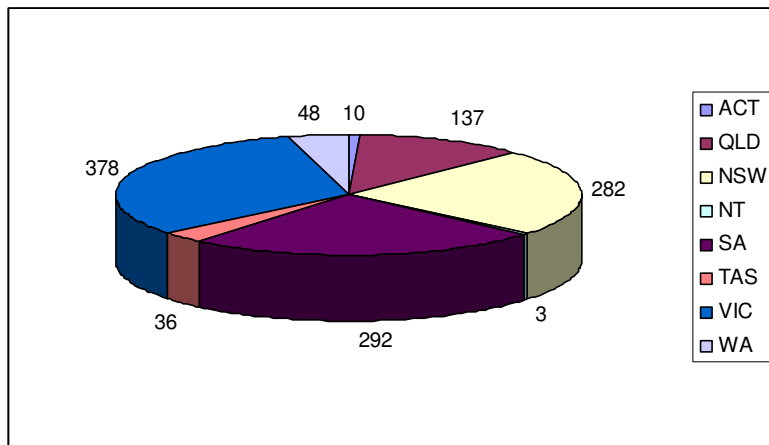


Figure 1 – Respondents' origin by State/Territory

The state most represented in the survey was Victoria, with 31%, followed by South Australia with 25% and New South Wales with 24%.

59% of respondents came from regional areas, 32% live in suburban areas and 9% in urban areas.

Detached houses accounted for 97% of the responses, with the majority (81%) of the houses consisting of three or more rooms. Around 98% of the respondents own their houses, while only 2% are tenants.

The net income of the respondents' households was spread over all income categories (figure 2).

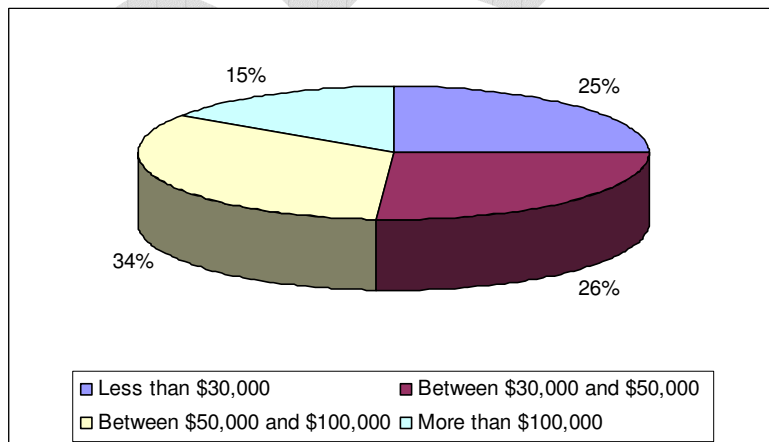


Figure 2 – Net income

3.2 Environmental practices and concerns

The environmentally friendly practices respondents liked most include waste recycling (95%), rainwater recycling (86%), composting (81%) and having low-flow

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showers installed (66%). The least preferred practice was the ownership and use of a hybrid car, shared by only 4% of the respondents.

Climate change was the respondents' main environmental concern (48%) followed by water scarcity/drought (36%). These two views were distributed differently among state/territory (figure 3) and dwelling areas (figure 4).

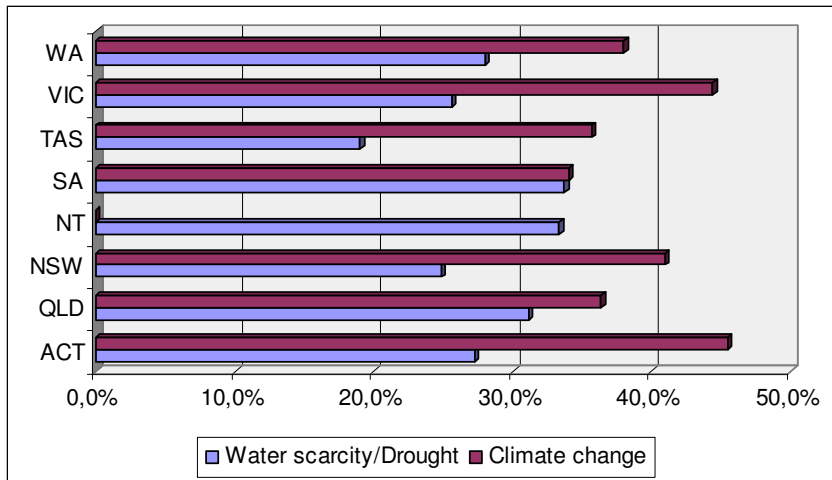


Figure 3 – Main environmental concerns, by state

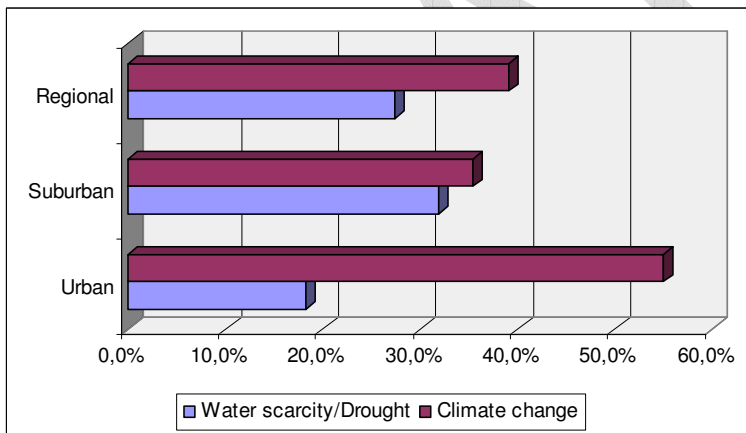


Figure 4 – Main environmental concerns, by dwelling area

(What do the percentages mean? Particularly in Fig. 3. Remove decimals on graphs)

3.3 Climate change perceptions, causes and envisaged solutions

Climate change was considered as having a high or very high impact in Australia for 89% of the respondents and 85% of the respondents considering it as already impacting Australia.

Whilst around 80% considered climate change to be a result of human activity, this perception differs slightly according to the respondent's State. More people agreed with this statement in Tasmania (91%), ACT and Victoria (82%), while fewer respondents from Western Australia (78%) and Queensland (75%) agreed. Around

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71% of the respondents considered climate change to be unstoppable but its severity can be diminished.

The preferred solutions to tackle climate change consisted of the large deployment of renewable energy (44%), and consumer behaviour change, involving energy conservation (36%) and energy efficiency (12%). Nuclear power and clean coal were viewed as the primary option by only 5% and 2% of the respondents, respectively.

The preference for 'large deployment of renewable energy' was preferred by 45% of respondents from New South Wales, 42% in South Australia, 38% in Queensland and 35% in Victoria.

The 'consumer behaviour change (save energy)' as a preferred measure was shared by 46% of respondents from WA, 41% in Tasmania and 36% in ACT. This preference was the top measure in the states ACT, Western Australia and Tasmania, and was the equally-preferred measure with 'large deployment of renewable energy' in Victoria, both with 35%.

3.4 Solar energy equipment

3.4.1 Motivation to acquire

Among the various factors that contributed to the acquisition of the PV system, 'good impact on the environment' was a motivator for 78% of the respondents, followed by 'economic benefits', cited by 40% and 'remote area' mentioned by 37% of the respondents. Of the respondents mentioning "economic benefits" as a motivator, 63% are currently connected to the grid.

Around 21% also mentioned other reasons for acquiring a PV system, such as a desire for independence from the grid and energy self-sufficiency, opportunity to take advantage of the existence of a government rebate for PV systems, giving an example to younger children, and the better reliability of solar power in opposition with grid unreliability.

3.4.2 Grid connection

For the 56% of the respondents that are connected to the grid, 20% mentioned that their PV system's grid connection took more than 3 months from their initial request. For the 44% of the respondents that are not connected to the grid, the majority (52%) chose to remain unconnected due to the difficulty of being a long distance from the grid, or the large investment required to obtain grid connection (22%).

3.4.3 Rebates and RECs

The rebates were claimed by 91% of the respondents. Of the 9% of the respondents that did not claim the rebate, around half was due to lack of eligibility: either the system was installed before the programme began or the system was not compliant with the rebate regulations (such as self-installed or second hand systems).

RECs were not claimed by 68% of the respondents that claimed a rebate. Lack of knowledge over their eligibility is the main reason presented by 62% of the non-claimers. About 12% of the respondents chose not to claim RECs and for 8% of respondents others claimed the RECs on their behalf.

3.4.4 Financials

The financial payback forecast by respondents can be seen in figure 5.

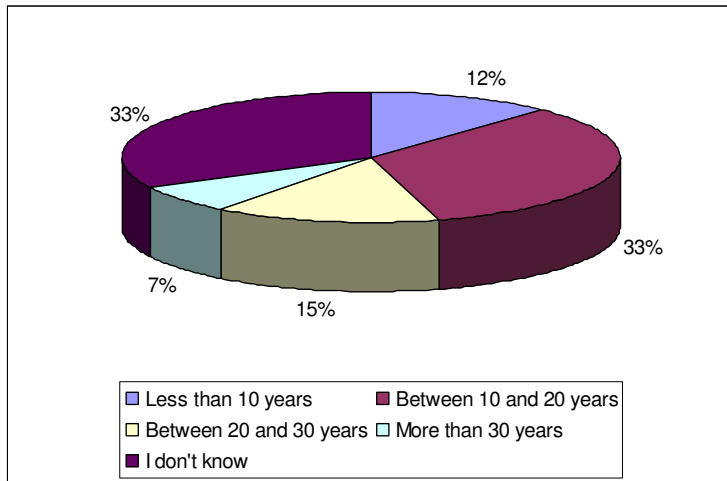


Figure 5 – Initially forecasted payback times for the PV system

These financial forecasts vary according to the main purpose of the PV investment. While the 45% of respondents who list 'living in a remote area' as their motivator for purchasing a PV system had no idea of the payback period, this percentage diminishes to 28% in the 'environmental reasons' motivator and to 27% in the 'economical benefits' motivator.

There is little variation in payback forecasting among the different income levels.

After the installation of the PV system, 84% of the respondents that are still connected to the grid say that their electricity bill reduced. Forty-eight per cent of this group considers their electricity bill to be reduced by more than 35%.

The financial aspects of the PV system, after acquisition, are seen very differently among respondents. While 40% considered the PV system as good value for money, around 23% saw it as an investment taking too much time to pay off.

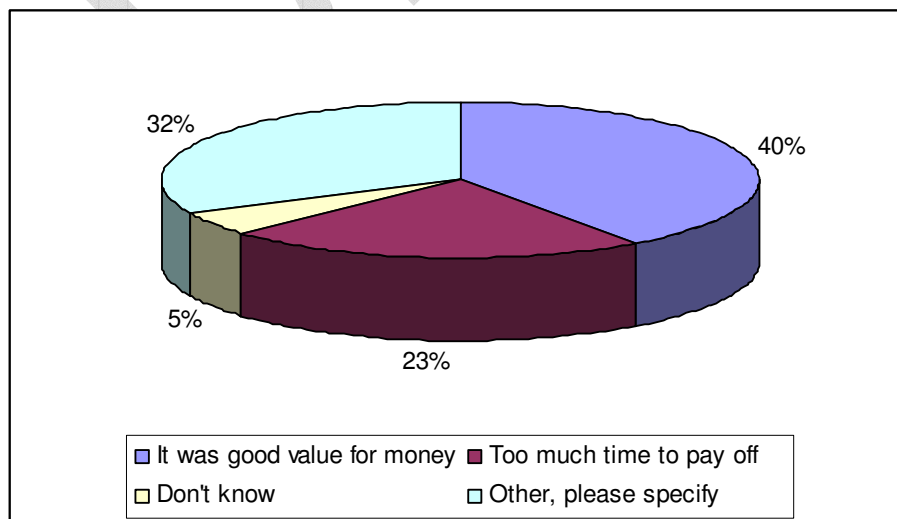


Figure 6 – Opinions over the economic value of the PV system

While the PV system was considered good value for money among 36% of the respondents mentioning ‘environmental reasons’ for their acquisition, this percentage rose to 50% among those citing ‘economical reasons’ for investment and 54% for respondents giving ‘living in a remote area’ as a motivation.

Around 32% expressed different views over the financials of their acquisition. Some mentioned never having considered their PV system acquisition as a financial investment but a means to reduce their own environmental impact, or the only real electricity generation alternative because of remoteness and thus having no or too-costly alternatives for grid connection (higher than their PV system investment). Others mention concerns over future energy prices (much higher than at present) and reliable supply capability as more important reasons than financial payback.

The preferred optimal payback period is 6 to 10 years (57%) followed by a period of 11 to 20 years (19%).

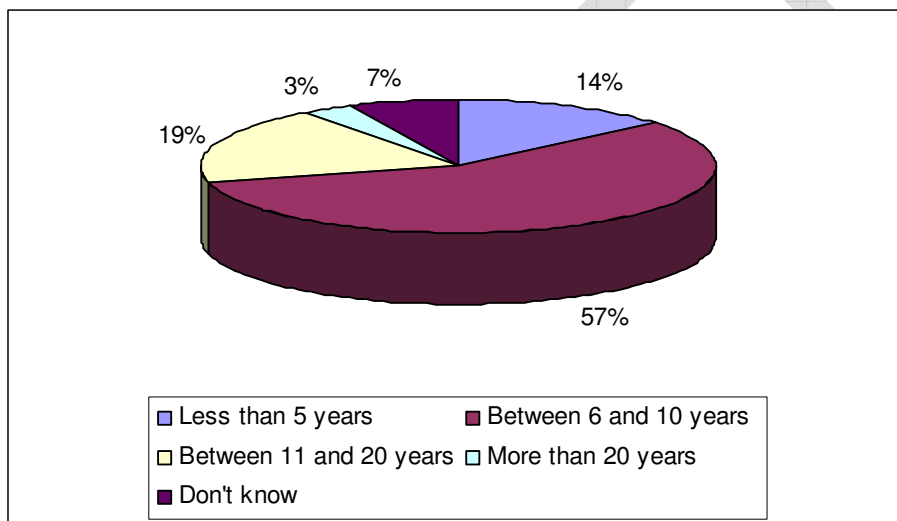


Figure 7 – Optimal PV system payback period

These views on optimal payback were fairly consistent across states, income levels, and motivation for system acquisition.

3.4.5 PV influences on other measures

The majority (61%) of respondents mentioned an increase in their awareness of their household energy consumption as a consequence of their photovoltaic investment. Some mentioned that this increased awareness came from the need to match electricity demand with their system supply capacity (mostly among remote PV systems), the need to minimise the PV system’s capacity and initial financial outlay, or the wish to maximise the system’s electricity export and financial return.

Respondents mentioned that monitoring their electricity consumption increased their understanding of their consumption and the links to habits and appliances, enabling them to make effective reductions in energy consumption. Some mention the ease of consumption reduction once its misuse by wasteful habits or low efficiency appliances was acknowledged and understood.

Importantly, this increased awareness was referred to as having enabled a change in consumption habits, with energy ratings of electrical equipment taken into account in acquisition decisions.

Solar hot water systems are owned by 61% of the respondents, from which 25% mention that owning either their solar PV system influenced them to acquire their solar hot water system or vice versa.

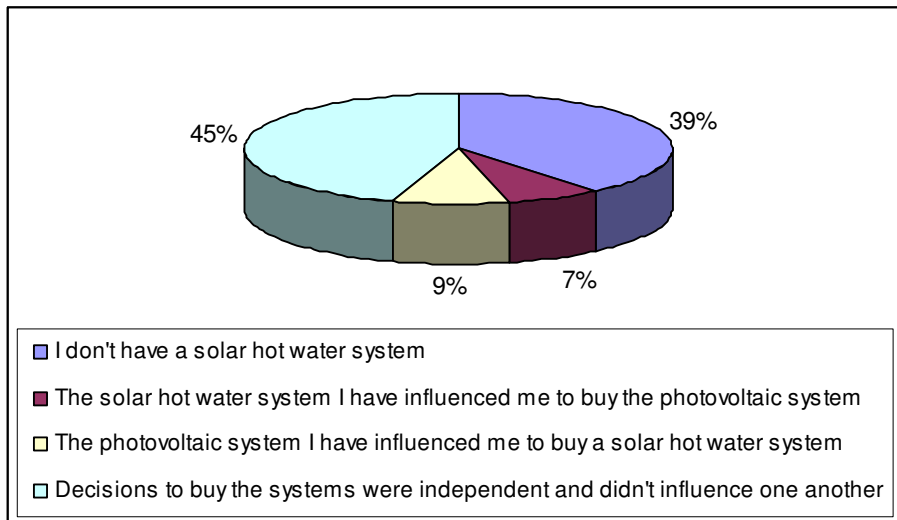


Figure 8 – Influences between PV and solar hot water

GreenPower is used by 44% of the respondents who are connected to the grid. From these, 23% mention mutual influence between the use of GreenPower and the PV system acquisition.

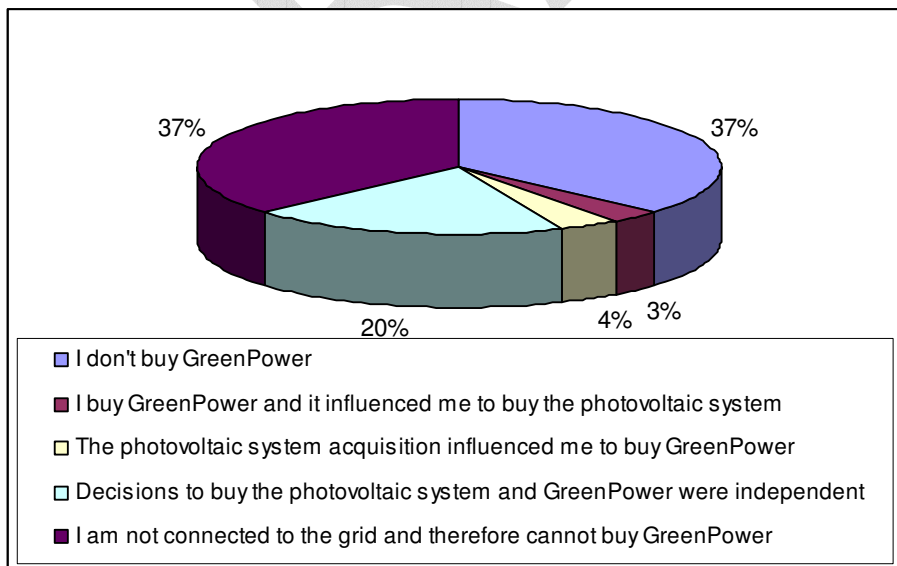


Figure 9 – Influences between PV and GreenPower

Energy efficiency measures had already been taken by 79% of respondents before acquiring their PV system, and 87% took or were planning to take further energy efficiency measures after the PV system was installed. For 46% of the respondents, the PV system influenced or motivated them to take energy efficiency measures.

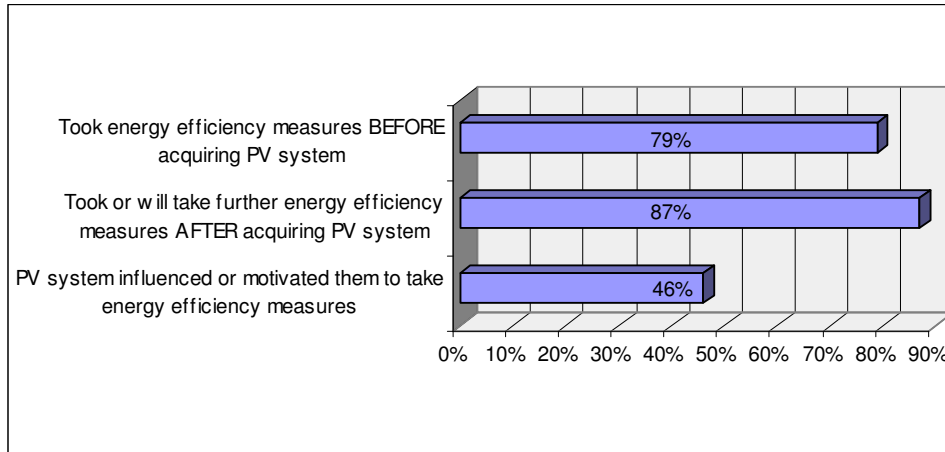


Figure 10 – Influences of PV system ownership and energy efficiency measures

The positive influence of owning a PV system in motivating energy efficiency measures was higher (49%) among respondents that were extremely or very satisfied with the system, gradually decreasing to be lower (30%) among dissatisfied and very dissatisfied PV owners.

The most popular energy efficiency measures are:

- 'replacing light bulbs with the most efficient on the market' (88% of the respondents); and
- 'buying efficient appliances' (86% of the respondents).

Energy conservation measures follow a similar path. They were already taken by 85% before acquiring the PV system and 89% took or were planning to take further measures after the PV system was installed. The positive influence of owning a PV system motivated 50% of the respondents to take energy conservation measures.

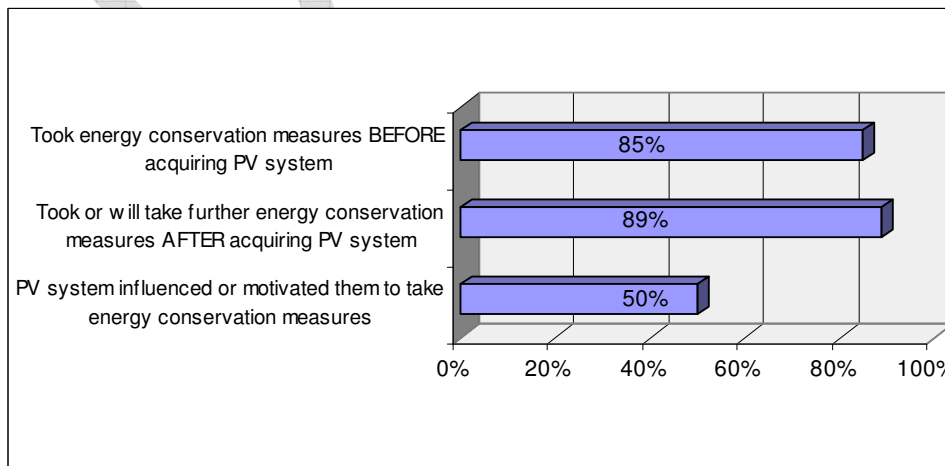


Figure 11 – Influences of PV system ownership and energy efficiency measures

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As with energy efficiency, the positive influence of owning a PV system in motivating energy conservation measures was higher (52%) among respondents that were very satisfied with the system, gradually decreasing to be lower (35%) among dissatisfied and very dissatisfied PV owners. In contrast, the absence of the mentioned influence of the PV system is viewed by 5% of the very satisfied PV owners, gradually increasing to reach a peak of choices (53%) among the very dissatisfied respondents.

The most popular energy conservation measures were 'no lights left on in rooms not being used' capturing 94% of the answers and both 'heating/cooling working only when there are people in the house' and 'no appliances are left in stand-by', each capturing 64% of the answers.

3.4.6 Respondents' overall satisfaction with their PV system

Individuals' PV systems were considered to be performing to expectation by 85% of the respondents. The remaining 15% of the PV system owners that consider the system as performing below expectations cite the following as reasons for their dissatisfaction:

- perception of poor output performance and efficiency of the system;
- incapacity of the installed system to cope with household demand, especially in winter or on cloudy days;
- inverter or other component problems and difficulty in getting them fixed in acceptable timeframes; and
- inexistent or unsuitable monitoring or system installation problems.

Around 74% of the owners are either very or extremely satisfied with the system.

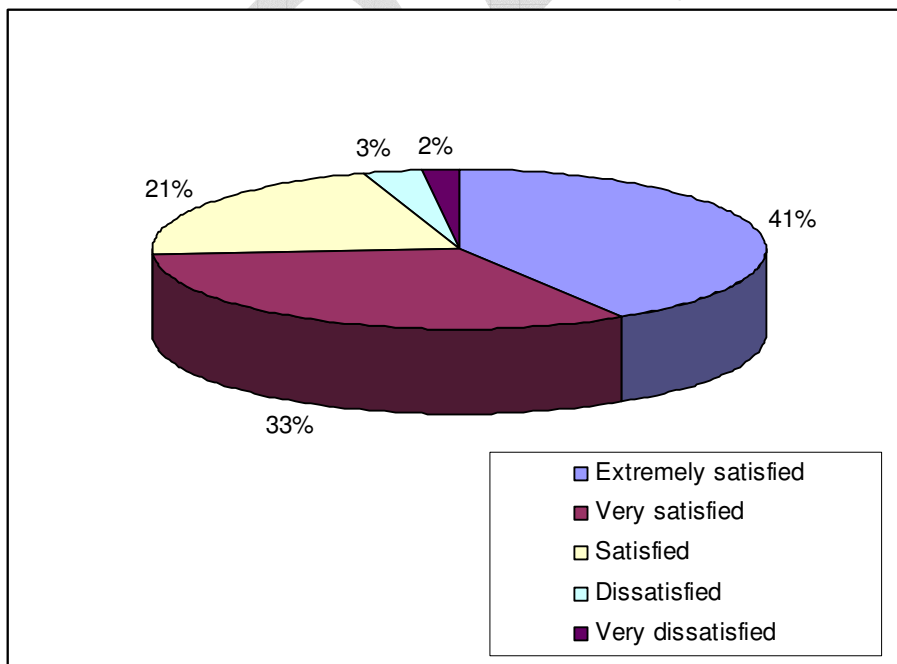


Figure 12 – Satisfaction with the PV system

Higher levels of satisfaction were obtained among respondents that consider their financial investment as good value for money (92% either very or extremely

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satisfied), than among respondents considering the financial investment as having “too much time to pay off” (57% are very or extremely satisfied).

While expanding on their satisfaction, respondents mentioned the following reasons:

- having a diminished environmental footprint
- having no power bill
- having a more reliable source of electricity (no blackouts)
- operational simplicity and stability of the PV system

Respondents dissatisfied with their PV systems presented several justifications, including:

- economical reasons (too high upfront costs, poor financial return of the PV system and the “poor” rate received by their power (grid-connected) – 33%
- problems with suppliers, installers and electricity retailers (for grid connected) – 22%
- PV system performing below expectations or purely technical problems with some components of the PV system such as batteries and inverters – 8%

Only 18% of the PV system owners would not consider transporting or acquiring a new PV system when moving to a new residence, justified by either being dissatisfied with the experience of owning a PV system or due to being retired and considering themselves too old to re-invest.

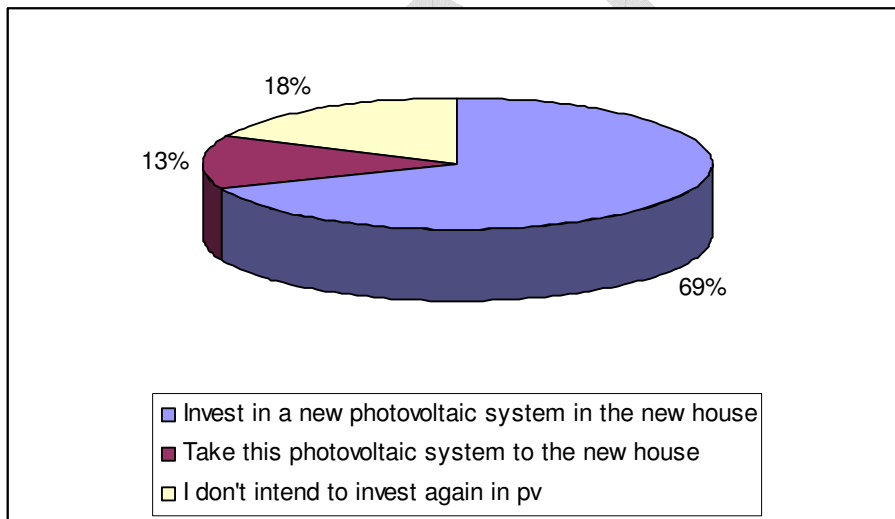


Figure 13 – Future intentions relating PV system

3.4.7 Stimulation of PV system acquisition uptake

The implementation of higher economic incentives was elected the main motivator required to stimulate further uptake of PV systems by 76% of the respondents.

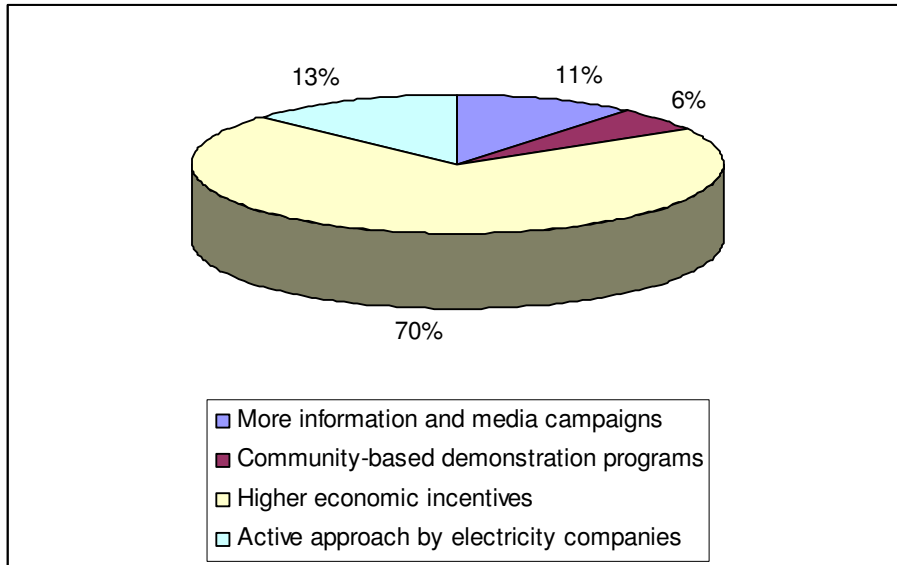


Figure 14 – Stimulating further PV system uptake

Respondents gave several suggestions for the establishment of such economic incentives, such as raising electricity prices to reflect environmental impacts, lowering the prices of the PV systems and their installation through government subsidies, increasing PV rebates or interest-free loans for PV systems, or establishing feed-in tariffs that can give a premium rate to electricity produced. The German model of feed-in tariffs was also mentioned by several respondents as a good example for Australia to follow.

While expanding on the ways to stimulate PV systems uptake, the following contributing factors were also mentioned:

- making the installation of PV compulsory on new homes (new building code) and a part of the house energy rating scheme;
- informing and providing incentives for homebuilders to incorporate PV in new homes;
- making the PV systems and components more efficient and reliable; and
- clarifying information on PV systems for domestic users.

Around 74% of respondents mention that their PV system gathered interest from others (neighbours, colleagues, friends, family, or others).

4 Discussion of the results

From the evaluation of the survey results, several considerations are to be noted:

Environmental practices and concerns of PV owners - The high rate of environmental practices among respondents does not come as a surprise, considering that a ‘good impact on the environment’ was the main reason for PV system acquisition. Environmental concerns were dominated by climate change and water scarcity/drought, as would also be expected. The difference in levels of concern may have been influenced by the differences among states and regions.

Climate change views and solutions - It is worth noting the large majority of respondents who perceive a high or very high climate change impact for Australia

see this impact as already happening. The preferred solutions to tackle climate change could also be also expected since they reflect the current practices that these respondents have already adopted (having their own renewable energy system and having adopted energy efficiency and conservation practices).

Influence between PV, Solar Hot Water, Energy Efficiency and Energy

Conservation - There seems to be a positive inter-influence between owning a solar system and signing up for GreenPower. More importantly, the PV system ownership appears to be motivating the users into energy efficiency and conservation practices. This situation is understandable for owners of remote systems who mention that the need to meet demand with supply of electricity. Among grid-connected users, the desire to minimise their initial investment and maximise their return is driving the majority to adopt energy efficiency and conservation practices, contributing to lowering their electricity use and probably giving an important contribution to the widespread perceived cut in the power bill.

Rebates and RECs - Rebates were claimed by the large majority of PV system owners, when fulfilling eligibility conditions. But, a large majority of respondents didn't claim RECs, largely because of being unaware of their ability to claim RECs on their system. It is legitimate to question the efficiency of the information available over this form of rebate.

PV systems financial views – The views on the forecasting and evaluating financial aspects of their PV system acquisition are widely distributed. Respondents living remotely believe that alternatives to PV may be somewhat limited and access to power is more important than so-called payback times. Still, respondents, tend towards a preferred optimal PV system payback period of 6 to 10 years.

PV systems uptake stimulation – Despite the differing financial views over the acquisition of their own PV system, respondents consider higher financial incentives as essential to stimulate further uptake. These could take the form of higher rebates and/or feed-in tariffs, with a buy-back premium rate able to stimulate the Australian domestic market, similar to what has happened in Germany.

There seems to be a lack of clear information and knowledge on the monetary value that a PV system can deliver to its owner over its operational period. This extends to the lack of information from retailers about not only the price, but also the terms and conditions of contracts and arrangements for the buy-back of electricity.

For users considering the capital investment, the recent increase in the value of the federal PV rebates (thus lowering capital costs) may be stimulating enough. Whilst some users make the investment without economical concerns, users who are looking to the long-term, may find it difficult to understand the system payback and economical benefits after payback due to both the aforementioned lack of information and the poor rates of return in the absence of feed-in tariffs.

Importantly, a significant percentage of users mention the establishment of mandatory PV system installations for all new houses being built, as well as including such systems in the house energy rating scheme and building codes, as a good measure to increase uptake.



Among the majority of respondents, social networks appear to be a relevant source of information and influence over potential adopters of such systems. Research⁴ has already highlighted the positive influence of these networks. Remembering that 'environmental reasons' was the main motivator for adoption of a PV system, it is likely those PV systems owners' social contacts maybe nearer such values and thus keen on environmentally friendly practices and technologies. Therefore, a positive PV owner's experience, allied with clear financial expectations and adequate payback periods, may give a significant contribution to increase PV system uptake.

PV owners experience satisfaction - It is important to note the expression of satisfaction associated with being energy autonomous, as well as a satisfaction with performance and reliability of their PV systems. The dissatisfaction resulting from problems with installation and equipment, as well as incorrect sizing of the systems (to take into account cloudy days or the dwelling's electricity demand), should be taken on board by the industry in order to establish users trust in PV systems technology.

5 Recommendations

Given the relevance that respondents attribute to increased financial incentives for the stimulation of solar PV uptake, it is recommended to further explore how the financial aspects are incorporated in the decision to adopt a PV system. Namely:

- what the initial perceptions on the economics of PV systems are (as it is public perception that mandates their initial acquisition behaviour.)
- what the financial factors important for a decision to buy a PV system are (capital, payback, upfront rebates, ongoing feed in tariffs, etc.)
- if potential buyers look at long or short term investments.
- if long term post-payback benefits are accrued in the financial view.
- if clearer information on payback is important to the decision process.

The results of such enquiries could enable an understanding of the incentive schemes (feed-in tariffs, higher rebates, or other solutions) that would grant better results, as well as the type of information to convey to the potential market.

There is high potential for PV system owners to adopt or increase energy efficiency and conservation measures as a result of their enthusiasm and increased "energy awareness" due to their PV system acquisition. The benefits of these energy efficiency and conservation measures (namely reduction of emissions) should be accounted for in the calculations of the overall benefits of any federal government incentive, which may allow envisaging an interesting cost for CO² abatement and enable the repositioning of the PV rebate schemes in relation to other carbon abatement measures.

It may be interesting to further explore and compare the actual energy benefits attributable to the PV system with the energy benefits arising from savings obtained through energy efficiency and conservation practices, adopted by the users of PV systems. Including information on these may improve potential owners' perceived financial equation and thus stimulate their uptake.

Finally, with 22% of the respondents who were dissatisfied with their purchase citing problems with suppliers, installers and electricity retailers, it would be valuable to

⁴ Motivating Home Energy Action - A Handbook of What Works, Shipworth, Michelle, AGO, <http://www.greenhouse.gov.au/local/motivating/index.html>, accessed on 20 September 2007



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explore a breakdown of this dissatisfaction and the underlying reasons. Anecdotal evidence suggests that the lack of clear processes for both connecting to the grid and securing a retail agreement leads to much of the frustration experienced by grid-connection proponents, and further work on both providing clear information on the current state of affairs and establishing standard connection agreements would be welcome.

DRAFT