

## Summary of community attitudes toward nuclear and other low emission energy technologies.

Peta Ashworth  
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In September 2008, Professor Ross Gaurnaut, described climate change as a diabolical policy challenge and outlined a number of initiatives to address the issue. Low emission energy technologies provide one such opportunity, to endow Australia with a more sustainable energy system. However like any new technology, there may be a social risk to the acceptance of new low emission energy technologies. With a goal to halve greenhouse gas emissions by 2050, CSIRO's Energy Transformed Flagship (ETF) has been researching public attitudes to climate change and energy technologies since 2003. The major findings of this body of research are summarised in this document.

### Processes for data collection reported

CSIRO's social research on climate change and energy technologies has used a mix of qualitative and quantitative research processes to gather data around Australian perspectives to low emission energy technologies. Specifically reported in this document are the results of three computer assisted telephone surveys (CATI) conducted in 2005 and 2006 with a random sample of the public from the states of Queensland and New South Wales. The findings from each of these large samples (n=2,700) were consistent and therefore generalisable to the whole of Australia. Reference is drawn to three citizens panels which were conducted as part of the Energy Futures Forum in Perth, New South Wales and Victoria (2005- 2006) and the final set of results tabulated includes the latest research of CSIRO (conducted in 2007 – 2009) when engaging a random sample of the population to participate in a one day large group workshop on the topic of climate change and energy technologies. To date five workshops have been conducted in Brisbane, Melbourne, Perth and Adelaide, and one specifically targeted at the 18 – 25 age group for the general public in the state capital cities.

### Rationale for engaging lay public

Early work of the social research program of the Energy Flagship demonstrated that the Australian public has a genuine appetite for more information on the topic of climate change and energy technologies<sup>1</sup>. The research also showed the lay public have an excellent propensity for grappling with such a complex issue and identifying a possible way forward for Australia's future energy mix. Using a dialogic approach to engage the public is based on the premise that increased knowledge will lead to more informed decision making and positive attitudes - particularly about new and emerging energy technologies. It also provides a process for accessing the opinions of the Australian public to identify their current issues and concerns with the topic - for both policy makers and technology developers.

### Attitudes and knowledge of climate change

All of our research confirms that Australians agree that climate change is an important issue to Australia, particularly for those in the 18 – 25 age groups. However, their self-rated knowledge of climate change is much lower than their strength of opinion about it. The table below summarises the mean responses collected from the Computer Assisted Telephone Interviews (CATI) and large group workshops (LG). The question asked "*How strongly do you agree climate change is an important issue for Australia*", where 1= strongly disagree, 4 = unsure and 7=strongly agree. Respondents were also asked to rate their knowledge about climate change where 1= no knowledge, 4 = moderate knowledge and 7= high knowledge.

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<sup>1</sup> Ashworth, P., Pisarski, A. & A. Littleboy. (2006) Social and Economic Integration Program Final Report: Understanding and incorporating stakeholder perspectives to Low Emission Technologies in Queensland. Pullenvale: Centre for Low Emission Technology. November.

**Table 1: Australians' attitude and knowledge to climate change**

	Jun, 2005		Jun, 2006		Jun, 2006		Feb, 2008		Mar, 2008		Jun, 2008		Nov, 2008		Feb, 2009	
	QLD		QLD		NSW		Youth		Brisbane		Melbourne		Perth		Adelaide	
	CATI		CATI		CATI		LG		LG		LG		LG		LG	
	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean
Support	893	6.2	900	6.2	900	5.6	29	7.0	60	6.7	47	6.6	62	6.2	131	6.5
Knowledge	893	4.2	900	4.2	900	4.3	29	4.9	60	4.4	47	4.3	62	4.2	131	4.6

The qualitative components of CSIRO's research confirmed that many Australians still have limited knowledge about the causes of climate change and what can be done for mitigation. For example, many do not understand the difference between the hole in the ozone layer and global warming, or the links between energy consumption and CO<sub>2</sub> emissions etc. When engaged in discussion about the topic, they often become quite concerned and depressed about the enormity of the problem, however through the process of discussion, recognise that there is a role for government, industry and themselves in addressing the issue. The developed versus developing world conundrum also featured heavily but most agree that Australia has a responsibility to develop cleaner options for energy generation that can also be deployed in the developing world.

### Support for the range of energy technologies

Overwhelmingly, the Australian general public shows strong support for Australia's energy to be generated from renewable energy forms, in particular solar power, followed by wind. They are less tolerant of fossil fuel based power, although during workshop discussions, their understanding of the need for time to transition from a predominantly coal based power supply to a more sustainable energy system increases. This alone highlights the value in engaging Australians in discussion about the topic. Interestingly, the results from the youth workshop indicate the 18 - 25 age group are far less tolerant of any time for transitioning and would like to see an immediate change to low carbon options that do not involve generating power from fossil fuels, despite the costs involved. Australian's are also reporting a lower tolerance for nuclear energy, although many are indicating an uncertainty about the technology and there was a slight positive shift in some of the workshops as a result of the workshop process and discussion. The following table summarises the range of support for each of the low emission technologies, either through the CATI or from the beginning (without any information) to the end of the day long workshop on the topic.

**Table 2: Australians' support for the range of energy technologies? <sup>1</sup>**

	Jun, 2005	Jun, 2006	Jun, 2006	Feb, 2008	Mar, 2008	Jun, 2008	Nov, 2008	Feb, 2009					
	QLD	QLD	NSW	Youth	Brisbane	Melbourne	Perth	Adelaide					
	CATI	CATI	CATI	LG	LG	LG	LG	LG					
Biofuels	-	-	-	<b>4.2</b>	<b>4.7</b>	4.9	5.0	<b>4.4</b>	<b>4.9</b>	<b>4.6</b>	<b>5.1</b>	<b>4.9</b>	<b>5.2</b>
(CCS)	4.5	4.8	4.7	4.0	4.1	4.1	4.4	<b>4.2</b>	<b>5.0</b>	4.4	4.6	<b>4.7</b>	<b>5.6</b>
Coal	-	-	-	2.3	2.3	2.9	3.2	3.3	3.8	3.2	3.5	<b>3.2</b>	<b>3.7</b>
Geothermal	-	-	-	5.5	5.7	5.4	5.5	5.1	5.1	5.3	5.0	<b>5.7</b>	<b>6.1</b>
Hydro	5.1	5.0	5.1	<b>5.1</b>	<b>4.3</b>	5.3	5.2	5.0	5.3	<b>5.8</b>	<b>5.1</b>	<b>5.5</b>	<b>5.2</b>
Nat. Gas	-	-	-	4.3	4.5	4.8	4.8	5.0	5.0	4.7	4.6	5.1	5.1
Nuclear	3.1	3.5	3.7	2.7	2.4	2.9	2.9	<b>3.1</b>	<b>3.8</b>	<b>4.2</b>	<b>4.6</b>	3.8	3.9
Oil	-	-	-	2.6	2.4	3.3	3.2	3.4	3.4	3.3	3.5	<b>3.2</b>	<b>3.6</b>
Solar	6.0	6.0	6.0	6.7	6.6	6.5	6.6	6.6	6.7	6.7	6.8	6.7	6.6
Wave/tidal	-	-	-	5.7	5.6	5.8	5.7	5.3	5.6	6.0	5.9	<b>5.8</b>	<b>4.2</b>
Wind	5.1	5.2	5.1	6.1	6.2	6.2	6.3	6.1	6.3	6.4	6.4	6.3	6.5

1: Attitude was measured as (1) strongly disagree, (4) unsure, (7) strongly agree

Note: Paired t-tests (p<0.05) were used to identify significant changes between before and after means scores, significant differences between the scores are marked in **bold**.

### Knowledge of the range of energy technologies

When asked to rate their knowledge of the range of energy technologies, responses varied considerably. As would be expected, more conventional forms of energy technology that have existed in Australia for some time, received higher self-rated knowledge than energy technologies which are starting to be considered in the

Australian context such as carbon dioxide capture and storage, geothermal, nuclear and wave/tidal. The results from the large group workshop also demonstrate the impact of the process on increasing individual's knowledge on the range of energy technologies. CSIRO is currently analysing a Time 3 survey and conducting follow up interviews to investigate the longitudinal effects of the process on individual knowledge and attitudes – whether these maintained over time. Our earlier research has demonstrated that once engaged in the topic, most individuals continue to research the range of options, make changes to their own energy consumption behaviours and talk to friends and family about what they have learnt.

Table 3: Australian's self-rated knowledge of energy technologies<sup>1</sup>

	Jun, 2005 QLD CATI	Jun, 2006 QLD CATI	Jun, 2006 NSW CATI	Feb, 2008 Youth LG	Mar, 2008 Brisbane LG	Jun, 2008 Melbourne LG	Nov, 2008 Perth LG	Feb, 2009 Adelaide LG					
Biofuels	-	-	-	4.1	5.0	4.2	4.9	3.3	4.7	3.6	4.7	3.8	5.0
(CCS)	3.3	3.4	2.0	3.0	4.9	3.2	4.4	2.6	5.1	2.8	4.8	2.9	5.1
Coal	-	-	-	4.4	5.5	4.3	5.0	4.1	5.5	4.2	5.0	4.4	5.4
Geothermal	-	-	-	3.3	4.9	3.5	4.6	3.1	4.9	3.3	4.7	3.7	5.3
Hydro	4.2	4.2	3.5	3.9	4.7	4.2	4.9	4.1	5.1	4.2	4.9	4.3	5.1
Nat. Gas	-	-	-	3.8	5.1	4.1	4.8	3.9	5.4	4.2	5.0	4.4	5.2
Nuclear	3.2	3.6	3.4	3.9	4.9	3.8	4.5	3.6	4.8	3.7	4.7	4.1	4.8
Oil	-	-	-	4.2	4.9	4.2	4.8	4.2	5.3	4.2	4.8	4.4	5.0
Solar	4.5	4.5	4.3	4.7	5.7	4.8	5.3	4.5	5.6	4.7	5.5	4.9	5.7
Wave/tidal	-	-	-	3.2	4.1	3.6	4.4	3.4	4.7	3.6	4.7	3.6	4.8
Wind	3.5	3.7	3.5	3.8	5.2	4.2	5.1	4.2	5.3	4.3	5.2	4.5	5.4

1: Knowledge was measured as (1) no knowledge, (4) moderate knowledge, (7) high knowledge

Note: Paired t-tests ( $p < 0.05$ ) were used to identify significant changes between before and after means scores, significant differences between the scores are marked in **bold**.

### Priority ranking of energy technologies

Participants were asked to prioritise how they would allocate funds to the range of energy technologies to accelerate their deployment in Australia. In this instance a low number indicates a higher priority and the results can range from 1 to 10. The results are consistent with individual support in that solar and wind are the most preferred sources of electricity. Coal, nuclear and oil tend to compete for the last position on the hierarchy.

Table 4: Prioritised ranking of preferred energy technologies for deployment in Australia

	2006 QLD		2006 NSW		Feb, 2008 Youth		Mar, 2008 Brisbane		Jun, 2008 Melbourne		Nov, 2008 Perth		Feb, 2009 Adelaide	
	Workshop Before	Workshop After	Workshop Before	Workshop After	LG Before	LG After	LG Before	LG After	LG Before	LG After	LG Before	LG After	LG Before	LG After
Solar	n/a		2.7	3.0	1.7	1.8	2.1	1.9	1.9	2.1	3.0	2.1	2.1	2.5
Wind	n/a		3.2	3.1	2.9	2.4	3.1	3.3	2.6	2.7	2.5	2.8	3.1	3.6
Wave/Tidal	n/a		n/a		4.3	4.6	4.3	4.7	4.4	5.3	4.4	4.1	5.2	6.8
Geothermal	n/a		3.8	5.2	4.2	4.0	4.9	5.2	6.1	6.7	5.5	6.1	4.8	3.8
Nat. Gas	n/a		4.7	4.6	6.6	6.2	6.5	6.0	5.6	6.1	6.6	6.4	5.8	6.0
Hydro	n/a		5.3	5.9	5.6	5.9	5.2	5.3	5.5	5.6	5.1	6.5	5.7	6.3
Biofuels	n/a		4.3	5.2	5.8	5.9	6.2	5.5	7.0	6.4	7.2	6.7	6.7	6.7
CCS	n/a		6.0	4.3	6.5	6.2	6.7	7.0	7.1	5.7	6.9	7.2	6.5	4.3
Coal	n/a		6.7	6.3	9.6	9.6	8.8	8.7	8.6	8.4	9.0	8.6	8.7	8.4
Nuclear	n/a		6.6	7.7	8.7	9.4	8.8	9.1	8.5	8.2	6.9	6.6	7.7	8.3
Oil	n/a		n/a		9.9	9.8	9.2	9.1	8.8	8.8	9.2	8.9	9.1	9.0

### Early phone survey results on nuclear

Drilling down into the results from the earlier CATI surveys, the question "Australia should consider using nuclear energy for generating electricity in the future" was the one issue which saw some shifts in opinion between survey

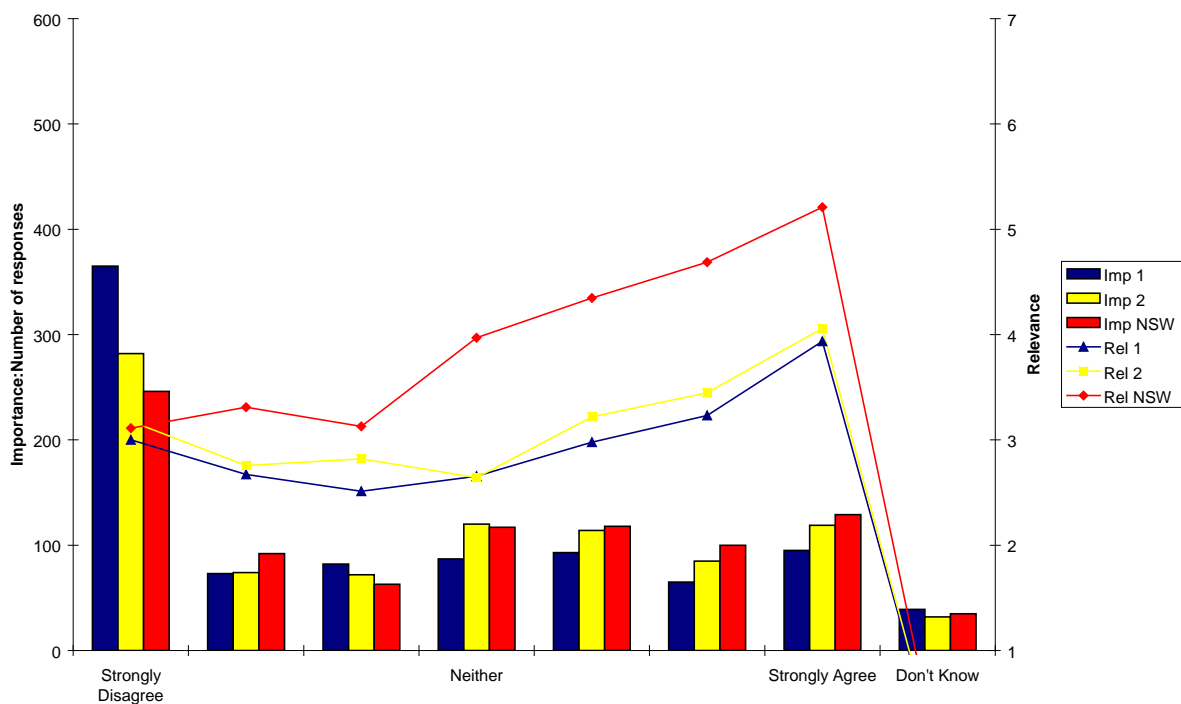
one and two in the Queensland results. The CATI survey was designed and analysed based on the “four degrees of opinion<sup>2</sup>”. The four degrees help to identify where individuals sit in relation to the issue based on their:

1. Direction: Is the opinion for or against the issue?
2. Degree/extremity: Is the opinion strong or mild
3. Saliency: What is the degree of personal interest?
4. Intensity: What is the degree of personal commitment?

Respondents were asked to rate their answers on a seven point scale where 1 is low and 7 is high. The responses to the question on nuclear are summarised in Figure 1 below where direction and strength of opinion is summarised as importance (Imp) and saliency was reflected in a question “How relevant is the use of nuclear energy in Australia to you?” and therefore reported as relevance (Rel). The figure reports the results from the first CATI (Imp & Rel 1), second CATI (Imp & Rel 2) and the New South Wales CATI (Imp & Rel NSW).

It shows that in the first survey (2005) respondents were almost two to one against nuclear power with 57.8% disagreeing and 28.1% agreeing. However, by survey two (2006) the numbers were 47.5% disagreeing and 35.5% agreeing. The biggest shifts in opinions seemed to move from being strongly polarised either for or against nuclear into the middle. The results suggest that this may have been a product of the increased media attention nuclear power received when the previous Government made announcements about nuclear energy and the prospect of increasing uranium mining and export in Australia. This coverage appears to have made the population more uncertain about this option, as well as increase its relevance to them. Similarly, in New South Wales (2006) opinions on this topic were strongly polarised. Thirty five people did not know the answer to the question. Of those who did respond, 40.1% agreed while 46.3% of respondents disagreed. Fifty nine participants did not know or refused to answer the question on relevance. However, relevance was positively related to agreement such that people who agreed rated the relevance of nuclear energy higher. Similar to other issues in the survey, people with stronger opinions (both positive and negative) tended to rate their own levels of knowledge higher.

Figure 1: Importance and relevance of nuclear power



<sup>2</sup> Zaller, J. R. (1982). The nature and origins of mass opinion. New York. Cambridge University Press.

Sub group differences which were significant (at  $p < .01$ ) included gender differences where males reported more agreement, higher levels of knowledge, and higher levels of relevance than females. In addition, people with higher levels of education report higher levels of knowledge and relevance. Participants in the 25-34 year old age group, or 55 years and older group were more likely to agree with nuclear energy than other age groups. When it came to employment types, people employed part-time, unemployed people, and people performing home duties were less likely to agree, and reported lower levels of knowledge than other groups. Participants with higher income levels were more likely to agree, and reported higher levels of relevance.

In New South Wales, a total of 1,634 responses were recorded to the open ended question about what individuals know about nuclear energy (Table 5). The largest single group of responses (40.6%) involved negative reactions including associations with weapons, risk of terrorist attack on nuclear facilities, and many non specific descriptions of "risk" or "danger". Other common responses mentioned problems with storage of waste (34.4%), the risk of leakage of stored waste (17.9%), positive reactions about the value, utility or safety of nuclear power (12.8%), and responses describing nuclear power as clean or having low emissions (12.3%). A sizable minority of respondents (14.1%) reported no knowledge of nuclear energy. These results reflect similar responses to the Queensland surveys as well.

Table 5: What do you know about nuclear energy?

Open ended comments	Frequency	Percent
<b>Negative reactions</b> – negative images, association with war/weapons, dangerous/hazardous, risk of radiation, possible terrorist target	365	40.6
<b>Waste</b> - Storage of waste, waste has long half-life	310	34.4
<b>Leakage</b> - Possibility of leakage	161	17.9
<b>Positive reactions</b> – a good idea, can be safe, we should use it, good alternative energy source, OK if used/controlled properly, good way to go in the future, not as scary/risky as some people think	115	12.8
<b>Clean</b> – no greenhouse gases, low/no emissions	111	12.3
<b>Efficient</b> – cost effective, low running costs, high energy production	80	8.9
<b>Expensive</b> – high set up costs	38	4.2
<b>Used in other countries</b>	34	3.8
<b>Supply</b> - Australia has abundant supply of uranium	20	2.2
<b>Portability</b>	12	1.3
<b>Legislation</b>	3	0.3
<b>Other</b> - technical descriptions of how power is generated, "used in medical applications", we have plenty of safer alternatives, "don't know enough"	258	28.7
<b>Nothing/Don't know</b>	127	14.1

Note: 2 people refused to answer; frequencies may sum to more than 900 because respondents could provide more than one answer.

## Changes in knowledge and opinions of nuclear energy technology

The results show that nuclear energy is one of the energy alternatives Australians are least informed about, this is partly because historically nuclear energy has not played a role in Australia's energy supply. More recently though, with the Australian Government's decision to expand uranium mining and the ongoing discussions of mitigation options, nuclear power has begun to gain more prominence in discussions about greenhouse gas mitigation and ways of securing Australia's energy supply.

Early (2005/6) dialogue with the public on energy technologies facilitated through three, three day Citizen Panel processes conducted in Perth, Melbourne and Newcastle generated technology preference rankings in which nuclear technology was rated lower than coal or oil. As indicated in Table 4, more recent data indicates that it competes with the others for least preferable. This raises questions about whether the heightened discussion and

debate about uranium mining, climate change and the potential role of nuclear power generation in Australian is leading to shift in perceptions.

More conclusive data are available from an analysis of the large group data presented in this paper. These data provide an indication of how people may change their knowledge and opinions of nuclear energy when provided with information and the opportunity to discuss the technology. On average, respondents reported a significant increase in how informed they were of nuclear energy technology by the end of the workshop. That is most respondents finished the process with a medium or moderately high level of knowledge. Findings presented earlier and below show that over half of the respondents initially report to be unsupportive of nuclear or unsure of their support. By the end of the workshop there were either small groups of people reporting a small increase in tolerance for nuclear or overall there was no real change in the group response. However, nuclear was only one of several technologies that was discussed and more often in such a workshop, participants tended to focus on emerging technologies such as carbon dioxide capture and storage and geothermal rather than more established technologies.

When asked to rank the funding priority for energy technologies after the workshops, nuclear energy was repeatedly ranked low, mostly in the bottom three, along with coal and oil. The questions and comments participants raised about nuclear energy technology demonstrate there are mixed sentiments surrounding the technology, including some pleas for government to consider the technology and others to leave it out of the mix. It appears to be a highly emotive topic for many participants.

**Table 6: Changes in level of support for nuclear energy technology from the beginning to the end of the workshop**

	Feb, 2008 Youth		Mar, 2008		Jun, 2008		Nov, 2008		Feb, 2009	
	Before %	After %	Brisbane	After %	Melbourne	After %	Perth	After %	Adelaide	After %
Strongly disagree	37.9	0.0	39.3	37.7	34.0	14.9	16.1	16.1	16.8	17.6
Moderately disagree	10.3	34.5	11.5	14.8	14.9	12.8	6.5	1.6	11.5	6.9
Disagree	20.7	27.6	4.9	8.2	2.1	12.8	3.2	8.1	6.1	10.7
Unsure	13.8	13.8	16.4	11.5	25.5	23.4	25.8	17.7	29.8	20.6
Agree	13.8	6.9	8.2	14.8	8.5	14.9	16.1	14.5	16.0	24.4
Moderately agree	3.4	17.2	13.1	4.9	8.5	8.5	14.5	24.2	12.2	15.3
Strongly agree	0.0	0.0	4.9	6.6	6.4	10.6	14.5	17.7	6.9	4.6
Missing responses	0.0	0.0	1.6	1.6	0.0	2.1	3.2	0.0	0.8	0.0
Total	100	100	100	100	100	100	100	100	100	100

Most of the comments in relation to nuclear energy acknowledged the challenges including the management of waste and the related stigma from previous nuclear incidents. Overall the findings indicate that even after learning more about nuclear energy the majority of the public still report to be unsupportive or unsure of the technology. Typical comments that arose in the workshops in relation to nuclear included:

- More research into nuclear power options is needed.
- Encourage full use of renewables and nuclear power.
- To government - please reconsider using nuclear energy.
- Nuclear is out.
- Nuclear scares me, so don't do it, but perhaps we should.
- Nuclear sounds like a good idea but there are so many disadvantages as well.
- There is a backlash against nuclear energy because of disasters.
- There is strong disagreement and strong agreement with using nuclear energy.
- If we sell nuclear products we have to buy the waste back.
- Chernobyl is a big issue – was it a conspiracy to spin anti-nuclear?
- Nuclear may be ok, if managed correctly and safe storage of waste (long-term). France is 80% nuclear.

## Key themes from the Australian general public

From each of the workshop discussions there are a number of key themes that arise. The most resounding theme is that the Australian general public would like to see a clearly defined path to action for a low carbon energy future for Australia. This includes the wish for the government to implement their proposed 20% renewable target as a way of prioritising renewable energy as part of the mix. The other resounding theme is the need for leadership at all levels of government to address the issue of climate change. Workshop participants recognise that it is not easy and that changes will have to happen over time, however their tolerance for inaction is waning. Education and communication at all levels was also seen as being critical if Australia is going to be successful in changing energy consumption behaviours to capitalise on early wins through energy efficiency.

In relation to nuclear energy it appears that the majority of the public still have relatively low levels of self-rated knowledge about the technology, but despite this their opinions are quite polarised. Given continued discussions about the expansion of uranium mining and also public discussion of nuclear energy as an alternative low emission technology, it appears timely to consider further research to explore public perceptions to nuclear energy in Australia.

For further information, please contact:  
Peta Ashworth, CSIRO  
T: 07 3327 4145  
E: [peta.ashworth@csiro.au](mailto:peta.ashworth@csiro.au)

## Further reading and information

CSIRO's social research program is extensive and for the purposes of this document we have only presented the results of attitudes towards large scale energy technologies. Under the Intelligent Grid project, which is investigating the value proposition for distributed energy there is a large body of research around the Australian public's willingness to accept distributed generation and demand side management initiatives as a way of managing peak demand and mitigating CO<sub>2</sub> emissions. CSIRO also has an ongoing research projects investigating the effects of information provision and dialogue on informing community attitudes. One significant piece of work is Energymark, a kitchen table approach to the climate change energy dilemma. Below is a list of reference materials which provides more information. Please note the large group process reports for each state are currently being finalised and should be released in the near future.

### Centralised Energy Generation

Ashworth, P., Pisarski, A. & K. Thambimuthu (2009) Public acceptance of Carbon Dioxide Capture and Storage in a proposed demonstration area. Special Issue: **Proceedings of the Institution of Mechanical Engineers, Part A, Journal of Power and Energy**

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### Distributed Energy References

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Gardner, J. & Ashworth, P. (2008). Towards the intelligent grid: A review of the literature (pp. 283-308). In P. Droege (Ed.), **Urban Energy Transition: From fossil fuels to renewable power**. Oxford, UK: Elsevier

Gardner J., Ashworth, P. & S. Carr- Cornish. (2008) The Australian Public's Willingness to Accept Distributed Energy Technology. **International Solar Cities Conference, Adelaide**. February.

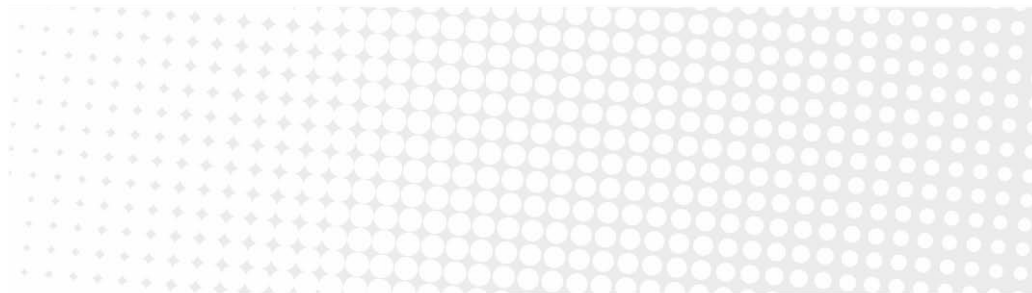
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### Contact Us

Phone: 1300 363 400

+61 3 9545 2176

Email: [enquiries@csiro.au](mailto:enquiries@csiro.au)

Web: [www.csiro.au](http://www.csiro.au)

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