

Queensland Consumers' Willingness to Pay for Electricity from Renewable Energy Sources

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ABSTRACT

In this paper, the results of a survey of Queensland households regarding their willingness to pay for renewable energy and support of the Federal Government Renewable Energy Target (MRET) policy are presented. Using results from this survey the perceived benefits to consumers' of the electricity generated from the renewable energy is analysed.

Survey results suggest that many respondents are willing to pay for green energy in general, while some of them are willing to pay for the benefits of future generations. Furthermore, the results suggested that some respondents are willing to pay for renewable energy for the reasons other than decreased air emissions. The results showed that the respondents holding the perception that a particular electricity generation technology does negatively affect the environment had a significantly different WTP compared to respondents holding the perceptions that the technology does not negatively affect the environment. Finally, consumers are willing to pay significantly more if voluntary payments were made possible compared to the Mandatory Renewable Energy imposts.

This is always a possibility with stated preferences that survey results may overstate actual willingness to pay. However, the results still provide a valuable insight on consumers' preferences. The results indicate that a more effective renewable energy policy reflecting these preferences can be put in place. In sum, the results suggest that consumer driven purchases can, in part, support the future of renewable generation capacity in Queensland, though reliance upon other policy alternatives may be needed.

Introduction

The possible threat of global warming has led to policy reforms focusing on emission reductions to be proposed and implemented in some countries. The electricity sector contributes a significant proportion (33%) of Australia's total greenhouse gas (GHG) emissions due to Australia's reliance on generating electricity mainly from coal¹ (AGO 2000). In Australia in 1999/2000, coal accounted for 94% of electricity capacity in Queensland, 98% in NSW, 97% in Victoria and 70% in Western Australia. The states of NSW, Victoria and Queensland accounted for nearly 81% of total electricity consumption in 1999/00 (ESAA 2001). The share of electricity generated from renewable energy technologies in Australia totals to about 10% and is mainly from large hydro. In 2001, Queensland has installed capacity of 500MW of various renewable energy technologies, which is about 5.4% of total installed electricity generation capacity in Queensland (ESAA 2001). Since then, several new renewable energy projects started in Queensland, e.g. Rocky Point Cogeneration Plant built by Stanwell Corporation that uses bagasse, wood waste, and other biomass to generate electricity.

The cost of electricity production from the renewable energy technologies is usually much higher than the cost of electricity production from fossil fuels. An average cost of production of electricity from coal fired electricity generation technology is 24-36\$/MWh, from some

biomass – 24-70\$/MWh, from wind – 60-150\$/MWh, from solar – 120-750\$/MWh (Coombes and Corderoy 2000 and Taylor 1999). In 2004-05, in Queensland an average price of the electricity on the electricity market was \$29/MWh (NEMMCO 2005) that is much lower than the cost of electricity production from most renewable energy technologies. Therefore producers of electricity from most renewable energy sources need to receive a premium for their electricity in order to cover their costs of production.

To account for a negative environmental impact from electricity generation, the Mandatory Renewable Energy Target (MRET) policy (among others) has been implemented in Australia. The MRET policy is designed to increase the competitiveness of renewable energy technologies and increase its adoption and thus diversify the electricity technologies mix and reduce GHG emissions from electricity generation. The mandatory target is for a 2% increase in renewable electricity market share by 2010, growing from 10.5% to 12.5% of the total electricity production. The target has been translated into a fixed electricity requirement of about 25,500 GWh (or 9,500GWh increase) by 2010 (Renewable Energy (Electricity) Act 2000). This policy is a supply side measure. However, consumers of electricity might be willing to support such a policy, or if they are given a choice, to voluntarily buy green energy for their households and thus support electricity production from renewable energy sources.

Currently, consumption - based products are accredited under the National Green Power Accreditation Program. Such products offer a green energy electricity tariff to customers, with the size of the contribution directly related to electricity consumption. In some cases, customers can purchase a ‘unit’ of renewable energy at a fixed price that is based on average consumption. Almost all New South Wales, Victorian, Queensland, Western Australian, South Australian and Australian Capital Territory energy retailers now have at least one accredited Green Power product. In the contestable (deregulated) markets, all domestic and commercial customers can choose to buy a Green Power product offered by any retailer licensed in that state.

In 2004, Queenslanders were buying more electricity generated from renewable sources than people in other states. The quarterly report of the National Green Power Accreditation Program showed almost half of the 115,726 Australian households which bought "green power" during the period between 1 July and 30 September 2004 were in Queensland. Queensland had 49,390 green power domestic subscribers, almost the same as NSW (16,843) and Victoria (33,636) combined (Green Power 2004). If the awareness of the existence of the green electricity on the market can be judged by the number of households who are buying the green power, Queensland would be the state that is more aware about such product compared with other states in Australia. The greater awareness of Queenslanders of the existence of the green product (i.e. electricity produced from the renewable sources) compared with the rest of Australia makes them a good population to test what are the important variables that affect consumers’ willingness to pay for electricity generated from renewable energy sources. It can be assumed that since the green power is a familiar good for Queenslanders, the construction of the value for the renewable energy will not be a difficult task for them.

To elicit consumers’ values for different attributes of renewable energy, one must also understand the benefits of buying electricity from renewable energy sources. Electricity generated from renewable energy contributes to clearer air by offsetting carbon dioxide and other emissions from power plants that burn fossil fuels (e.g. coal, gas). It also helps to conserve non-renewable fossil fuels - oil, coal and natural gas. Boosting energy diversity is another important benefit associated with the electricity generated from renewable energy. An important feature of using renewable energy for electricity generation is that it supports local economies where renewable generators are located, creating jobs and increasing tax revenues in local areas.

Previous surveys (e.g. Roe et al. 2001) have indicated that consumers are willing to pay for emission reduction, but emphasized that they are willing to pay more for emission reduction if it is specifically related to greater use of renewable energy. This possibly indicates that electricity generated from renewable energy sources has values other than emission reduction. The questionnaire developed for Queensland asked respondents (on a Likert scale) to state their opinions for some of the attributes, such as emission reduction from electricity generated from the renewable energy now and in future, that people like the idea that electricity is produced locally and from different energy sources.

While consumer-driven demand for 'green labelled' electricity has bloomed in countries such as Sweden (Eikeland 1998), the potential for such change in Australia and Queensland in particular has not been fully assessed. Understanding consumers' willingness to pay higher prices to obtain electricity service with certain environmental characteristics is important for predicting the success of various energy generation technologies in a deregulated market and for helping regulators maintain an appropriate mix of renewable support policies. The focus of this paper is to provide some insight into Queensland consumers' demand for green electricity that promises emission reduction. The results from a survey designed to elicit consumers' willingness to pay for green electricity are presented.

Research Questions

Previous surveys (Rowlands et al, 2001; Roe et al, 2001; Batley et al, 2001 and Farhar 1999) have indicated that consumers are willing to pay for renewable energy. It is difficult to compare the results of these surveys because of the different methods used, different questionnaire design, different way of presenting information and sometimes different questions asked.

Roe et al. (2001) applied choice modelling and hedonic analysis² to the US green electricity market. The survey was conducted by directly questioning respondents from shopping malls in eight different US cities in 1997. Eight hundred and thirty five usable responses from 1,001 respondents were obtained (83.4% response level). Respondents were presented with randomly assigned information disclosure sheets of monthly price, fuel mix and air emission values and they were asked to choose which one to buy³. Roe et al (2001) found that many population segments are willing to pay particularly for the emission reduction due to the increased reliance upon renewable energy source not just for the emission reduction due to change in fossil-fuel mix.

Batley et al. (2001) studied WTP for the electricity generated from renewable energy in the UK. They also employed a survey, but a postal one. A random stratified sample of at least 0.5% of the households at ward level across the whole Leicester city was used. Following the pilot survey, 2,250 questionnaires were sent in 1997. The response level was 27.2% (similar to one obtained in the Queensland survey). Their results support the hypothesis that consumers are willing to pay more for green energy – 34% of respondents (from total 667) were willing to pay 16.6% extra for electricity generation from renewable energy sources. This indicated that willingness to pay is not high enough to deliver a 10% target of generation electricity from renewable energy in the UK.

Rowlands et al. (2001) estimated WTP in Canada, Ontario and found that 80% of all respondents (480) are willing to pay more for green electricity. Respondents were asked to select their preferred energy package given six different (fictional except one) options. The packages differ with respect to both price of the package to consumers and the resource used to produce electricity⁴. Of the 527 survey returned, 480 (or 91%) identified their preferred electricity provider. Eighty percent of respondents (383) were willing to pay more for green energy. The WTP in Ontario was a bit higher than in other studies – 50% of respondents were

willing to pay 15% and 25% of respondents – 25% extra for electricity generation from renewable energy sources. This was explained by the fact that Ontario has the worst air pollution in Canada (Rowlands et al. 2001).

Above mentioned studies indicated that there is a demand for the green energy. The correlations between willingness to pay for the renewable energy and gender, income, age, knowledge were reported. However, the models (Batley et al 2001) showed that income was not a good predictor in the model. Empirical studies also indicate the link between WTP for the electricity generated from renewable energy sources and knowledge of the causes of global climate change (Roe et al. 2001, Rowlands et al. 2001 and Batley et al. 2001). Greater knowledge of the causes and consequences of climate change, and increased information about emission levels from different types of electricity generation plants and pricing externalities can be important factors in consumers' decision making process. If consumers are placed in a position to be able to make informed choices about purchasing electricity from different sources, thus approximating a market with perfect information, then a socially optimum level of pollution will eventuate. Therefore, in the Queensland survey, the knowledge of some issues of environmental quality and the climate change has been operationalised in order to evaluate this theory.

The mentioned above surveys have been conducted in countries other than Australia (e.g. USA, UK, and Canada). The different socio-economic conditions might affect the applicability of these results to other countries, and to Australia (Queensland) in particular. Furthermore, Batley et al. (2001) indicated that WTP in one area within the country can differ from the national one. Therefore, it was important to conduct survey in Queensland to explore consumers' WTP for green electricity. The following research questions have been investigated in this survey:

Research Question 1: What is the level of willingness to pay (WTP) for electricity generated from renewable energy in Queensland? What are the main variables that influence willingness to pay, (i.e. knowledge of the causes of climate change and perception of the importance of the environmental issues). What are the socio-economic and socio-demographic characteristics of consumers of renewable energy, e.g. income, education, gender?

Research Question 2: What type of renewable energy technology, e.g. wind, solar, biomass, are consumers most willing to support?

Research Question 3: What is the preferred mechanism of support for renewable energy: voluntary or mandatory? Though a voluntary mechanism of supporting public goods³ create a problem of free-rider, consumers will have a choice of payments. On the other hand, the mandatory mechanism (e.g. the MRET policy) will make everyone to pay. It is expected to find more support among consumers to a voluntary payment.

Data and Method

This research employed the contingent valuation method to elicit monetary willingness to pay for renewable energy to estimate the value of the environmental attributes that are not priced by the market. Contingent valuation (CV) surveys need to be very specific about the nature of the good valued, the reference level of utility and the property rights, the conditions for provision of the good, the relevant prices of other goods and payment for it. In order to collect an un-biased data, the scenarios should be realistic, the payment vehicle should be appropriate, the survey instruments and collection method should be unbiased and the sample should be a representative from the relevant population (Mitchell and Carson 1989 and Hanemann 1994). These conditions are met in the Queensland study. The good to be valued in the Queensland survey was the value of electricity generated from renewable energy

sources. Respondents are familiar with payment for their electricity consumption; the construction of the value of the electricity from renewable energy is not a hard task for them.

CV methods usually employ either dichotomous choice or open ended approaches. The dichotomous choice approach has many advantages over the open ended approach, e.g. it is simple for respondents, it reduces the incentive for respondents to provide strategic responses (Hoehn and Randall 1987) and the method of employing “close-ended” formats rather than “open-ended” was recommended by the NOAA panel (Arrow et al. 1993). However, the decision was made in favour of using open-ended⁶ question for several reasons. Firstly, the past surveys results and the pilot survey indicated that there exists a wide range of bids consumers’ are willing to pay for the electricity generated from renewable energy. Consumers are willing to pay from zero to a hundred percent⁷ of their electricity bill as an increment for renewable energy (Roe et al. 2001 and Rowlands et al. 2001). For the Queensland survey, the decision was made to consider the offers of two major electricity retailers in Queensland (Energex and Ergon⁸) for green customers and to offer respondents a choice from \$0 to \$100 per quarterly electricity bill⁹.

Since the range of prices was from \$0 to \$100, the use of the dichotomous choice approach would require a very large sample size to cover all possible bids¹⁰ (Bateman et al 2001). On the other hand, there was no indication what range would be more appropriate in order to reduce the number of possible bids for the dichotomous choice survey.

Secondly, the good under the study (i.e. electricity generated from renewable energy) is well known to respondents since all of them use electricity and pay electricity bills. Therefore, it was assumed that the construction of the value for the electricity from the renewable energy sources would not create difficulties among respondents as it can be with some of the environmental goods that respondents are unfamiliar with.

Thirdly, dichotomous choice models can result in a biased price estimates compared to the open ended models due to the anchoring effects and therefore, higher starting offered bids can lead to a higher estimated willingness to pay (Green et al 1998 and Mitchel and Carson 1989). It should be mentioned that open-ended CV approaches can produce responses that can be considered too high to be reliable (Green et al, 1998). Finally, the last reason for choosing an open-ended question for this research was that this research is more exploratory and the very aim of this is to estimate what is an acceptable price range for renewable energy.

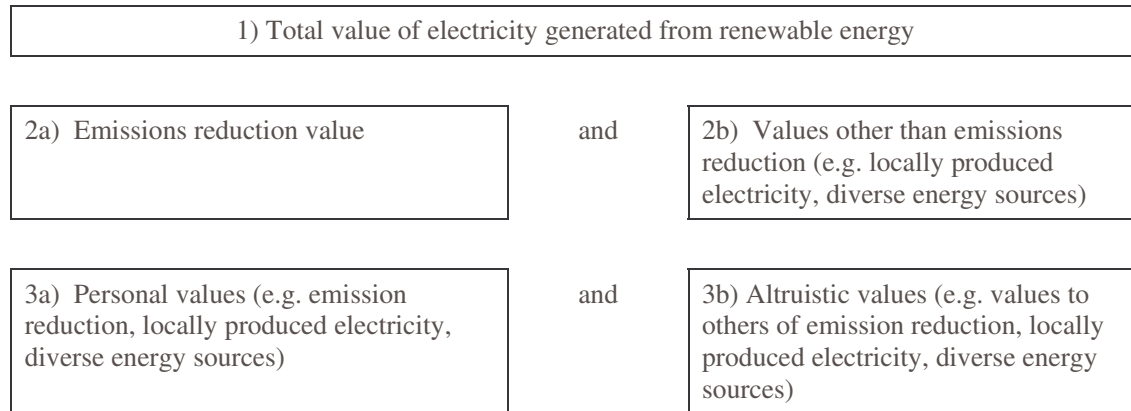
Two separate questions were offered to consumers in the survey (Question A (Q.A) and Question B (Q.B)¹¹). The question Q.A was asking how much respondents were WTP for electricity generated from renewable energy sources as suggested by the MRET policy (i.e. representing support for the policy) and the second question Q.B was asking about voluntary contribution to increase the generation of the electricity from renewable energy sources (i.e. representing voluntary support for the renewable energy). Respondents were asked to treat both scenarios independently.

The elicitation questions used a “ruler” format. It is a friendly format that saves space over the large table comprising a range of numbers design, and provides a continuous variable for data analysis. After the responses were received, the approximate answer was measured by the ruler and recorded. This format also allows respondents to indicate “protest” bids (e.g. zero payments).

Standard economic theory suggests that the total economic value of a good or service comprises of several components, such as use and non-use values. Applying the methodology of Mitchel and Carson (1989) to the evaluation of different values of electricity generated from renewable energy, the following values¹² are attempted to be captured by the questionnaire: 1) total value of electricity generated from renewable energy sources, 2a)

emissions reduction value, 2b) values other than emissions reduction, and values of electricity generated from renewable energy distinguished between 3a) personal value and 3b) value for other people (Figure 1).

Figure 1 Values elicited in the survey



Survey results

A simple random sample of 820 households from the entire Queensland population using Telstra's White Pages phonebook was drawn in August 2004 by the University of Queensland Social Research Centre (UQSRC). The first mail out was done in August with reminders sent in September. The total received usable questionnaires were 213. This included the questionnaire received from the initial mail-out (140 returned) and from the reminders (73 returned). The total response rate was 26%. Once the responses were obtained, the relationship between willingness to pay dependent variables and a range of independent variables, including income, age, gender, perceptions of environmental issues and knowledge of the causes of the climate change using regression analysis have been tested

Demand function using the open ended bids

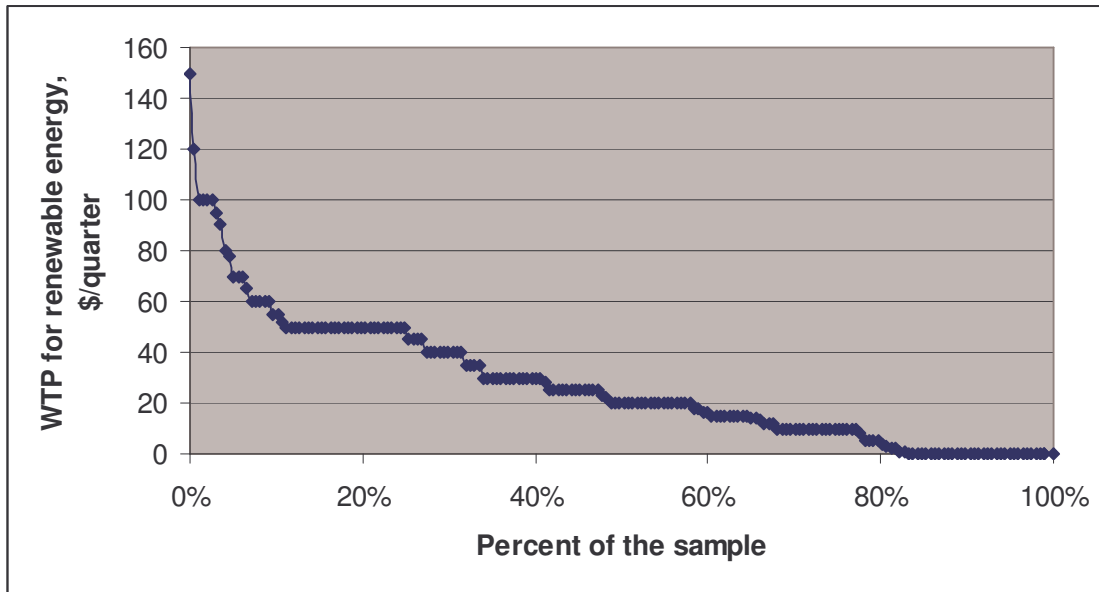
The estimated demand function using the open ended bids is presented in Figure 2. It shows that a very small proportion of respondents are prepared to pay high bid levels, but that as bid levels fall, support increases. About 30% of respondents are prepared to pay \$45/quarter extra on their electricity bills for renewable energy (the voluntary option).

The average bid for the voluntary option is \$27.99, with a standard deviation of \$25.86. The median bid is \$20. For the policy support, the average bid is \$21.95 (Table 1).

Table 1 Voluntary versus mandatory WTP for green electricity

		Voluntary: <i>How much more are you WTP for green energy</i>	Policy: <i>How much more are you WTP for 2% increase in green energy</i>
N	Valid	197	168
	Missing	16	45
Mean		27.99	21.95
Median		20.00	20.00
Std. Deviation		25.86	21.80

Figure 2 Demand function for the renewable energy (voluntary option)



Correlations between WTP for renewable energy and independent variables

The correlations between WTP for renewable energy and other variables have been examined. The results are shown in Table 2. WTP for renewable energy is found to be significantly correlated with education (correlation coefficient is 0.22), high income (0.22), age (-0.3), and attitude towards the environmental issues (0.23). The knowledge of the causes of the climate change and gender were not as good predictors for WTP for renewable energy. These correlation coefficients mean that the higher the education, the higher the income, younger people, people who regard other environmental issues as important and who knows what causes climate change are the more likely they will be willing to pay for renewable energy. For example, those respondents who are more educated are willing to pay 22% more for renewable energy than those who are less educated.

Table 2 Correlations among Voluntary WTP for green energy and independent variables

		WTP for green energy	Education	Age	Men	Knowledge	Family Income \$1200+	Issues
How much more are you WTP for green energy	Pearson Correlation	1						
	Sig. (2-tailed)							
	N	197						
Education	Pearson Correlation	.224(**)						
	Sig. (2-tailed)	.002						

	N	192						
Age	Pearson Correlation	-.296(**)	-.253(**)	1				
	Sig. (2-tailed)	.000	.000					
	N	192	202	208				
Men	Pearson Correlation	-.004	.010	.091	1			
	Sig. (2-tailed)	.958	.891	.193				
	N	195	205	207	211			
Knowledge of Climate Change	Pearson Correlation	.131	.144(*)	-.119	-.137(*)	1		
	Sig. (2-tailed)	.069	.039	.090	.049			
	N	195	205	206	209	211		
Family Income \$1200+ per week	Pearson Correlation	.222(**)	.304(**)	-.241(**)	.179(**)	.068	1	
	Sig. (2-tailed)	.002	.000	.000	.009	.326		
	N	197	207	208	211	211	213	
Environmental Issues	Pearson Correlation	.227(**)	.050	-.064	-.134	.558(**)	.044	1
	Sig. (2-tailed)	.001	.476	.361	.054	.000	.530	
	N	193	203	204	207	208	209	209

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

Voluntary payments versus policy support

The results of the CVM survey showed that consumers are willing to pay about \$22/quarter to support the increase in electricity generation from renewable energy sources in support of the MRET (10% to 12%). The mean for voluntary contributions to increase the generation of electricity from renewable energy sources was \$28/quarter, which is 30% higher than WTP for the policy for a mandatory increase of renewable energy generation in the electricity supply. It is not a surprising result, since an adverse reaction to most regulatory policies is well known. In some qualitative responses, people indicated that they do not trust that money

collected to support policy will be spending as intended. Also, consumers indicated that they feel that if they are buying renewable energy directly from the supplier, they directly reduce emissions. That is probably why people were willing to pay higher prices if they were given a choice of buying black or green electricity instead of supporting a policy aimed at the increasing market share of the green electricity in the electricity supply industry in Australia.

The implication for the retailers is that the mean price they can obtain for selling the renewable energy to a voluntary market is high enough (\$18/MWh¹³) to allow a retailer to buy renewable energy produced from some biomass. Electricity from wind and solar still needs to be subsidized by government in order to be competitive with electricity generated from biomass or fossil fuel.

The choice of renewable energy technology to generate electricity can also be crucial for the electricity generator, since the retailers will only buy electricity they can sell to the market. The research has shown that it is much easier to sell electricity generated from solar, and wind than from small hydro or wood waste. That is not a surprising result but confirming the expected attitude of the consumers. Almost 66% of respondents preferred to buy electricity generated from solar energy. This is an expected result, since solar energy seems to be perceived as the cleanest source of electricity. Large hydro is ranked second (11% of respondents). Wind is ranked third in the first choice of electricity from renewable energy sources. About 10% of respondents indicated that wind would be their first choice of electricity generation.

What are the benefits of electricity generated from renewable energy to consumers?

The results have shown that the perceived personal benefits from using electricity from renewable energy sources accounted for 30% of the total stated voluntary payments for renewable energy. The rest (or 70%) benefits can be attributed to the altruistic motives, such as benefits to other people including friends and future generations that will benefit if the current consumer is using electricity from renewable energy sources. This is a high percentage, indicating that people are concerned not only about their own personal benefits but also behaving altruistically.

The perceived benefits of emission reduction from using electricity from renewable energy sources accounted for about 40% of the total voluntary payments for renewable energy. The rest (or 60%) benefits represent benefits other than emission reduction, for example benefits from locally produced electricity, and from having diverse electricity sources. This is also a high percentage, indicating that renewable energy has more value to consumers than only emission reduction. Thus the policy makers were right stating that increasing of the market share of the renewable energy has only partly the aim on the emission reduction.

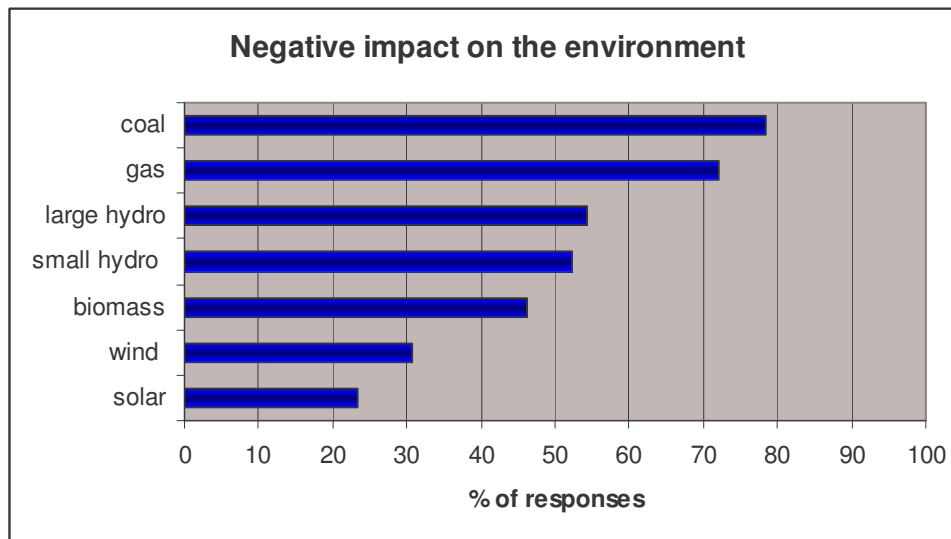
Most respondents indicated that they believe that RETs will reduce emissions now and in future. Therefore, the response rate from people who think that RETs will not reduce emissions now and in future is low. It, however, can provide some indication of how much willingness to pay for the electricity produced from renewable energy sources differ if respondents do not believe that RETs reduce emissions. The interesting result is that people who think that RETs will not reduce emissions now are still willing to pay the mean price of Au\$13/quarterly electricity bill. That probably indicates the monetary representation of the values of electricity generated from renewable energy sources other than emission reduction. However, if respondent thinks that using RETs will not reduce emissions in future, the mean price falls to Au\$1/quarterly electricity bill, indicating that the long term emission reduction is an important characteristic of renewable energy (Table 3).

Table 3 Descriptive statistics of voluntary WTP for renewable energy and perception that RETs reduce emissions now and in future

		N	Mean, \$/quarter	Std. Error
Voluntary: How much more are you WTP for green energy	RETs will NOT reduce emissions now	6	13.33	8.33
	RETs will reduce emissions now	125	32.86	2.42
	RETs will NOT reduce emissions in future	3	1.67	1.67
	RETs will reduce emissions in future	155	31.73	2.13
	RETs will NOT reduce emissions now	7	21.00	11.74
Voluntary: Personal benefits	RETs will reduce emissions now	116	31.24	2.42
	RETs will NOT reduce emissions in future	4	14.25	13.59
	RETs will reduce emissions in future	145	30.80	2.14
	RETs will NOT reduce emissions now	7	18.86	9.34
Voluntary: Emission reduction benefits	RETs will reduce emissions now	103	44.74	3.15
	RETs will NOT reduce emissions in future	4	14.25	13.59
	RETs will reduce emissions in future	131	43.27	2.77

Knowledge of the impact on the environment

Respondents were asked to indicate on a Likert scale whether they agree or disagree that electricity generated from particular source has a negative impact on the environment. “Strongly Agree” and “Agree” responses formed the “Negative impact on environment” category. “Disagree” and “Strongly Disagree” responses formed the “NOT Negative impact on environment” category. The responses from the “Neither Agree Nor Disagree” category were omitted. An illustration of the perception of the impact of various electricity generation technologies on the environment is given in Figure 3.

Figure 3 The perceived impact of electricity generation technologies on the environment, %

Almost 79% and 72% of respondents¹⁴ indicated that generation electricity from coal and gas respectively had a negative impact on environment. The generation of electricity from both small and large hydro electricity generation technologies was perceived as having a negative impact on environment by 52% and 54% of respondents respectively. Biomass, on the other hand, was seen as a cleaner energy source – only 46% of respondents thought that electricity generated from this type of technology would not negatively affect the environment. There were unexpected results about attitudes to wind and solar electricity generation. About 31% and 23% of respondents stated that electricity generated from wind and solar respectively would negatively affect the environment¹⁵. It may be a protest against large wind turbines that can create a visual pollution.

The perception of the environmental effect of electricity generation technology and the price respondents are willing to pay for renewable energy

The results have shown that respondents who perceive wind, solar, coal and gas as having negative impact on the environment, had significantly different WTP for renewable energy compared to those who perceive those technologies as not having negative impact on the environment. The mean WTP for wind and solar if person perceive them as green technologies are around \$30 for each technology (Figure 2). If a person for some reason considers wind or solar as negatively affecting the environment, they are willing to pay only around \$21 extra per quarter for electricity generated from renewable energy technology. Those who see producing electricity from coal and gas as negatives for the environment are willing to pay \$31 and \$34 respectively for renewable energy. However, if the person thinks that coal and gas electricity generation technologies do not affect the environment negatively, they are willing to pay for renewable energy at significantly lower prices: \$21 and \$18¹⁶ respectively (Table 4).

Table 4 Perceived ‘greenness’ and WTP for RETs

Technology		WTP for the electricity generated from a renewable energy technology	
		Perception of the impact on the environment :	Perception of the impact on the environment :
large hydro	Mean, \$	24.3	29.4
	N	68	80
	Std. Deviation	25.5	25.0
biomass	Mean, \$	28.2	27.7
	N	73	64
	Std. Deviation	25.7	28.0
wind	Mean, \$	30.5	21.5
	N	123	52
	Std. Deviation	25.0	25.9
small hydro	Mean, \$	28.2	24.4
	N	66	69
	Std. Deviation	26.8	23.7
solar	Mean, \$	30.1	20.7
	N	137	41
	Std. Deviation	26.8	21.4
coal	Mean, \$	21.0	31.3
	N	37	138
	Std. Deviation	23.4	26.7
Gas	Mean, \$	17.6	34.3
	N	39	100
	Std. Deviation	19.7	28.4

Model for willingness to pay for the renewable energy (voluntary)

Regression analysis was used to estimate several different bid functions of different functional form. On statistical grounds, SLR with the transformation of the dependent variable (square root) model was superior. The models with significant variables are reported in Table 5. Model 1 includes only the 4 socio-demographic variables, sex, age, education and income. In Model 2 the environmental issue concern and knowledge of climate change scales, and the post material values scale are added. The results indicate that the WTP for the renewable energy is influenced strongly by one’s age. Younger Queenslanders are more willing to pay higher prices for the renewable energy. Income is an important predictor in both models. Environmental issue concerns increase the propensity to pay for renewable energy, although the knowledge of climate change measure and education are insignificant at the 0.05 level. Finally, the R squared results also indicate that extended regression models ‘explain’ a substantially greater proportion of the variation in the WTP for the renewable energy. That means that inclusion of additional variable such as the environmental issues scale is important in order to model consumers WTP.

Table 5 Models for willingness to pay for the renewable energy (voluntary)

Model	1	2
Intercept	7.83**	3.46**
Men	0.39	-0.039
Age (years)	-0.043**	-0.041**
Tertiary Education	0.44	0.48
Family Income \$1200+	1.189*	0.97**
Environmental Issues ¹⁷	-	0.06**
Knowledge of Climate Change ¹⁸	-	-0.02
R Squared	0.12	0.20
n	(186)	(181)

* < .05 ** < .01

Source: Queensland Survey on Renewable Energy (2004).

Conclusions

This paper presents the analyses of Queensland consumers' willingness to pay for electricity generated from renewable energy sources. It provides insights into Queensland consumers' demand for green electricity and factors that affect it.

About 65% of the respondents indicated that they were willing to pay about \$22/quarter for an increase in electricity generation from renewable energy sources from 10% to 12% (as per current MRET policy). A higher amount (\$28/quarter) has been estimated if a voluntary payment could be made for the renewable energy. Comparison the results to the costs of the electricity generated from renewable energy technologies showed that there is some support of renewable energy from consumers side of the market but it is not enough to reach the current MRET policy goal. Understanding why consumers are willing to pay for electricity generated from renewable energy are important for policymakers to implement a renewable energy policy that is successful in increasing consumer-driven demand for green electricity.

Renewable energy provides more benefits for consumers rather than the emission reduction – only about 40% of the total voluntary payments for renewable energy were accounted for direct emission reduction. The rest being other benefits such as locally produced electricity, and diverse electricity sources. The high percentage (or 70%) benefits can be attributed to the altruistic motives, such as benefits to friends and future generations that will benefit if the current consumer is using electricity from renewable energy sources.

The results have shown that when people who perceive an impact of electricity generation technologies as negative to the environment, state significantly different WTP they are willing to pay for than those who perceive those technologies as not being negative for the environment. On his basis alone, the prices consumers are willing to pay can be in the range from \$18 to \$34.

The results of models have also shown that significant predictors are age, high income and environmental issues concern variables.

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- ¹ The electricity can be produced from a variety of energy sources, e.g. fossil fuel, such as coal and gas; and renewable energy sources, such as wind, solar, biomass, large or small hydro.
- ² Results were compared to the actual price premiums. Roe et al (1999) found that the survey results are likely to overestimate actual WTP. The difference between stated and observed willingness to pay can be large: despite of the high number of people stating that they would be willing to pay for renewable energy, less than 1% of eligible customers have signed on to Green Power in Australia, that accounts for approximately 0.2% of total sales (Passey and Watt 2002, p.5).
- ³ Three alterations in a service's environmental profile were used: a 1% decrease in emissions; a 1% decrease in emissions accompanied by a 1% increase in fuel mix from renewable energy sources; and 1% decrease in emissions accompanied by a 1% increase in nuclear power in fuel mix (replacing a decrease in fossil fuels).
- ⁴ The price increased by 25% for electricity generated from 100% renewables, 15% for electricity generated from 60% renewables and 10% for electricity generated from 20% renewables. For the option of increasing the share of fossil fuel by 30%, the price of electricity generation declined by 5%. The increase in hydro by 80% was accompanied by the price of electricity generation increase by 5%. The "same as now" option consisted of electricity generation from 50% nuclear, 30% large hydro and 20% fossil fuel electricity generation technologies.
- ⁵ The emission reduction from using more renewable energy can be considered as a public good.
- ⁶ Strictly speaking it is a close-ended type because the interval, although a very broad one (\$0-\$100), was specified. However, the respondents were presented with an opportunity to state any amount they were willing to pay.
- ⁷ One hundred percent increase in the electricity bill seems an improbably high amount for Australia. That would translate into about \$180/quarter.
- ⁸ Energex (2004) offers consumers to pay extra \$10-\$60 per quarterly electricity bill for electricity produced from renewable energy; Ergon (2004): more than \$120 per electricity bill.
- ⁹ The option of paying \$120 looks unrealistic for the majority of households. However, if any respondents were willing to pay more than \$100, the opportunity was available with the provision of an "Other amount" category. Another criteria for narrowing the payment options down was the use of pilot surveys. From 15 returned questionnaires no one respondent selected an amount higher than \$100 (in fact the amount consumers were willing to pay was considerable less than \$100).

¹⁰ The size of the sample size was limited due to the budget constraints.

¹¹ **“Question A.** Currently in Australia about 10% of electricity is generated from renewable energy sources. Under the Renewable Energy policy this will be increased to 12% by the year 2010. Please indicate on the line below how much **more** on top of your current **quarterly** electricity bill you would be willing to pay on a long term bases, e.g. more than five years, for this increase in electricity generation from renewable energy sources?
Please answer this question bearing in mind how much you are **able** to pay and place an “X” on the line to represent the amount.



If an **Other amount**, please specify how much _____ \$/quarter

Question B. The above questions were asked to determine how much you would be willing to pay to support a policy aimed at increasing the share of electricity generated from renewable energy in Australia. Now think about a different situation. Instead of having a policy, **you** are given a choice of buying electricity generated from renewable energy from retailers.

Assume that you have an option of buying 100% of your electricity from renewable energy sources. **Each quarterly** electricity bill will result in a reduction of emissions from electricity generation equivalent to **taking one car off the road for a year¹¹**.

Please indicate on the line below how much **more** on top of your current **quarterly** electricity bill would you be willing to pay for the electricity generated from renewable energy sources on a long term basis, e.g. more than five years?

Please answer this question bearing in mind how much you are **able** to pay and place an “X” on the line to represent the amount.”



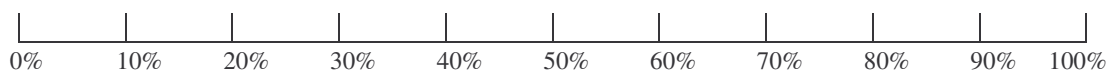
If an **Other amount**, please specify how much _____ \$/quarter

¹² The following question has been asked to capture this value:

Q9. On the line below, please indicate the percentage (approximately) of the payment in Question 8 that depends on **your personal** benefits from using electricity from renewable energy sources (e.g. emissions reduction, locally produced electricity, diverse electricity sources).

The remaining percentage will be assumed to represent the indirect value to you because **other people** including friends and future generations benefit if you are using electricity from renewable energy sources (e.g. emissions reduction, locally produced electricity, and diverse electricity sources).

Please place “x” on the line at that percentage



Q10. What percentage (approximately) of the payment you indicated in Question 8 depends on you and others (including future generations) benefiting **only** from emission reduction by using more electricity from renewable energy sources.

The remaining percentage will be assumed to represent the value of electricity generated from renewable energy sources that is different to the value of emission reduction.



¹³ Simple calculations have been used to derive \$/MWh.

Source	The MRET, 2% Voluntary
Average Qld household's electricity consumption, Enegrex (2004) MWh/year (1)	6.35

WTP for the renewable energy, \$/quarter (2)	Qld survey (2004)	22	28
WTP for the renewable energy, \$/year (3)= 4*(2)		88	112
WTP for the renewable energy, \$/MWh (4)= (3)/(1)		13.86	17.64

¹⁴ Respondents who stated their perceptions of the affect of the particular technology on the environment.

¹⁵ Information was not collected about why respondents viewed different energy sources as having negative impact on the environment.

¹⁶ These figures were derived by extracting the WTP for the electricity generated from the renewable energy technology for the person holding a particular perception of the affect of this technology on the environment, i.e. negative.

¹⁷ This scale was constructed from seven questions each of them asking whether the following environmental issue is an important issue for the respondent: climate change, soil degradation, noise pollution, wildlife destruction, logging of rainforest, water pollution and air pollution. The scale constructed from questions assessing knowledge of global climate change was reliable (Alpha 0.70), while the scale tapping environmental concern was highly reliable (Alpha 0.90).

¹⁸ This scale was constructed from four questions each of them asking about respondents' perceptions of what causes climate change: deforestation, motor vehicle emissions, burning coal and depletion of the ozone layer.