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Electricity consumers in regional Australia: social acceptance of coal-fired power and renewable energy

ABSTRACT

Purpose

The purpose of this study is to explore the concept of social acceptance and examine public opinions on climate change, renewable energy and fossil fuels in regional Australia. Understanding public opinion is critical given the need for governments to transition energy production away from fossil fuels and towards renewable energy in order to meet obligations under the 2015 UN Paris Agreement on Climate Change.

Design/methodology/approach

A survey was developed and respondents (n= 325) were recruited face-to-face in a regional city in Northern Australia. Data was then analysed using IBM SPSS 20 software. Frequency distributions, cross tabulations and non-parametric tests were performed.

Findings

Respondent-completed questionnaires reveal positive attitudes towards renewable energy. Overall, respondents agree that climate change is occurring and that society has a responsibility to act to minimise its effects. Surprisingly, consumers who support coal-fired power show strong support for renewable energy, despite being undecided on the climate change issue and not perceiving a connection between electricity usage in the home and climate change.

Consumers who are opposed to coal-fired power show low support for all fossil fuels, despite the fact that they will continue to underpin the Australian energy system for some time to come. In addition, demographic variables, notably gender and education, along with political affiliation, are associated with varying levels of support for particular energy technologies.

Limitations

The findings are based on a convenience sample of mostly urban North Queensland residents and hence is not fully representative of Queensland's population. The study is descriptive in nature and there is a need for explanatory research to validate key findings on demographics.

Implications

The research has several policy implications. The cost competitiveness of both solar and wind technology over coal-fired generation needs to be emphasised. Furthermore, altruistic appeals such as benefiting future generations may also be effective. Commercial marketing techniques may be useful in boosting support for emerging renewable energy resources, such as geo-thermal and fuel cell technology, amongst females. It is recommended that misconceptions about coal-fired power be addressed, for instance through community-based programs, if Australia is to make a transition to a low-carbon electricity market.

Contribution

This article represents an attempt to examine the attitudes of regional Australians towards a wide range of energy resources and show, by drawing on the literature on social acceptance, the key factors that underpin support for renewable energy.

Keywords

Renewable Energy, Fossil Fuels, Climate Change, Social Acceptance.

INTRODUCTION

The 2015 UN Paris Agreement on Climate Change has set challenging sustainable development targets (Burnes, 2017). One of objectives of the Paris Agreement is to hold the increase in global average temperature to well below 2°C above pre-industrial levels, and significantly reduce the risks and impacts of climate change (United Nations, 2015). If the UN's targets are to be achieved, then fossil fuels have to be substantially and rapidly reduced across the globe. The world's energy sector is, therefore, faced with a major problem: how to fulfil energy demand efficiently without harming the planet. Increasing concern is evident in the literature regarding the sustainability of current forms of energy generation: "*Scientists, politicians and macro-marketers alike have come to realise that most existing energy systems are unsustainable and that progress towards sustainability will require significant changes in the production and consumption of energy*" (Claudy, Peterson, & O'Driscoll, 2012, p. 324).

In 2017, just 12.1% of global electricity came from clean sources, and since carbon dioxide levels continue to rise, this means that investment in renewables has a long way to go (Solheim, Espinosa & Stieglitz, 2018a). While investment in new renewables varies across countries, there were sharp increases in investment in Australia in 2017, an increase of 147 per

cent, to $8.5 billion (Solheim, Espinosa & Stieglitz, 2018a). However, electricity is predominantly generated from fossil fuels in Australia (Djerf-Pierre et al., 2016). Often described as a 'quarry' economy (Mercer & Marden, 2006), access to abundant fossil fuels offers Australia a significant comparative economic advantage which is likely to pose a threat to an energy transition. For instance, research finds that when concerns about climate change conflict with economic concerns, economic concerns prevail (Christoff, 1998). The barriers posed by the coal lobby to an energy transition in Australia are well documented in the literature (Biggs, 2016; Edenhofer & Flachsland, 2013; Hall & Taplin, 2008; Muenstermann, 2012). Australia, therefore, faces a conundrum: while heavily investing in renewable energy could help it reduce carbon emissions, a transition away from coal is likely to have adverse implications for regional economies dependent on coal mining (Commonwealth of Australia, 2017a), as well as for energy security and electricity pricing (Commonwealth of Australia, 2017b). A recent report by the Australia Energy Market Regulator (AEMO) emphasises the need to retain existing coal-fired generation, as well as to plan for the closure of plants when they reach the end of their technical life. It is estimated that about 30 per cent of coal resources in Queensland will shut down over the next 20 years (AEMO, 2018).

Given the need for an energy transition, it is important to understand public support for coal-fired electricity vis-à-vis other supply sources. Such understanding is especially important in regional contexts where community expectations of the energy sector are changing. In Queensland, there has been a remarkable adoption of small-scale solar photovoltaic (PV) systems by households (Biggs, 2016; Sommerfeld et al., 2017a), with an estimated 30% of households having roof-top solar (Climate Council of Australia, 2017). Despite this signal of change, electricity generation is predominantly coal-fired in this state (Martin & Rice, 2012). Coal is the largest export industry in Queensland and there are plans to exploit significant coal resources in the West Queensland Galilee Basin, including the development of a large mine

(by the Indian Adani conglomerate) at Carmichael (Caldecott, Tilbury & Ma, 2013). There has been considerable opposition to the mining project, and prior to the 2017 state elections, the Premier of the Labour government announced a withdrawal of support for a loan to the Adani project (O'Brien, 2017). Public pressure can be an important factor driving government policy and hence it is important to understand public opinion on energy policy (Pietsch & McAllister, 2010).

A critical reading of previous literature relating to energy transitions reveals that only partial attention is paid to social acceptance, even though widespread public support is needed when developing large-scale energy infrastructures (Batel & Devine-Wright, 2015; Friedl & Reichl, 2016; Moula et al., 2013). Biggs (2016, p. 204) notes that while significant research has been done on the dominance of fossil energy and the challenge of driving renewable energy development in Australia, "*much of the research (academic and industry) is narrow and segmented, focussing singularly on technical, market or institutional barriers".* Scholarly focus tends to be on policy since it is seen as the 'engine room' for renewable energy development (Martin & Rice, 2012). According to Moula et al., (2013, p. 90), "*despite the studies on public attitudes towards renewable energy technologies, genuine understanding of the dynamics of public acceptance remains elusive*". The aim of this article is to report findings from a survey of regional Australians and examine attitudes towards a range of energy technologies that may support, or undermine, sustainability. We develop the literature on social acceptance further, by conducting comparative analysis on pro-coal and anti-coal groups of respondents and by examining key factors that drive support for various energy technologies. Very few Australian scholars assess consumers' attitudes towards a range of energy technologies in a single survey, which is a limitation in terms of understanding support for renewable energy overall (Stoutenborough et al., 2015).

LITERATURE REVIEW: RENEWABLE ENERGY TRANSITIONS AND SOCIAL ACCEPTANCE

Renewable energy transitions, as a narrative, refer to a transition away from fossil fuels, such as coal, gas and oil, in order to mitigate the effects of climate change (Araújo, 2014). Numerous studies conclude that system-wide transformations are required to grapple with climate change and move to a low-carbon energy system (Geels, 2012; Jacobsson & Lauber, 2006). Given that Australia's electricity sector is one of the most carbon-intensive in the world due to its reliance on coal-fired electricity (Byrnes, Brown, Foster & Wagner, 2013), a transition to renewable energy needs to be at the centre of Australia's climate change mitigation effort (Kallies, 2016). Along with the development of renewable energy, there are other ways of reducing emissions from the energy sector, namely energy saving and efficiency, switching to natural gas and CO_2 recovery (van Ettinger, 1994). As the energy market transforms, there is a critical need to understand the ways that consumers may respond to future energy policies and to the various energy technologies designed to achieve positive environmental outcomes. The following section presents a summary of the literature on social acceptance.

Social acceptance and public attitudes towards electricity sources

A social licence to operate – most simply described as community acceptance of a project – is increasingly recognised as necessary and beneficial to mining and other developments (Paragreen & Woodley, 2013; Prno, 2013; Walsh et al., 2017). Social licences can be granted by various stakeholder groups, and a licence from one group does not translate into approval from all stakeholder groups. For example, while a wide group of stakeholders, such as the state government, may find a project acceptable, non-governmental groups, local business and

community members, may be less accepting and withhold a social licence (Dare et al., 2014). The meaning, and application, of the social licence concept varies across energy industries (Hall et al., 2015). In studies of renewable energy, social acceptance appears to be the preferred term, and although this concept is yet to be adequately defined (Wüstenhagen, Wolsink & Bürer, 2007), it provides the conceptual background of this work.

Scholars conclude that acceptance of controversial energy technologies (i.e., fossil fuels, hydro and nuclear) is shaped primarily by perceived benefit, followed by trust in regulatory institutions and risk perception (Bronfman et al., 2012). In relation to mining, the perceived benefits of mining (i.e., general wealth, infrastructure, and employment) are positively related to acceptance of mining, and perceived negative impacts of mining (i.e., living cost, other industries, and the environment) are negatively associated with acceptance of mining (Zhang & Moffett, 2015).

There are several studies of public responses to large-scale energy structures such as wind farms (Batel et al., 2013; Batel & Devine-Wright, 2015), nuclear power (Spence, Poortinga, Pidgeon & Lorenzoni, 2010). Scholars suggest that social acceptance of renewable energy (RE) is influenced by perceptions of cost, economic impact as well as climate change beliefs (Moula et al., 2013). Most studies take a sectoral approach, i.e., focusing on a single energy technology such as solar or wind, with a few exceptions (Bronfman et al., 2012; Sütterlin & Siegrist, 2017; Truelove, 2012). There is increasing interest in community energy and how communities become engaged in energy projects (Dibb & Roby, 2018). The literature shows that consumers are strongly supportive of renewable energy (Devine-Wright, 2007; Dockerty, Appleton & Lovett, 2012; Stoutenborough et al., 2015; Sütterlin & Siegrist, 2017; Truelove, 2012; Warren, Lumsden, O'Dowd & Birnie, 2005). This is not surprising given that the perceived risks – personal, social and environmental - are low (Bronfman et al., 2012). However, Sütterlin & Siegrist (2017) find that when people integrate drawbacks into abstract and general evaluations

of renewable energy, this diminishes acceptance. Rising electricity prices have been a feature of the Australian marketplace over the past decade (Orton & Nelson, 2015), and when Australians are presented with generation cost data, support for RE decreases (Ashworth et al., 2012). There is considerable discussion in the literature on sources of community opposition to citing decisions, such as the NIMBYISM ('Not In My Back Yard') concept (Dear, 1992; Hall et al., 2013; Pidgeon & Demski, 2012), and this stream of literature draws on strong traditions of qualitative enquiry. However, 'place attachment' (i.e., emotional bonds that form between people and their physical surroundings) is increasingly seen as a more significant explanation for resistance to local development (Devine-Wright, 2009; Vorkinn & Riese, 2001).

A variety of personal (e.g., age, gender), social-psychological (e.g., environmental and political beliefs, knowledge and direct experience) and contextual factors (e.g., size of development, community collaboration) combine to shape public acceptance (Devine-Wright, 2007; 2008). For instance a study by Dowd et al., (2011) concludes that limited understanding of geothermal technology and various concerns (such as water usage and seismic activity instigated by drilling) affect social acceptance. Key factors are perceived environmental, economic and social impacts, as well as governance (i.e., the mechanisms for making permit decisions and the availability of transparent information) and demographic factors (Wang et al., 2016). A recent study shows that the level of social acceptance for wind power is contingent upon age, income, educational level and location of residence (Yuan, Zuo & Huisingh, 2015). Likewise, Dimitropoulos & Kontoleon (2009) observe that educational level is significant for local acceptability of wind-farm investment. Moula et al., (2013) conclude that there is a positive correlation between income and level of support for different RE technologies. However, there is no clear consensus with regard to how some socio-demographic factors are related to acceptance of renewable energy. For instance, an Australian study notes that people

who fall into the ‘renewables oriented’ segment are more likely to be on low to moderate household incomes, as well as female and employed (Carr-Cornish et al., 2011).

Acceptance of renewable energy technologies is associated with a high level of concern about climate change (Moula et al., 2013; Spence et al., 2010). Some scholars conclude that sections of the Australian public are sceptical about climate change (Fleming & Vanclay, 2010; Morrison et al., 2013) and that voters’ notional support for measures to address climate change does not extend as far as a willingness to pay higher energy bills (Bell & Hindmoor, 2014). In contrast, other studies demonstrate that Australians clearly believe that climate change is happening and a large majority are in favour of adopting a plan to reduce emissions and are willing to pay for environmental protection (Carson et al., 2010; Pietsch & McAllister, 2010). It is acknowledged that people who do not view fossil fuels as harmful, and who identify as ‘environmentally-sceptic’, can be some of the biggest supporters of renewable energy due to local economic benefits (Jepson et al., 2012; Slattery et al., 2012).

Political affiliation is seen as a consistent predictor of environmental concern (Jones & Dunlap, 1992; McCright et al., 2014; Van Liere & Dunlap, 1980) and scholars indicate that acceptance of renewable energy is associated with political affiliations (Karlstrøm & Ryghaug, 2014). For instance, people who support the Green Party in Australia tend to be concerned with climate change and environmental issues (Tranter, 2011) and are more likely to have a smaller carbon footprint and to purchase green products (Kahn, 2007; Kahn & Morris, 2009).

In summary, the topic of energy has generated a vast body of academic work, which is a reflection of its role in climate change and in the world economy. In contrast, studies on social acceptance have received much less attention. A review of the literature shows that there are multiple factors that influence social acceptance of various energy technologies, including perceived impacts, political beliefs, concerns about climate change and environmental harm, a sense of economic opportunism and socio-demographics.

METHODOLOGY

This article uses a quantitative research method, notably a survey, since surveys are commonly used to measure attitudes of the general public in the energy policy literature (see Stoutenborough et al., 2015). The research questions are as follows:

(1) What attitudes do consumers hold in relation to climate change and energy resources and do attitudes vary according to support for coal-fired power?
(2) Is support for renewable energy linked to political affiliation and demographic variables, such as age, gender, income and education?

Scales

A series of statements were developed to measure respondents' attitudes towards climate change and energy resources and the scales were informed by the literature. While several items measuring concern for sustainability were validated in earlier studies (Dunlap & Van Liere, 1978; Eagle, Hamann & Low, 2016; Eagle, Low, Case, & Vandommele, 2015), a few items were specifically developed to capture issues of relevance to Queensland. Attitudes were captured on a five-point Likert scale with anchor points 1 = strongly disagree to 5 = strongly agree. Socio-demographic measures included gender, age, income, home ownership, educational attainment, employment and industry employer. Respondents were asked to indicate what political party they generally supported, with the three major Australian parties specified, as well as 'other' and 'prefer not to say' options. The 'left-right' schema is a

traditional delineation in Australia politics and the major parties tend to follow this schema (Fielding et al., 2012).

Questionnaire development, sample, recruitment of respondents

Ethical approval was granted by the Human Ethics Committee at James Cook University (H6601). The survey was distributed in a regional city, Townsville, since its economy has links with mining. An intercept survey was conducted in key locations in the city, such as the main waterfront reserve, popular markets and major shopping centres. An online questionnaire link was emailed to participants who wished to complete the survey in their own time. Traditional face-to-face distribution methods were used to overcome potential biases in sampling that may be introduced in pure online surveys, such as access to those that are more technologically aware, well-off or employed in certain jobs (Curry et al., 2005). An incentive (the chance to win an Apple iPad) was used to encourage completion of surveys. A total of 362 people replied to the survey, but after data cleaning, a total of 325 usable surveys were analysed.

Frequency distributions, cross tabulations and non-parametric tests were employed, using IBM SPSS 20 software. When data is skewed, then the most appropriate statistical tests are non-parametric tests and they are commonly used in studies of consumers' attitudes towards renewable energy (Coleby, Miller & Aspinall, 2009; Halder, Havu-Nuutinen, Pietarinen, & Pelkonen, 2011; Liarakou, Gavrilakis & Flouri, 2009; Zyadin, Puhakka, Ahponen, Cronberg & Pelkonen, 2012). The Mann Whitney test was used here for testing the homogeneity between two groups (Field, 2013), along with the Bonferroni correction (Armstrong, 2014).

FINDINGS

The next section of the paper summarises the key findings from the survey.

Summary statistics

A profile of the sample is shown in Appendix A. The summary statistics are as follows: there are slightly more female (54.5%) than male respondents in the survey. Income levels are diverse. An estimated 13% have a total household income of less than $30,000. 17% report a total income of $30,000-$64,000; 20.4% are in the $65,000-$99,000 bracket and 31.8% earn more than $100,000. The remainder report 'nil' or 'do not know/prefer not to answer'. Data from the Australian Bureau of Statistics (ABD, 2016a) shows that the average disposable household income was $51,896 in 2016 (after tax and Medicare levies), so our sample is reasonably diverse. There are more home-owners (55.2%) than renters (39.8%) in the sample. The sample is well-educated, with 26.8% reporting a Bachelor's degree as their highest level of educational attainment. This is higher than average. Statistics show that 17% of the Australia's population has a Bachelor degree (ABS, 2016b). Respondents come from all age groups, with most (67%) aged from 20 to 49 years. Half the sample (50.8%) are in full-time employment and respondents work in a variety of industries. With regard to political identification, respondents who support the main parties are captured in the sample, although there is a large number of non-responses.

Climate change and energy-related beliefs

One objective of this research is to evaluate attitudes towards climate change and energy resources. Table 1 represents the results. The figures are mean values (where 1= strongly disagree and 5 = strongly agree). Another objective is to test whether attitudes differ according

to the level of support for coal. There is a small segment that supports coal in the energy mix (n=66, approximately 21% of the sample). A relatively large number of respondents indicate that they are 'opposed/strongly opposed' to coal-fired power (approximately 44% of the sample). A significant number of respondents are undecided about coal, with 114 ticking the 'neither support nor oppose' category (approximately 35% of the sample).

The pro-coal group rate the economic benefit of renewable energy lower than the anti-coal group, with the mean score above the neutral score. The anti-coal group score higher on items relating to the negative environmental impacts of coal, imprudent use of fossil fuels, belief in human-induced climate change, economic impact of RE and relative cheapness of solar photovoltaic power.

Statistical tests show that there are significant differences in attitudes between the different coal groups. There is strong evidence ($p < 0.001$, adjusted using the Bonferroni correction) of a difference in attitudes between the pro-coal and anti-coal groups (using the Mann Whitney test). Statistically significant differences are evident with regard to item 1, relating to use of electricity and climate change; item 2, on human-induced climate change; item 3, on investment in RE stimulates economic growth; item 4 relating to the price of solar; item 5 covering non-avoidance of fossil fuels; item 6, on environmental impacts of coal; item 7, on rapid use of fossil fuels; item 8, on responsibility to develop RE for future generations; item 9, on high levels of energy use impacting future generations; item 10, on Queensland being rich in RE and item 11, on fully exploiting Queensland's RE resource.

Table 1

Climate change and attitudes towards RE: comparision of pro-coal and anti-coal groups

Attitudinal Scale Item	Mean (n=323)	Neutral (n=114)	Pro-Coal (n=66)	Anti-Coal (n=143)	p (Mann Whitney)
1. There is no link between electricity used in the home and climate change	2.43	2.50	3.05	2.06	**.000**
2. Human-induced climate change is occurring at some level	4.19	3.96	3.76	4.57	**.009**
3. Investment in renewable energy is a means of stimulating economic growth	3.95	3.81	3.48	4.26	**.000**
4. Solar photovoltaic (PV) is the cheapest form of electricity	3.36	3.29	3.09	3.52	**.009**
5. Fossil fuels (i.e. coal, gas, oil) should <u>not</u> be avoided because they support the economy	2.74	2.96	3.48	2.24	**.000**
6. The environmental impacts associated with coal-fired power stations are often overstated	2.69	2.89	3.41	2.20	**.000**
7. We are using up supplies of fossil fuels (i.e. coal, oil, gas) too fast	3.89	3.74	3.56	4.15	**.000**
8. It is our responsibility to develop renewable energy for future generations	4.45	4.27	4.15	4.73	**.000**
9. High levels of energy use will impact future generations' standard of living	4.27	4.11	4.02	4.51	**.000**
10. Queensland is rich in renewable energy sources (e.g. solar, wind)	4.10	3.94	3.86	4.36	**.000**
11. Queensland's renewable energy sources (e.g. solar, wind) should be fully exploited	4.33	4.11	3.92	4.71	**.000**

Level of support for the technologies used to generate electricity

Frequency analysis illustrates the level of support for the various technologies used to generate electricity. Table 2 shows the percentages of respondents who support a particular energy source. The figures are mean values (where 1= strongly oppose and 5 = strongly support). Overall, there is strong support for the mainstream renewable energy sources, in particular solar and wind; there is support for all other forms of low-carbon electricity, apart from nuclear energy, and there is low support for fossil fuels such as coal, gas and oil.

There are significant differences in attitudes between respondents who support coal-fired power and those who do not (based on the Mann Whitney test), using the conservative Bonferroni-corrected significance level. Statistically significant differences are evident with regard to seven (7) energy sources, such as coal (U=.000; z= -12.30, p<.001); natural gas (U= 2,814.0; z= -4.742, p<.001); oil (U=1,351; z=-8.276; p<.001); solar (U=6,113; z=4.737, p<.001); wind (U=6,125; z=4.453, p<.001); marine (U=5.848; z=3.399, p=.001) and nuclear (U=2,926; z=-4.438; p<.001). The anti-coal respondents show strong support for some of the mainstream sources of renewable energy, with solar power getting the highest score (4.55) out of all fuel sources. In contrast to the anti-coal respondents, the pro-coal respondents show stronger support for some fossil fuels, such as natural gas (3.42) and oil (3.66). Nuclear receives the lowest score out of all fuel types and it is the least preferred source of electricity. No significant differences in attitudes are evident in relation to biomass, hydro-power, geothermal energy, fuel cell technology and battery storage.

Table 2

Support for technologies used to generate electricity: comparative analysis

Energy	Sample Mean (n=323)	Neutral (n=114)	Pro-Coal (n= 66)	Anti-Coal (n=143)	**p** (Mann Whitney)
Biomass	4.01	3.85	4.23	4.04	.251
Coal-fired power	2.63	Neutral (3)	Support (4.18)	Oppose (1.61)	**.000**
Natural Gas	2.98	3.26	3.42	2.54	**.000**
Hydroelectric Power	4.27	4.16	4.32	4.33	.525
Oil	2.72	3.02	3.66	2.05	**.000**
Solar	4.70	4.56	4.55	4.87	**.000**
Wind	4.62	4.60	4.30	4.78	**.000**
Marine Power	4.37	4.26	4.11	4.57	**.001**
Nuclear	2.55	2.70	3.11	2.18	**.000**
Geothermal	3.81	3.67	3.85	3.90	.419
Fuel cell technology	3.61	3.96	3.78	3.67	.477
Battery Storage	4.07	3.89	4.03	4.22	.093

Factors associated with the acceptance of electricity sources

Chi-square analysis is used to examine respondents' support for electricity sources and political affiliation. For this analysis, support for electricity sources (originally in a five-point scale) is collapsed into a three-point ordinal scale ('support', 'neutral' and 'oppose'). It must be noted that half of the sample ticked 'other' and 'prefer not to answer' when asked about political

affiliation, so the results have to be treated with caution. Table 3 shows the percentages of respondents who support a particular energy source.

Table 3

Support for energy technologies by political affiliation

Support for Electricity Sources	*Greens (n=33)*	**Political Affiliation** *Labour (n=62)*	*Liberal National (n=54)*	*Other/Not Stated (n=171)*	**Chi-square**
Biomass	63.6	77.4	75.9	74.2	χ^2 = 7.133, p = .309
Coal	6.1	16.1	40.7	18.0	χ^2 = 31.206, p =.000
Natural Gas	12.1	38.7	53.7	33.8	χ^2 = 22.918, p=.001
Hydro-electric power	87.9	87.1	94.3	83.4	χ^2 = 4.709, p=.582
Oil	9.4	28.3	50	18.5	χ^2 = 44.545, p=.000
Solar	100	93.5	98.1	97.5	χ^2 = 6.261, p=.395
Wind	100	95.2	92.5	93.8	χ^2 = 7.001, p=.321
Marine power	97	87.1	86.8	84.7	χ^2 = 16.174, p=.013
Nuclear	21.2	22.6	46.3	22.9	χ^2 = 18.204, p=.006
Geothermal	72.7	72.6	70.4	57.5	χ^2 = 15.376, p=.018
Fuel cell technology	60.6	49.2	57.4	49.1	χ^2 = 3.993, p=.678
Battery Storage	84.8	75.8	77.8	75.2	χ^2 = 8.845, p=.182

There is a significant association between support for fossil fuels and political affiliation. In relation to coal; only 6.1% of Greens support coal whereas 40.7% of Liberal National Party (LNP) or conservatives, support coal (χ^2 [6, 310] = 31.206, p < .001, Cramer's V =.224). Respondents who support natural gas tend to be drawn from Labour and the LNP (χ^2 [6, 309] = 22.918, p < .05, Cramer's V=.193). Respondents who support oil tend to be drawn from the

LNP (χ^2 [6, 301] = 44.545, p < .001, Cramer's V =.272). There is a significant association between support for nuclear power and political affiliation (χ^2 [6, 306] = 18.204, p < .05, Cramer's V= .172) and support arises from the LNP.

In terms of support for the renewable energy sources, respondents do not differ significantly in their support based on political affiliation, with solar and wind power receiving very high scores. There are two exceptions, however, and they relate to non-mainstream or emerging RE sources. There is a significant association between political affiliation and support for marine power (χ^2 [6, 305] = 16.174, p < .05, Cramer's V= .163 (weak correlation)) as well as support for geothermal energy (χ^2 [6, 309] = 15.376, p < .05, Cramer's V= .158 (weak correlation)).

Cross tabulations are useful in exploring whether demographic variables are associated with support for various electricity sources. Age and income[i] are not significant. Education (see Table 4) is significant in relation to support for oil (χ^2 [10, 306] = 19.910, p < .05, Cramer's V=.180) and fuel cell technology (χ^2 [10, 312] = 21.127, p < .05, Cramer's V=.184).

Table 4

Support for electricity sources by educational level

Support	**None**	**Year 10/12**	**Trade**	**Cert/Dip**	**Degree**	**Post-Graduate**	**Chi-square**
Oil	83.3	28.3	18.2	23.1	26.2	15.9	χ^2 = 19.910, p = .030
Fuel	83.3	31.5	50	56.8	50.6	59.4	χ^2 = 21.127, p = .020

3 cells (16.7%) have expected counts less than 5. The minimum expected count is 1.45.

6 cells (33.3%) have expected count less than 5. The minimum expected count is .40.

There is a significant relationship between gender and support for a range of energy technologies (see Table 5), notably coal (χ^2 [2, 318] = 7.460, p < .05, Cramer's V=.153 (weak correlation); nuclear (χ^2 [2, 315] = 19.050, p < .001, Cramer's V= .246); geothermal (χ^2 [2, 318]

= 14.566, p < .05, Cramer's V=.214), and fuel cell technology (χ^2 [2, 315] = 11.502, p < .05, Cramer's V=.191). More males than females support controversial technologies such as nuclear and emerging sources of energy.

Table 5

Support for energy technologies by gender

Support for Electricity Sources	**Gender**		**Chi-square**
	Males (n=145)	*Females (n=175)*	
Coal	24.3	17.2	χ^2 = 7.460, p = .024
Nuclear	37.5	16.4	χ^2 = 19.050, p = .000
Geothermal	75.7	55.2	χ^2 = 14.566, p = .001
Fuel cell technology	61.8	42.7	χ^2 = 11.502, p = .003

DISCUSSION

The purpose of this research is to investigate the relative support that regional Australians have for the various technologies used to generate electricity along with the factors that drive acceptance. Investigating the attitudes of citizens helps inform policy makers about the level of support that exists for electricity policies within their electorate. The development of renewable energy is a political issue, touching upon issues such as jobs, electricity pricing, climate change policy and environmental protection. Hence, policy formation is generally responsive to public pressure. To take a different perspective from the literature, this paper steps back from focusing on any single energy technology and instead asks – what level of support exists for renewable energy and fossil fuels, how do demographic factors and political

affiliation affect support, and finally how can policy makers use this information to influence public opinion?

Overall, our study demonstrates strong support for renewable energy, including highly specialised technologies such as battery storage, which is predicted to be a game-changer for intermittent electricity sources such as solar and wind technologies (Lior. 2012), and our findings are in line with the literature (Agnew & Dargusch, 2017; Dockerty et al., 2012; Stoutenborough et al., 2015). This support appears to be influenced by a belief in human-induced climate change, awareness of the impacts of energy use for future generations and perceived need to exploit abundant natural resources in the region. The literature highlights indicators of acceptance such as climate change concern, economic benefit, political beliefs and demographic factors (Devine-Wright, 2008; Carr-Cornish et al., 2011; Moula et al., 2013) and this study lends support to these perspectives. For instance, most respondents are inclined to agree with statements such as "human-induced climate change is occurring at some level" and "investment in renewable energy is a means of stimulating economic growth". This study shows that consumers discriminate between a range of energy technologies, with low support for nuclear, coal, gas and oil. These findings are not particularly surprising since these plants are complex chemical processing facilities that emit or produce toxic waste. In the case of nuclear power, the dread of a nuclear catastrophe is seen as an obstacle to wider public support (Ansolabehere & Konisky, 2009), and more so in the aftermath of the Fukushima nuclear disaster (Han, 2014; Kim et al., 2013). In addition, opposition to gas in regional Australia is linked to the rise of vocal pressure groups (Biggs, 2016).

This study focuses on two theoretically interesting sub-groups in the survey, respondents who supported coal-fired power and those who did not. The information gained from this comparative analysis should be useful when considering 'target' markets for marketing communications. The findings show significant differences in attitudes between the

pro-coal and anti-coal groups. For instance, the anti-coal group is more inclined to agree with the statement that "solar photovoltaic (PV) is the cheapest form of electricity." A recent report published by the United Nations concludes that while the cost of renewable energy technologies varies a great deal between countries, and within countries, in an increasing number of markets, solar PV and wind are the cheapest of all (Solheim, Espinosa & Stieglitz, 2018b). Likewise, analysis from Bloomberg New Energy Finance (2018) predicts that wind and solar will be cheaper than coal-fired generation in many countries by 2050. Hence, the cost competitiveness of the mainstream technologies should be emphasised if the sector is to maintain its social licence to operate.

This study finds support for coal-fired power amongst one fifth of the sample. This is surprising given that coal is a much-maligned industry. There is a substantial literature on the social, environmental and health impacts associated with coal mining on local communities (Lockie et al., 2008; Morrice & Colagiuri, 2013; Petkova et al., 2009; Zhang & Moffat, 2015). Coal is particularly rich in carbon, and the burning of black coal can produce more than twice its weight in carbon dioxide (Hong & Slatick, 1994). The environmental costs of electricity generation (especially for coal) are externalised, resulting in lower private, but higher social costs for fossil fuels, compared to renewable energy (Byrnes et al., 2013). The pro-coal respondents are not climate change sceptics but they appear unsure or unconvinced about the sustainability impacts of mining, manifested by the mean score of 3.41 (neutral) for the statement, "the environmental impacts associated with coal-fired power stations are often overstated". Hence, misconceptions about coal need to be addressed if Australia is to make a transition to a low-carbon electricity sector. Furthermore, pro-coal respondents are less likely to agree that the use of electricity is a contributor to climate change, which supports previous research on the 'disengaged' segment (Carr-Cornish et al., 2011). Hence, educational campaigns aimed at improving energy literacy may be warranted. Scholars are recommending

community-based programs as a way of stimulating communities to think about energy transitions and develop local solutions to global problems (Krumdieck et al., 2012). Whether awareness of the links between electricity use and climate change boosts acceptance of renewable energy amongst certain sections of the population remains to be seen. A study on community commitment to renewable energy revealed that people are more sensitive to local economic benefit rather than to global sustainability discourses (i.e. climate change) (Islar & Busch, 2016).

The pro-coal respondents support the development of renewable energy on selected sustainability criteria (despite being somewhat undecided on the climate change issue). They agree with several of the positive (and altruistic) aspects related to renewable energy development, in particular, responsibility to future generations; exploiting abundant renewable resources and dealing with the scarcity of fossil fuels. In addition, they are inclined to agree (with a mean score above neutral) that investment in renewable energy is a means of stimulating economic growth. As noted previously, this generalised support for renewables is in line with the literature (Stoutenborough et al., 2015; Dockerty et al., 2012) and scholars suggest that support for fossil fuels can co-exist with support for renewables due to economic gains (Jepson et al., 2012; Slattery et al., 2012). Hence, amplifying positive sentiment towards renewable energy should help build legitimacy for an energy transition in regional Australia.

Almost half of the sample (44%) identify as 'anti-coal' and furthermore, they are opposed to all fossil fuels, not just coal. This may be due to sustainability concerns. These respondents are more inclined than the pro-coal group to agree with the statement "we are using up supplies of fossil fuels (i.e. coal, oil, gas) too fast", suggesting that concerns about resource scarcity could drive acceptance of an energy transition. Studies highlight that social acceptance is contingent on people's perceptions of demand for electricity and need to counter domestic resource scarcity (Yuan et al., 2017). Opposition to fossil fuels, in particular gas, warrants

further investigation given that these resources are extensively utilised in Australia and diversity of supply is seen as crucial to energy security (Australian Government, 2015).

Our study examines the influence of political affiliation on social acceptance. Analysis shows that there is a statistically significant relationship between political affiliation and support for fossil fuels and nuclear energy. Studies show that acceptance of nuclear power (which is a low-carbon technology) is correlated with political beliefs (Devine-Wright, 2008; Tranter, 2011). Surprisingly, political affiliation is not associated with support for renewable energy, apart from marine power and geo-thermal energy. The cross-political support for nearly all forms of renewable energy conflicts to some degree with studies that associate political party membership with support for renewable energy (Cacciatore et al., 2012; Karlstrøm & Ryghaug, 2014). This study suggests that acceptance of mainstream renewable energy sources is now the norm and is no longer tied to 'left/right wing' voting patterns in Australia.

Despite the expanding literature on renewable energy, evidence of the impact of demographics on social acceptance is far from being consistent and conclusive to date. Hence, this study contributes to the literature. It shows that there is a significant association of gender with support for the more controversial and emerging energies technologies (i.e., coal, nuclear, fuel cell technology and geothermal), with females showing less support than males for these sources. A large-scale European study also reveals gender effects, with women being more in favour of coal, oil, wind than men, and less favourable towards gas, nuclear, hydroelectric, biomass and ocean energy (Balta-Ozkan & Le Gallo, 2017). Another study suggests that women are less supportive of geothermal than men (Polyzou et al., 2010), since women show more concern with the risks associated with new technologies than men (Siegrist, 2000) and environmental concerns exist in relation to geo-thermal energy (Dowd et al., 2011). Furthermore, a low level of acceptance for an energy technology tends to be linked to low levels of public awareness (Yuan, Zuo & Ma 2011), which may explain this study's finding in

relation to geo-thermal energy. Given that Australia has considerable hot rock/geothermal energy potential (Bahadori et al., 2013), a possible gender divide needs to be addressed. Hence, there is potential to use commercial approaches to achieve higher acceptance of new, energy-related initiatives. This study suggests a positive correlation between education level and support for fuel cell technology, which is not surprising, since education is commonly associated with better knowledge of technology (Sommerfeld et al, 2017b).

This study has its limitations. The sample, although diverse, is a convenience sample of mostly urban North Queensland residents and hence is not fully representative of Queensland's population. This study is descriptive in nature and there is a need for explanatory research to validate key findings, particularly in relation to the link between political affiliation, gender, education and support for various energy technologies.

CONCLUSION

The Paris Agreement envisages a world where global electricity is no longer skewed towards fossil fuels. A rapid transition towards renewable energy is required to keep the increase in global average temperature to well below 2°C above pre-industrial levels. This paper argues that since fossil fuels underpin the energy system in Australia, we need to understand public attitudes towards non-renewable energy sources as well as towards renewable energy. If support for fossil fuels is strong, and linked to climate-scepticism, then this could threaten the planet's sustainability. Underpinned by the academic concept of social acceptance, this empirical study examines people's beliefs and attitudes towards climate change, fossil fuels and renewable energy. The findings are promising. There is strong support for a range of renewable energy sources, in particular wind and solar; this support appears to be influenced by climate change beliefs and economic imperatives, and is no longer tied to 'left/right wing'

voting patterns in Australia. However, there are significant differences in attitudes between consumers who are in favour of coal-fired power and those who are not. The study found that misconceptions about coal-fired power exist, where respondents downplay its environmental impacts and fail to see a link between electricity usage in the home (predominantly coal-fired) and climate change. Education or community-based programs could help address misconceptions about coal-fired power and promote renewable energy, which is essential if Australia is to make a transition to a low-carbon electricity market.

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Appendix A

Profile of sample

Item		Percentage
Gender (n=321)	Male	45.2
	Female	54.5
	Other/prefer not to say	0.3
Age (n=321)	Under 20 years	5.3
	20-29 years	22.1
	30-39 years	22.7
	40-49 years	22.1
	50-59 years	15.3
	60 years or over	12.5
Work situation (n=319)	Full-time	50.8
	Part-time	9.1
	Seeking work	3.4
	Retired	6.3
	Home Duties	4.1
	Student	19.7
	Other	6.6
Industry	Retailing and wholesaling	6.5
	Electricity, gas, water or waste	0.3
	Education	19.2
	Mining	1.7
	Agriculture	4.5

	Manufacturing	2.1
	House construction	4.1
	Health Services	10.3
	Arts, sports or recreation	2.7
	Not applicable	28.5
	Other	19.9
Educational qualifications (n=317)	No qualification	1.9
	Year 10 or 12 certificate	18
	Trade Certificate/apprenticeship	6.9
	Certificate or Diploma	25.9
	Bachelor Degree	26.8
	Post-graduate degree	20.5
Total household income (n=314)	Nil	5.7
	Less than $30,000	13.1
	$30,000-$64,000	17.2
	$65,000-$99,999	20.4
	$100,000-$149,999	17.2
	$150,000-$199,999	11.1
	$200,000-$249,000	2.9
	$250,000-$299,999	0.6
	Do not know/prefer not to say	11.8
Housing ownership (n= 322)	Owned (by you) outright	25.8
	Owned (by you) with a mortgage	26.4
	Being rented/shared	39.8

	Defence Housing Australia	1.9
	Housing Services	1.6
	Other	4.7
Political affiliation (n=310)	Australian Greens	10.6
	Australian Labour Party	20

[i] The chi-square test indicated that there was a significant association between support for solar power and income (χ^2 [16, 311] = 38.295, $p < .05$, Cramer's V=.248) but the test was not valid given that 70% of the cells had an expected frequency of less than five. The result, however, could be treated as a preliminary insight into social acceptance.