

Public Perceptions of Onshore Wind Power: How Psychology and Sentiment Shape Australian Clean Energy

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Abstract

Onshore wind technology continues to proliferate across the world. As wind power grows, public perceptions have shifted in unforeseen directions. In Australia, local opposition to wind farms, originally based on protestations against visual impact, have shifted towards concerns about the low-frequency noise output of wind turbines, concerns at odds with scientific research. The manifestation of health fears is better explained by current research on the impacts of health-based misinformation presented by wind farm opposition groups. The role of risk perception is explored, with particular reference to issues regarding control and equity. Value systems and ‘cultural cognition’ are also discussed. The importance of low-carbon generation entails a close and motivated examination of the public perception of new technology, with the Australian energy landscape serving as a fascinating case study.

Introduction

Onshore wind power forces us to consider a difficult conundrum. Yuriko Saito wrote in ‘Contemporary Aesthetics’ in 2004 that ‘the turbines represent technology, which in general is regarded as incompatible with or incongruent in, a relatively uncultivated landscape setting. However by necessity, wind farms have to be located on open, unhindered lands. As a result, they are viewed as machines intruding in a garden, to borrow Leo Marx’s imagery’ [1]. Individual attitudes reign in this field, as this characteristic has been found to have the most influence in the aesthetic response to wind power [2]. Aesthetics remain a salient issue in the development of the technology; indeed, Australia Treasurer Joe Hockey declared he was ‘utterly offended’ by the sight of a development near the Australian Capital Territory, and Prime Minister Tony Abbott has expressed anxiety about wind farms ‘sprouting like mushrooms all over the fields of our country’ [3]. However, health issues now dominate discourse around public perception of onshore wind power in several large countries. Research highlights the shifting nature of public perception towards wind energy. Baxter *et al.* [4] write of their work on the highly-polarised issue of wind in Ontario that ‘though the literature suggests that aesthetic preferences best predict turbine support the key predictors in this study are: health risk perception, community benefits, general community

enhancement and a preference for turbine-generated electricity’. Devine-Wright describes a disconnect between an eagerly-professed desire for rapid renewable energy expansion in the United Kingdom, and the concerns of communities in which these technologies will exist [5].

As a component in a technologically diverse energy system, onshore wind power will play a role in the growth of modern energy technology. Wind and solar output cannot be despatched by the grid operator, but it can be accurately predicted [6]. Modelling can inform how we plan for the deployment of these technologies. In 2013, the Australian Energy Market Operator (tasked with ensuring the security of the National Electricity Market, an interconnected system on Australia’s eastern seaboard), performed a study examining a 100% renewable energy scenario in Australia [6]. They found a potential installed capacity of 26 500 MW of onshore wind power by the year 2050 (assuming moderate transformation speed and high demand growth). The authors of the study incorporate variability and geographical resource availability into their study, along with economic factors, including the predicted and current costs of the technologies.

Technical and economic simulations of renewable energy growth regularly, and problematically, neglect

the public perception of renewable energy [6]. Although these issues are more often situated within the domains of social science, psychology and politics, human reactions to the rapid proliferation of renewable energy are a major factor in the spatial and geographical viability of onshore wind energy. The public perception of wind farms is now more important than ever.

Rapid Changes

A large body of scientific research has established the impacts of the release of greenhouse gases into the Earth’s atmosphere. The Intergovernmental Panel on Climate Change recently released a report which states that ‘human interference with the climate system is occurring, and climate change poses risks for human and natural systems’ [7]. There has been substantial effort to seek alternatives to the burning of fossil fuels to generate electricity.

Harnessing the kinetic energy stored in the atmosphere has been a contributor to human prosperity for many centuries. Machines that used wind power can be traced back 1000 years, and the highly-recognisable Dutch windmills have existed since the 12th century [8]. The first electric wind turbine appeared on the American market in 1925, and the National Aeronautics and Space Administration built the MOD-0 in September 1975 – a 2 bladed research turbine with a power rating of 100 kW at 8 m per second [9]. By the early 2000s, wind turbine size (both in dimensions and capacity) had grown by a factor of 10 [8].

The first Australian wind farm was an experimental project consisting of six 60 kW turbines, built in 1987 [10]. Situated near the town of Esperance, the pilot project led to the construction of the Ten Mile Lagoon project in 1993, comprising nine Vestas 225 kW wind turbines. Ten Mile Lagoon wind farm sits off a coastal ridge 16 km west of Esperance. Another early wind power adopter was the Mawson station in the Australian Antarctic Territory of East Antarctica. The scientific research station acquires 70% of its energy needs from a 1 mW turbine, which was installed in 2003 [11]. Both Ten Mile Lagoon and the Mawson turbine sit far from population centres.

In Australia, wind technology was adopted at an increasing rate through the 2000s, with 206.7 mW installed in 2007, 355.9 mW installed in 2008 and 661.8 mW installed in 2009 [12]. In 2009, the then-Labor government changed Australia’s federally mandated (and rather modest) 2% ‘Renewable

Table 1 Installed wind energy in Australia, by state, 2013 [14]

State	Installed capacity, MW	No. of turbines	No. of projects
South Australia	1205	561	16
Victoria	939	454	13
Western Australia	491	308	21
New South Wales	282	170	9
Tasmania	310	124	7
Queensland	12.5	22	2
Northern Territory	0	0	0
Australian Capital Territory	0	0	0

Energy Target’ (RET) policy, to an ambitious yet feasible 20% of Australia’s forecasted demand in the year 2020 [13]. This was a target of 41 000 gWh. The energised scheme gave Australia’s onshore wind industry a boost. This can be seen in recent statistics from the Clean Energy Council, who put 2013 installed capacity at 3240 mW, broken down by state in Table 1 [14].

The RET scheme works through the creation of ‘large scale generation’ certificates for every megawatt hour of renewable energy output, which are then sold to retailers. Retailers surrender a specified quantity every year, ensuring Australia gradually increases the quantity of renewable energy in its supply. Coupling the scheme to energy output ensures wind energy developers build in productive locations with plentiful wind resource. Open landscapes unhindered by objects such as trees, buildings and rocks tend to allow wind to reach higher velocities than one might find in an urban environment or within a forest. This also means wind turbines are visible components of the landscape.

Bell *et al.* [15] identified a ‘social gap’ in 2005 (revisited in 2013), consisting of an inconsistency between publicly declared support for wind energy and strong local opposition. Hall *et al.* [16] considered this phenomenon in the context of Australian development, and identified four factors that seem to emerge: trust, the distribution of justice, procedural justice and place attachment. The authors write that ‘Without addressing these themes and engagement approaches in policy development, wind energy may not achieve the anticipated status as first and majority contribution towards achieving Australia’s RET’ [16].

Early Community Reactions

As necessarily visible wind turbines grew in number and size, public reactions initially took a familiar

form. Many people supported the technology, and perceived their presence as an improvement and that broad level of public support has continued. In 2009, Clean Energy Council polling showed 93% of respondents were in support of government renewable energy schemes [17]. ‘Essential Vision’ polling released in September 2014 shows that 60% of respondents want more emphasis on wind power, and 26% want the same [18]. These surveys incorporate a random sample of individuals across the country. As samples closer to operational or developing onshore wind projects are considered, public perception grows more varied and more complex.

In Australia, early opposition to wind projects was based on aesthetic complaints, and a small collection of environmental impacts. Opposition groups that grew in response to wind farm developments were known as ‘landscape guardians’. The name is a clear, evocative statement of principles. The template for ‘landscape guardian’ groups sprung from anti-wind farm sentiment that had emerged in Britain, specifically the ‘British Coastal Guardians’ [19]. As the prevalence of wind power grew towards the latter end of the 2000s, regional landscape chapters had formed in various locations across Australia. An interesting set of omissions from the written and spoken messages of ‘landscape guardian’ groups were the visual impacts of human activities from mining, coal seam gas extraction or the development of transmission infrastructure. Curiously, the national ‘Landscape Guardians’ were exclusively focused on wind farm projects, and their approach was intensely political. A segment aired on the Australian Broadcasting Corporation (ABC) current affairs program, *Four Corners*, saw the then-president of the ‘Landscape Guardians’, Randall Bell interviewed:

“Andrew Fowler: For Randall Bell and the Landscape Guardians, the battle against wind farms is no longer purely a scientific argument.

Randall Bell: It’s always political. It always was. I never got it until very late in life that it was always going to be about votes” [20].

The various chapters of the ‘landscape guardians’ likely impacted local perceptions of wind farms, but the extent of this is difficult to retrospectively estimate. However, the focus of anti-wind farm activism in Australia has since changed significantly. Relatively reasonable concerns, centred around changes to the landscape and the impacts of development on local

wildlife, were overshadowed by a surprising new campaign.

Invocation of Health Fears

The Waubra Wind farm was completed in July 2009. It sits 35 km north-west of Ballarat, in Victoria. During construction, opponents of the project posted advertisements in the local newspaper, the ‘Pyrenees Advocate’, warning of an illness they had termed ‘Waubra Disease’. Symptoms of the ‘disease’ were said to include ‘sleep disturbance, nausea, headache and increased heart rate, coming to a house, farm or school near you’ [19]. Rumours spread that the Waubra Primary School was to be shut down as a result of health fears over the wind project. These rumours were empathically denied by the school itself [19]. A group known then as the ‘Waubra Disease Foundation’ (later, shortened to ‘Waubra Foundation’) was created – primarily by members of Landscape Guardian organisations. All of the founding members had wind farm developments near their properties [21]. Several residents near the Waubra Wind farm were indeed complaining of health impacts. ABC national radio spoke to some in February 2010. One stated that ‘Within weeks of the last [turbines] being turned on I started getting headaches, started getting heart palpitations’. Another says ‘Mostly ear pressure, headaches, heart palpitations, high blood pressure’ [22].

This shift away from aesthetics and towards health fears was likely to have been inspired by a self-published book released in 2009, entitled ‘Wind turbine syndrome: A Natural Experiment’. In the book, Nina Pierpont, a physician living close to a planned wind farm in Malone, New York, details her claims that low-frequency and high-frequency wind turbine noise as directly responsible for the emergence of health complaints in people living nearby [23]. Documents obtained through Freedom-of-Information requests outline what the New South Wales health department saw of the research – they wrote that

“This ‘study’ is not a rigorous epidemiological study; it is a case series of 10 families drawn from a wide range of locations.....[this] work has not been properly peer reviewed. Nor has it been published in the peer-reviewed literature. The findings are not scientifically valid, with major methodological flaws stemming from the poor design of the study” [24].

Despite the flaws in the study, it served a springboard for the rapid spread of health concerns to several other countries, including Australia. Curiously, it has been observed that in English-speaking countries there is a greater propensity for the expression of health concerns in regard to wind turbines than in non-English speaking countries. For instance, a website established by wind farm opponents to list anecdotal reports of wind farm health impacts show a vast majority of reports in the United Kingdom, North America and Australia [25]. China, Germany, Spain and India share the bulk of the world's installed wind power capacity [26] but see relatively few health complaints on the website, suggesting there is more to the emergence of negative public perceptions of wind power than the mere presence of wind turbines.

A study by Professor Simon Chapman, Professor of Public Health at Sydney University, found no relationship between the presence of wind turbines and complaints related to noise and health impacts in Australia. 33 of 51 wind farms were found to have never been the subject of a complaint, complaints of health impacts were rare until 2009 and of an estimated population of 32 789 individuals living with 5 km of wind farms, there were a total of 129 complainants [27].

Several government bodies across the world have attempted to assess whether there is sufficient scientific evidence to provide a physical, noise-based explanation for 'wind turbine syndrome'. These investigations consistently return negative results. Professor Chapman has created a collection of meta-analyses that details the numerous times scientific investigation has failed to uncover any evidence for 'wind turbine syndrome' [28]. Most recently, 'Health Canada' has undertaken a large-scale epidemiological study, in collaboration with 'Statistics Canada', to evaluate the health impacts of wind turbines – the as-yet unpublished results state there is no link between wind turbine operation and self-reported sleep, illnesses and perceived stress and objective measures of stress and sleep quality [29]. The study incorporated a large sample size – 1238 households, alongside a wide variety of turbine types, but was rejected by wind farm opponents almost instantly after the preliminary results announcement.

In addition to distinct geographic variations, public perceptions of wind projects change over time. The Waubra Wind farm, once the subject of strong negative perceptions, saw something of a public-

perception turn-around in 2013. Local residents in the town of Waubra, along with Victorian environment groups, sent a 300-signature petition to the Waubra Foundation to stop using town's name (the Waubra Foundation refused; claiming that the name of the organisation was 'revered worldwide') [30]. The geographic and temporal changes in public perceptions of onshore wind power are significant, not just for wind but for all clean technologies. The conversion of natural resource into energy necessitates machinery in open spaces, and as such, understanding the complex reasons for these discrepancies is an important venture for the future of clean technology.

Theory

Misinformation can, in and of itself, play a role in the emergence of symptomatic experiences. Research that examined media warnings about the health impacts of electromagnetic fields found that the likelihood of experiencing symptoms increases as one's exposure to these warnings increases [39]. This has been termed the 'nocebo effect' – something Professor Simon Chapman explores in his desktop analysis of Australian wind farm complaints [27]. Professor Chapman and I collaborated on a case study in which we found that the Cherry Tree development was immediately impacted by the presentation of health warnings of wind power, as expressions of concern and predicted health impacts dominated local news coverage [31]. Research conducted in New Zealand used real health warnings about wind farms that had previously been presented to communities considering wind farm developments, alongside exposure to sham and genuine wind farm low frequency noise exposure. This research determined that exposure to noise had little effect, rather, health warnings were found to be predictors of symptoms reports attributed to low-frequency noise [40, 41]. A recent paper published in 'Frontiers' summarised the evidence for the nocebo hypothesis, stating that 'Media stories, publicity or social discourse about the reported health effects of wind turbines are likely to trigger reports of similar symptoms, regardless of exposure....the same pattern of health complaints following negative information about wind turbines has also been found in other types of environmental concerns and scares' [42]. Health fears related to wind turbines have emerged in different technologies, and share many traits – research by Witthoft and Rubin demonstrate the impact of health warnings in media coverage of WiFi technology, for example [43].

Risk perception theory also plays a role in the emergence of health fears around onshore wind farms. Peter Sandman, a risk perception expert, has largely led this field. He identifies several factors that tend to lead people to overestimate the risk of a behaviour or environmental factor. Issues of ‘voluntariness’, ‘fairness’, ‘benefits’ and ‘controllability’ stand out as particularly relevant to the construction of wind farms [44]. Wind farm developers have focused heavily on the resolution of scientific questions, such as the energy payback of wind turbines or evidence for health impacts. The prevalence of risk perception themes is often missed. Research applying Sandman’s principles of risk perception to a mobile phone tower development in Sydney found 11 of the 12 components of community risk perception were applicable to the case study [45]. Video footage of community protests against the tower, based largely on health fears around the mobile phone tower, are starkly evocative of recent health concerns about wind power in Australia – as one concerned resident succinctly states in the footage, ‘I just don’t think they appreciated the depth of community feeling’ [46].

Government policy created with the intent of fast-tracking our technological response to the threat of climate change, can also play a role in skewed risk perception. Research published after the introduction of the Green Energy Act (GEA) in Canada found that ‘fright factors’ (triggers associated with skewed risk perception) increased significantly in media

coverage of onshore wind developments after the introduction of government legislation mandating wind farm development [47]. Other research directly implicates the GEA in ‘fuelling these perceptions of injustices in subtle and nuanced ways, particularly by acting as a major confounder to health risk concerns’ [48]. The impact of government policy on public perceptions of new technologies is often understated, and underexplored.

A simple, effective circuit breaker for the emergence of misperceived wind farm risks is the restoration of control and equity. Countries with high levels of community engagement and ownership have largely avoided the impassioned health fears seen in other countries. 40% of renewable assets in Germany are owned by individuals, as at 2010, shown in Fig. 1 [49]. The six turbine Coonooer Bridge wind farm in Victoria, Australia incorporates a sharing structure – the developer states that ‘Not everyone wants to live near turbines...we hold enormous respect for a community prepared to air and work through differences of opinion in a productive manner. We will continue to look for more ways to make this project a positive part of the local economy’ [50]. Health fears are not mentioned in media coverage of the project.

The importance of community ownership and engagement in the development of wind power cannot be overstated. However, new theories of science communication also have significant utility in understanding the best way to communicate established scientific

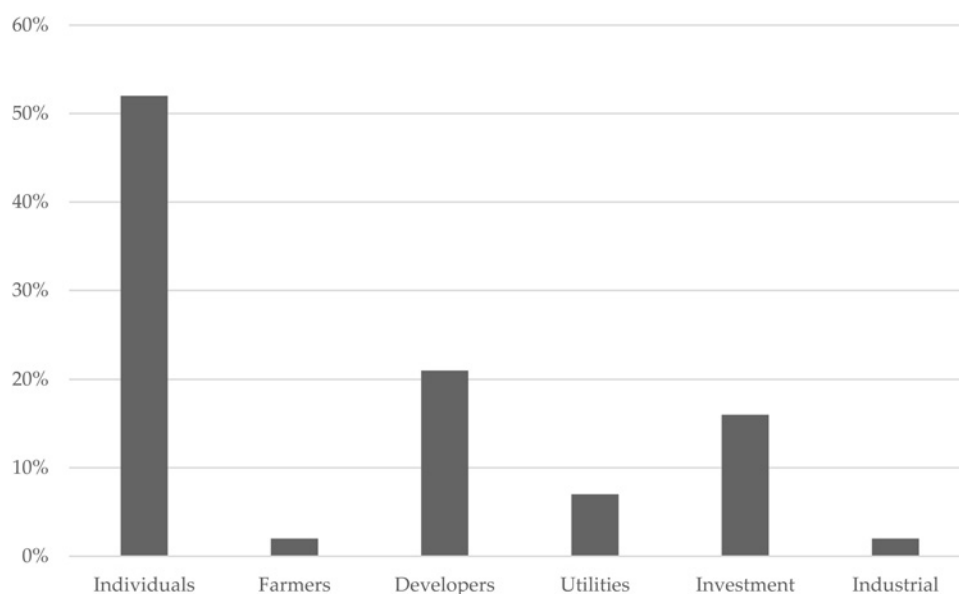


Fig. 1 Ownership of Germany renewable energy assets [49]

and engineering concepts about wind power, during the development process. A complex array of institutions and favourable social conditions can boost the transfer of knowledge around the experience of nearby wind turbines [51]. Given the spread of misinformation around health issues, and the power of this misinformation in the creation of anxiety and fear in communities considering wind farms, the simple presentation of scientific information is no longer sufficient. The 'Information deficit' model of science communication, which assumes those who express non-scientific beliefs are simply lacking information, is increasingly thought to be dangerously inaccurate [52]. Current and ongoing research, such as the 'Cultural Cognition' project at Yale University, suggests that we form risk perceptions congenial to deeply-held value systems, and information that contradicts these beliefs (no matter their scientific validity or lack thereof) can work to enhance them – something termed the 'backfire effect' [53]. The communication of scientific information to communities considering wind power, along with models of benefit sharing and community engagement strategies, are fraught with complexity, but new research is emerging such that engineers, scientists and developers might smooth the process of constructing new large-scale clean technology.

Conclusion

Among countries with differing dominant styles of wind power development, and at the level of individual wind projects there are stark differences in how local communities perceive the construction and operation of wind turbines. A variety of theories shed light on the factors that allow communities to develop a close relationship with the emergence of generation technologies that must necessarily be built in open spaces. In the early days, wind power was considered a threat to natural beauty. This can be mitigated and minimised through a close understanding of the factors that drive aesthetic perception.

In the past five years, a motivated campaign to spread health fears has risen to the fore – it now dominates discourse that would have otherwise been centred on impacts that are more tangible, and better supported by science. My own research [31] suggests health fears around this technology are catalysed by the introduction of health warnings, but also that some undercurrent of dissatisfaction is necessary for this effect to occur. An empowered and informed community, involved closely with decision making, can minimise this.

Public concerns are not specific to the size, shape or location of the technology – health fears related to low-frequency noise from wind turbines are as much a candidate for anti-wind farm campaigns as health fears related to electromagnetic radiation from large-scale solar facilities, despite both lacking supporting scientific evidence. Ironically, the generation technologies and fuel types we now heavily rely on, namely, fossil fuels, present risks that are underestimated by the public. The technology being deployed to lower the carbon intensity of our electricity systems is borne out of the hard work and ingenuity of many scientists and engineers. Those efforts risk being for naught, if they are not paired with concerted efforts to ensure the technologies are welcomed by the communities that must host them.

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Case Studies

The Cherry Tree Wind Farm Development

The Cherry Tree projects in Victoria illustrates the influence of external groups on community sentiment. When the project, owned by my employer Infigen Energy, was first announced, it drew little reaction from the local community. However, this situation changes significantly in 2012 when the local ‘landscape guardians’ group held a meeting at which the ‘Waubra Foundation’ attended. After this there was a rise in local objections on the grounds of health issues [31]. In response to the campaign against the wind farm, a local environment group named ‘BEAM’ established its own ‘myth-busting’ flyer in support of the project. The approval process for the wind farm ended up at the Victorian Civil Administrative Tribunal (VCAT), as the council delayed its approval process [32]. The VCAT process was drawn-out, with the majority of the hearing taken up to address health concerns – an interim order in 2013 saw a six-month hiatus pending more information on health impacts, though the project was eventually approved in late 2013 [33]. The local environment group has vowed to continue advocating for the project, demonstrating the importance of empowering local groups, in the face of outside involvement.

The Cape Bridgewater Wind Farm

The Cape Bridgewater Wind Farm in Victoria was completed in 2008 – it serves as a stark example of the importance of early community engagement. Prior to construction, the wind farm had been rejected by the VCAT, who stated in 1999

that ‘The principal issue for review centred upon the appropriate weight to be given to the benefits which would accrue from such a renewable energy facility compared with the dis-benefits in terms of the visual impact on the significant landscape values of Cape Bridgewater’. A group of local opponents led the campaign against the wind farm [34]. The controversy continued – the project was bought by international developer Pacific Hydro, and was submitted for planning approval. Strong local opposition continued, but this time the project was approved [35]. In 2015, local discontent lingers, but it manifests in a very different form. Several local residents claim to suffer negative health impacts from the project [36]. Repeated attempts by Pacific Hydro to investigate the noise output of the turbines have consistently turned up negative results. Recently, in an attempt to appease these discontented residents, Pacific Hydro agreed to them to select an acoustician to perform a study. The study spawned a long-running controversy, involving a raft of criticism of the study’s methods and results [37]. Since then, the author of the study has commenced defamation proceedings against a Sydney University academic who criticised the methodology, the research participants have commenced legal proceedings against Pacific Hydro, and the company has disbanded its Community Consultative Committee [38]. The components of successful community engagement are not simple; The Cape Bridgewater demonstrates that early community engagement is significantly more important than latent efforts.