RESOURCE ECONOMICS AND ENVIRONMENTAL SOCIOLOGY

Assessing Barriers to Renewable Energy Development in Alberta: Evidence from a Survey on Wind Energy with Rural Landowners

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Project Report #20-01

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UNIVERSITY OF ALBERTA
DEPARTMENT OF RESOURCE ECONOMICS
AND ENVIRONMENTAL SOCIOLOGY

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Table of Contents

Abstract 4
Introduction 5
Regulatory context and market conditions 6
    Provincial regulations 6
    Alberta’s renewable sector 8
        Wind farm development 9
    Adjacent markets 10
Identifying barriers to renewable energy development 11
    Social acceptability 11
        Perspectives on climate change and the environment 12
        Procedural and distributive fairness 14
        Institutions and trust 15
    Economic and policy context 17
    Environmental and technical challenges 18
    Summary of barriers 20
Survey research methods 20
Results 23
    Characteristics of the sample 23
    Energy beliefs 23
    Personal beliefs and norms 28
    Explaining support for wind energy procurement in Canada 34
        Support for further development of wind in Canada 35
        Support for wind energy procurement in Alberta 37
Discussion 41
    Social acceptability 41
        Perspectives on climate change and the environment 41
        Procedural and distributive fairness 43
        Institutional trust and governance models 44
        Concerns about wind infrastructure 45
        Perceived economic benefits 46
    Political and economic conditions 47
Conclusion 49
References 51

Tables

Table 1 Renewable capacity in Alberta as of August 2018 9
Table 2 Descriptive statistics for sample characteristics 23
Table 3 Presence of energy infrastructure on respondents' land and likelihood of installing renewable infrastructure if not present already.. 24
Table 4 Respondents exposure to wind infrastructure.. 25
Table 5 Understanding of the impacts of wind infrastructure (n=401) 27
Table 6 Levels of concern for a hypothetical nearby wind farm (n=401) 28
Table 7 Support for beliefs about the energy sector in Alberta (n=401) 29
Table 8 Trust in energy related groups or institutions (n=401) 30
Table 9 Descriptive statistics for personal and community norms (n=401) 31
Table 10 Opinions about energy business models (n=401).. 32
Table 11 Descriptive statistics on further development of energy sources in Canada 35
Table 12 Binary logistic regression predicting support for further wind energy development in Canada.. 36
Table 13 Descriptive statistics for statements about wind turbines.. 38
Table 14 Binary logistic regression predicting support for more wind turbines in Alberta 39

Figures

Figure 1 Map of rural landowner survey respondents in Alberta, Canada 21
Figure 2 Importance of alberta's energy sector to the respondent (n=401) 25
Figure 3 Knowledge of wind energy and turbines (n=401).. 26
Figure 4 Support for statements regarding environmentalism (n=401)...................................... 33
Figure 5 Support for statements regarding climate change (n=401)... 34

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Abstract

Despite having abundant wind resources, the Province of Alberta is slow to adopt wind energy. While recent provincial government initiatives have stimulated some new wind power projects, progress is limited, and with new regulatory changes in recent months, progress on renewable energy development may slow even further. What are the barriers to renewable energy development in Alberta? This report offers some answers to this question based on survey results from rural Albertan landowners (n = 401). The survey was implemented in early 2019 and offers insight into the perspectives of rural landowners who are in a position to host energy technologies on their properties. These technologies might include oil and gas wells but also emerging technologies such as wind turbines and solar panels. Within the report we explore key barriers to the adoption of wind energy infrastructure in Alberta. An energy market analysis and literature review reveal few technical barriers, as there is sufficient capacity in the southern region, where wind feasibility is highest. The published literature also points to economic barriers related to price uncertainty, the competitiveness of other energy sources, and policy instability. Looking more closely at social barriers, evidence from the survey indicates that landowners are sharply divided in their support for the further development of wind farms in the province. Many concerns stem from a lack of knowledge about wind infrastructure impacts, as well as issues with the procedures for implementing wind development and the distribution of benefits. Encouraging and facilitating future development of wind projects in Alberta will require that proponents highlight the environmental and economic benefits of wind farms and focus on providing benefits to local communities.

Introduction

Several studies find that Alberta has the natural assets and technical feasibility to support further renewable energy development (Banks, 2017, Barrington-Leigh & Ouliaris, 2015, Bell & Weis, 2009, Leitch, Hastings-Simon, & Haley, 2017, and Weides & Majorowicz, 2014). However, Alberta's renewable energy generation is low compared to the other provinces (Government of Canada, 2016, Government of Alberta, 2018, and National Energy Board [NEB], 2019a). Despite the importance and potential of renewable energy as part of a low carbon future, Alberta generated 11% of its electricity in 2017 from renewable sources (NEB, 2019a), significantly less than the national rate of 66% renewable generation (CER, 2020). Alberta's largest source of renewable energy is wind power, generated from turbines often built together at wind farms on rural land, producing roughly 5% of total electricity in the province.

Given this context, we seek to identify and document reasons for the slow uptake of renewable energy development in Alberta. Economic factors such as the price of renewable energy, and technical factors such as variability of energy from renewable sources like wind power are often cited as major barriers to renewable energy development. This report documents these barriers, but we also address other barriers in the social and political realm. Furthermore, we seek to understand how rural Alberta landowners perceive opportunities for renewable energy development. Rural landowners are of particular interest here because they are uniquely situated within the sites of energy productions. Historically, this production included coal, oil and gas development. With the onset of renewable energy technologies, these rural Alberta landscapes could also include wind, solar, geothermal, biomass and other energy technologies. In other words, rural landowners are at 'ground zero' for energy production and their views on renewable energy development will have major impacts on when, where, and how these technologies are developed in the future.

This report provides an analysis of energy market conditions in Alberta, a review of the published literature on barriers to renewable energy development, and results of a survey of 401 rural landowners in Alberta. In particular, we utilize descriptive statistics and regression analysis to answer the following questions: *What are the factors associated with rural landowner support and opposition to wind power in Alberta?*

In examining the conditions for wind energy development, we describe a range of barriers that are slowing the deployment of renewable energy in the province. We also point to several policy options for supporting renewable energy, based on insights from this analysis. In the following section, we examine the regulatory context and market conditions for energy development in Alberta.

Regulatory context and market conditions

Provincial regulations

In this section, we describe the regulatory framework and conditions for energy development in Alberta up to August 2019. Alberta's electricity market is deregulated, allowing private generators to participate in a competitive power pool. Subject to the approval of the Alberta Utilities Commission (AUC), any generator can connect to the grid, where the transmission network allows buyers to purchase the energy with Power Purchase Agreements (Alberta Energy Systems Operator [AESO], n. d. a, and Hastings-Simons, Kaddoura, Klonik, Leitch, & Porter, 2018). Independent Power Producers make competitive offers to sell their energy to the grid and receive a price at the intersection of electricity supply and demand on an hourly basis (Hastings-Simons et al., 2018). Smaller energy producers (under 5 MW) can develop projects under the Micro-Generation Regulation, allowing energy generation from renewable or alternative sources to offset the generator's use, as well as sell back excess power to the grid (Government of Alberta, n.d.).

Alberta is the third-largest producer of energy in Canada and trades electricity with British Columbia, Saskatchewan, and Montana (NEB, 2019a). In 2017, Alberta was an electricity importer (NEB, 2019a). The bulk of Alberta's energy comes from fossil fuel sources, with roughly 45% of electricity generated coming from coal and another 45% from natural gas in 2018 (NEB, 2019a). Despite having a number of legacy hydroelectric dams built in the 1900s, renewable electricity generation was quickly outpaced by fossil fuel energy development.

Under the New Democratic Party (NDP) government from 2015-2019, efforts were made to incentivize further renewable generation as part of the Climate Leadership Plan (Government of Alberta, 2018). A report for the Minister of Environment and Parks from the Alberta Climate Leadership Panel outlines the value of a renewable transition, describing employment opportunities, competitive energy generation (especially in conjunction with carbon pricing), compatibility with natural gas power production, and potential reductions to the wholesale energy price (Leach, Adams, Cairns, Coady, & Lambert, 2015).

The Government of Alberta established a goal of generating 30% of electric energy from renewable sources by 2030 within the *Renewable Electricity Act*, passed in 2016 (*Renewable Electricity Act*, 2016). To facilitate the development of renewable projects to meet this target, the AESO developed and implemented the Renewable Electricity Program (REP) (AESO, n.d.b). This program provides an Indexed Renewable Energy Credit, where the government pays or is paid the difference between the pool price for wholesale electricity sale and a bid price that represents the lowest acceptable cost for the renewable project (AESO, n.d.b). This program was designed to attract the most bidders by allocating the market price risk and opportunity to the Government of Alberta, providing revenue certainty for the renewable project owner (AESO, 2016a). In the first three rounds of the REP, 12 projects were selected to receive this funding, totaling 1,359.3 MW of renewable capacity to be operational by 2021 (AESO, n.d.c). The program was able to procure the lowest renewable electricity prices in Canada (AESO, 2019b).

In anticipation of introducing more renewable energy, the AESO has recommended a transition from an energy-only market structure to a capacity market structure (AESO, 2016b). Under a capacity market, generators are compensated for both producing energy and for providing capacity to produce energy (AESO, 2016b). This transition was recommended to ensure the system is reliable, provides stable revenue, drives innovation and cost discipline, and is adaptable to policy decisions (AESO, 2016b). The AESO determined that this transition would be required to accommodate the greater number of renewable generators being introduced by providing greater price stability and to incentivize investors to develop more renewable and natural gas projects because of the revenue sustainability (AESO, 2016b). However, critics of the program cited concerns about oversupply and higher prices. Current Energy Minister Sonya Savage stated that the energy-only market would provide more affordability and simplicity (Rieger, 2019).

As of 2019, Alberta saw a change in government to a United Conservative Party (UCP) majority government. At the time of writing, the UCP has cancelled the Renewable Electricity Program (Stephenson, 2019a), the planned capacity market transition (Rieger, 2019), and the provincial Carbon Tax (Bennett, 2019), potentially limiting further development of renewable energy projects.

Alberta's renewable sector

In describing the renewable energy market in Alberta, we draw upon primary data collected by our research team (Patel and Dowdell, 2018) as well as publicly available data from the AESO. Considering all operational projects in Alberta, the largest source of renewable capacity is wind, produced by wind turbines that dot the landscape of southern and central Alberta. The next largest source of renewable energy comes from hydroelectric dams along Alberta's rivers. Biomass energy generation contributes 16% of the total renewable capacity. Solar energy is a small portion of the renewable portfolio of Alberta, although this data does not include projects under 1 MW (Patel and Dowdell, 2018). Solar projects are the most common type of microgeneration project, with a total capacity of 43.5 MW in May of 2019 (AESO, 2019a).

Within Alberta, there are several wind and utility-scale solar farms in various stages of development, from initial planning to construction. A map of these projects has been created by a research team with Future Energy Systems, available online at: https://www.futureenergysystems.ca/resources/renewable-energy-projects-canada. Many of these projects, at the time of data collection, were in the process of competing for REP funding. However, with recent changes in government and an apparent shift away from renewable incentives, the completion of many of these projects is uncertain. Existing and proposed capacities for renewables sources are provided in Table 1.

Table 1 Renewable capacity in Alberta as of August 2018

Renewable Energy Source	In Operation (MW)	In Operation (% of total renewable capacity)	In Development (MW)	Total (MW)
Biomass	457.3	16		457.3
Hydroelectric	934.5	32		934.5
Solar	20.1	1	790	810.1
Wind	1485.2	51	3,314.2	4,799.4

Source: Patel and Dowdell, 2018

Wind farm development

While Alberta has the natural assets and feasibility to develop solar, hydroelectric, biomass, and geothermal energy production, wind energy presents a significant opportunity to generate renewable energy, as evidenced by the number of projects proposed for future development. Southern Alberta, in particular, has suitable capacity for wind power production (Bell & Weis, 2009). A study by Barrington-Leigh and Ouliaris (2015) evaluated a realistic scenario for wind development by examining sites with a wind speed of 7 m/s at 80 m above ground and excluded protected areas, Indigenous lands, a reasonable distance from population centres, and lands away from transmission lines. To account for competing land uses, environmental concerns, and unsuitable lands, it was assumed only 25% of the feasible lands could be developed. This analysis found that wind energy in Alberta could generate 169 TWh/year, 24% of Alberta's 2015 energy demand (Barrington-Leigh & Ouliaris, 2015). However, this is a conservative estimate, as the province has announced plans to add transmission capacity (AESO, 2019b) and increased economic competitiveness may result in a greater portion of the feasible lands being used for wind farms.

The construction of wind farms in Alberta falls under the jurisdiction of the Alberta Utilities Commission (AUC) (CANWEA, 2018). This commission applies the same environmental assessment rigor to all power plants, regardless of source. Alberta Environment and Parks also reviews applications and projects are required to abide by local municipal regulations (CANWEA, 2018). The AUC approval process also sets recommendations for consultation which may include the involvement of municipal leaders and locally affected landowners. All power plant projects over 10 megawatts are recommended to provide notification to residents within 2 kilometres of the project site and to do public consultation with all occupants, residents, and landowners within 800 metres. For projects between 1 and 10 MW, developers should notify occupants and landowners within 1,500 metres, but are not recommended to do any consultation (AUC, 2018).

Adjacent markets

Comparing Alberta's energy landscape to nearby jurisdictions provides context for Alberta's renewable energy sector. Alberta's renewable development is relatively lagging in comparison to British Columbia. In 2017, British Columbia generated 97% of its total electricity from renewable sources, the vast majority of which was from hydroelectric sources (NEB, 2019b). In contrast, Alberta's eastern neighbour, Saskatchewan, has an energy generation portfolio similar to Alberta's. In 2017, Saskatchewan produced 47% of its electricity from coal and 34% from natural gas. Saskatchewan has renewable generation targets higher than Alberta's, with a goal of having 50% of electricity produced from renewable sources by 2030 (SaskPower, 2017). Similar to Alberta, Saskatchewan recently approved several wind farms (NEB. 2019c). Unlike Alberta, both British Columbia and Saskatchewan have public corporations, BC Hydro and SaskPower respectively, that are responsible for the majority of energy production in their provinces (NEB, 2019b, 2019c).

Montana, Alberta's US neighbor to the south, also has a comparable energy landscape. Electricity wholesale and retail markets were deregulated in 1992 and 1997, allowing some consumers to choose their energy supplier. In 2007, the Montana Legislature reversed part of the deregulation act, resulting from a lack of competition for small-scale consumers and market volatility (Everts, Nowakowski, & Field, 2014). Electricity distribution and transmission are handled by either not-for-profit cooperatives, investor-owned public utilities, and one municipal electric utility. Energy retailers purchase energy from suppliers. Generation is provided by private and federal projects (Department of Environmental Quality, 2018). Montana exports 50% of the energy generated in the state (US Energy Information Administration (EIA), 2018). The majority of Montana's electricity (55%) is produced by coal power plants, likely a result of Montana having the USA's largest recoverable coal reserves. The next largest source of power comes from hydroelectricity (39.5%) followed by natural gas generators (2.7%) (US EIA, 2018).

Legislation requires energy suppliers to generate at least 15% of electricity sold in the state from renewable sources, which are defined to not include large hydroelectric dams (US EIA, 2018).

Montana's energy market is not dissimilar from Alberta's in many regards. Both jurisdictions have private energy generators and produce the bulk of their power from fossil fuel sources. Both jurisdictions also have significant fossil fuel extraction sectors. However, unlike Alberta, Montana is a significant electricity exporter.

Identifying barriers to renewable energy development

There is a long tradition in the social sciences studying questions of energy consumption, production, efficiency, and acceptance of new energy projects. The literature reviewed is focused in regions where considerable renewable energy exists, including Ontario, parts of the United States, and Europe. There is less information about the social context of renewable energy development in western Canada, partly because these technologies are relatively less developed.

Before we examine results from our survey of rural Alberta landowners, this section offers insight into the barriers associated with renewable energy development, and wind power in particular. In the following sections of this report, these barriers are compared to the conditions of Alberta's energy landscape and the findings of the provincial survey to determine policy, economic, and social barriers to renewable development in Alberta. The barriers to renewable and wind development are broadly categorised into the following themes: barriers to acquiring local social acceptability of wind farm operations, barriers to the economic feasibility of wind energy, environmental and technical barriers that complicate the development of wind infrastructure, and the policy barriers that affect wind development.

Social acceptability

In order to be developed without significant opposition, energy infrastructure projects require the general approval of people living in and around the project. The importance of social acceptability is highlighted in cases where local resistance has led to the cancellation of renewable projects in Canada's past, including a wind farm in Ontario, a run-of-river project in British Columbia (Shaw et al., 2015), and the Blue Highlands Wind project in Ontario (Jami & Walsh, 2014). In 2018, 758 renewable energy projects were cancelled in Ontario, the result of the newly elected provincial government fulfilling a campaign promise addressing public concern over rising prices and ineffective community engagement (Loriggio, 2018). Public resistance is often labelled or criticized as NIMBYism (Not In My Back Yard) (Devine-Wright, 2009). However, the academic literature suggests that public resistance is not necessarily inherent to renewable energy infrastructure, but is often a legitimate response to concerns regarding perceived fairness, mistrust in institutions, and dissonance with core beliefs and opinions. Factors that influence support for renewable energy projects identified in the literature are explored in this section.

Perspectives on climate change and the environment

Renewable energy is often promoted as a low carbon technology and valued as a method to maintain Canadian's energy-intensive quality of life while reducing carbon emissions. One of the primary benefits of renewable energy is to mitigate the impacts of the climate crisis by reducing greenhouse gas emissions. Therefore, if individuals are skeptical of climate science and the importance of climate action, they may struggle to see environmental benefits from renewable energy development. Kammermann and Dermont (2018) show that people who reject the idea of anthropogenic climate change also reject the need for clean energy transition. Research conducted in Germany finds climate change skepticism to be correlated with less enthusiasm for renewable energy (Engels, Hüther, Schäfer, & Held, 2013). This correlation was not very strong however, as even climate change skeptics were more likely to favour renewable energy sources over coal, oil, and nuclear energy (Engels et al., 2013). Hicks and Ison (2011) found similar results in their evaluation of community renewable energy schemes in Australia; some of the renewable energy proponents were climate skeptics. These results suggest that renewable energy skeptics can find value in the other benefits of renewable energy schemes, like economic or environmental enhancement.

Looking at the opposite situation, public belief in the science of climate change is associated with support for climate action. In a representative survey of adults in the United States, Ding et al. (2011) find that perceived scientific agreement is correlated with policy support for climate action. Controlling for other explanations like political orientation and demographics, the authors find misunderstandings about the scientific agreement on anthropogenic climate change that can undermine support for climate action (Ding et al., 2011).

These findings are similar to those of van der Linden et al. (2017). These authors used a representative sample of the US population to determine that communicating a scientific consensus would increase the respondents' opinion on human-climate change, while communicating misinformation about scientific consensus reduced perception of scientific agreement. Presenting both pieces of information resulted in an insignificant change in belief (van der Linden et al., 2017). This research highlights the potential for misinformation to challenge public support for climate action. Van der Linden et al. (2017) uses the literature of Koehler (2016) and Oreskes and Conway (2011) to describe ideologically motivated groups with vested interests that intentionally spread misinformation to challenge the public understanding of the degree of scientific agreement about climate change, successfully challenging social engagement and tying climate science to political identity (Dunlap & McCright, 2008).

Concerns about anti-climate action interest groups spreading misinformation are pressing in Alberta, where several prominent advocacy groups such as Friends of Science and Grassroots Alberta are among organisations spreading information against climate action (Grassroots Alberta, 2016; Deep Climate, 2009; Mittelstaedt, 2018). These groups attempt to persuade citizens that climate change is not caused by humans, but is rather a natural process (Grassroots Alberta, 2016) or caused by changes in the sun (Mandel, 2016). The Friends of Science webpage describes "common misconceptions about global warming", claiming that there is no evidence of global heating, CO2 does not drive climate change, and that climate change will not result in weather extremes (Friends of Science, n.d.). A pamphlet distributed by Grassroots Alberta describes the cost of renewable energy and carbon tax as having substantial negative economic impacts (Grassroots Alberta, 2016). Grassroots Alberta also paints a connection between pro-environmentalist views and anti-capitalist agendas (Grassroots Alberta, 2016).

These groups pose their advocacy as concerns about the cost of climate action. Grassroots Alberta describes their purpose as promoting the responsible and efficient use of tax dollars and policy creation (Grassroots Alberta, 2016). However, there is evidence to suggest these groups are motivated by the financial gain of reducing climate action regulation. Documents from the bankruptcy of Peabody Energy, a coal company, reveal that Friends of Science are among creditors, including other climate science denial advocates, that expected to receive money from the company. The creation of the company was also funded by a donation from Talisman

Energy, a fossil fuel company (Mandel, 2016). These companies stand to benefit from reduced climate action, fewer renewable subsidies, and eliminating the carbon tax. Grassroots Alberta does not provide specific information on their funding.

When broadening the scope from climate change concern to general environmentalism, the ability to predict renewable energy support becomes more complex. Warren, Lumsden, O'Dowd, and Birnie (2005) present historical conflicts between development and landscape conservation as a debate of socio-economic benefits and environmental costs. Renewable energy, especially wind infrastructure, presents a different dilemma, as development can be presented with environmental benefits from mitigating climate change impacts. Thus, environmentalists can find themselves on either side of renewable project support, opposing it due to potential harm to the local ecosystem or supporting it for climate change mitigation. Individuals can often find themselves in the middle, supporting renewable energy but opposing specific turbine proposals (Warren et al., 2005).

This debate is also related to issues of scale and time. The environmental benefits of wind energy as a carbon reduction mechanism are often related to global and national goals, while negative effects are at a local level (Khan, 2003). Khan (2003) finds differing perspectives of the relationship between the environment and economy at different scales; at the national level, wind projects are supported for their environmental benefits but require economic support. At a local level, the economic benefits of wind turbines in local employment and revenue generation are often supportive arguments, while environmental impacts are often considered negative concerns (Khan, 2003).

Procedural and distributive fairness

Moving to the process of identifying a wind farm location, designing a project, and gaining local buy-in, a number of key factors are identified in the published literature. In this context, community members often pose three questions regarding energy projects: Is the decision-making and regulatory process open, rigorous, and accountable? Are local actors being meaningfully engaged? How are the local benefits from the project distributed? (Shaw et al., 2015). The first two questions speak to the procedural aspects of the project, while the third question speaks to the fairness of impacts and benefits. Wüstenhagen, Wolsink, and Bürer (2007) identify these aspects of fairness as well as a third dimension of trust, as necessary for community acceptance.

Community energy literature often refers to the concept of procedural justice, defined as how fair and open the decision-making process is for renewable projects (Wüstenhagen et al., 2007). Projects that demonstrate procedural justice allow all relevant stakeholders an opportunity to participate in the planning process (Shaw et al., 2015). Public participation can be considered on a spectrum, where the lowest level of participation is a one-way provision of information and the highest level of participation involves engaging in meaningful conversations about the project and giving the community the ability to make decisions (Jami & Walsh, 2014). Decision-making processes can be considered unfair if there is not enough public engagement or if the engagement activities are considered unsubstantial (Jami & Walsh, 2014). Canadian case studies by Fast and Mabee (2015) and Shaw et al. (2015) find that public resistance rises in instances where local and regional authorities were disregarded or overridden.

The fairness of the decision-making process is also closely linked to the concept of distributive fairness, or the way benefits, impacts, and costs are spread amongst stakeholders (Shaw et al., 2015). If the community feels like the project has negative changes on their lives and the benefits, if any, that they receive are not worth the impacts, they are likely to oppose the project. Community engagement provides the platform for stakeholders to converse with developers and owners to determine the acceptable allocation of impacts and benefits. Concern over an unequal burden of environmental impacts and an unfair allocation of benefits were evident in the Canadian case studies done by Shaw et al. (2015). Communities saw little tangible benefits in economic development and perceived most economic benefits accruing to multinational developers and institutional investors (Shaw et al., 2015). Both Shaw et al. (2015) and Fast and Mabee (2015) note that the streamlining of renewable project approval led to perceived insufficient community involvement and participation resulting in reduced fairness among renewable projects.

Institutions and trust

Another dimension of community acceptance involves a sense of trust in local institutions (Wüstenhagen et al. 2007). Trust involves a continuous relationship between communities and project proponents, government agencies, and local residents evolving with numerous interactions over time. Bradbury et al. (2009) conducted research in the US examining the acceptability of carbon capture and sequestration across several states. In Bradbury et al.'s (2009) findings, focus group participants in the New Mexico and Texas regions expressed reservations about the Department of Energy and coal, oil, and gas companies, citing negative experiences with these groups in the past that continued to colour their opinions. Respondents who viewed themselves as guinea pigs for this new technology, expressed mistrust over who was conducting ongoing monitoring, were unsure about how they could obtain information or express concerns, and worried about the loss of landowner rights. These beliefs were often tied to past mistreatment by energy project proponents that had eroded trust with energy firms and the federal government. Trust was also an issue in the Ohio focus group, where examples of government oversight and failure to protect the community led to concerns over government involvement (Bradbury et al., 2009).

Shaw et al.'s (2015) research finds that communities sometimes perceive the provincial and federal government's support for energy projects as wanting to develop financial assets rather than fair decisions made in the public interest. The authors suggest that public resistance emerges as the public loses trust that the government will protect their social and ecological values (Shaw et al., 2015). Concerns are exasperated by a lack of engagement and communication. As Shaw et al. (2015) identify in their Canadian cases studies, when requirements for public engagement were reduced in British Columbia and Ontario, the lack of communication caused an amplification of concerns related to property value reductions, environmental impacts, viewsheds, and, most importantly, health impacts. Shaw et al. (2015) also note that community opposition rises as the legal requirements for assessments were weakened in British Columbia and Ontario, resulting in projects that were not subject to strenuous environmental assessment practices.

These dimensions of fairness and trust are closely intertwined, as greater community engagement can result in a fairer distribution of benefits and impacts, and numerous projects that are considered fair can foster trust in the long-term (Shaw et al., 2015; Jami & Walsh, 2014). This literature review presents evidence on the importance of fairness and trust to acquire local support for renewable energy.

Economic and policy context

Another barrier to the development of renewable energy relates to economic challenges. Ferguson-Martin and Hill (2011) found that wind projects often need financial support to be considered viable. The authors find that carbon pricing is an important policy to increase the competitiveness of wind energy. Saskatchewan energy stakeholders interviewed by Richards, Noble, and Belcher (2012) differed on whether wind turbines were cost competitive but did note that carbon pricing would increase the economic feasibility of wind turbines. The stakeholders identified a barrier in the form of the stability of carbon pricing schemes.

Jacobssen and Johnson (2000) define other sources of economic barriers, highlighting the poor articulation of demand for renewable technologies. In a review of 14 markets by Alagappan, Orans, and Woo (2011), the authors identify correlations between markets with high interconnection costs and lower renewable energy development.

Closely tied to economic barriers are the policy and regulatory barriers associated with energy projects. While many governments support renewable energies as low carbon climate action measures, the literature identifies several cases of political challenges. Jacobsson and Johnson (2000) present the idea of path dependency as a barrier, believing that governments can perceive renewable energy as risky and prefer to support incumbent generators. Stakeholders interviewed by Richards et al. (2012) in Saskatchewan that believed that wind energy was underdeveloped identified the lack of political leadership as a barrier. Participants noted the government may be responding to a public disinterested in renewable development, demonstrating greater concern for economic development that environmental concerns. Many jobs in Saskatchewan are tied to resource extraction, which may be taking greater priority in the public eye (Richards et al., 2012).

Ferguson-Martin and Hill (2011) found that wind energy development is affected by the stability of wind energy policies and the levels of support or opposition for other forms of energy. Jami and Walsh (2014) examine the renewable energy landscape in Ontario, finding that the province struggles with unstable policies and politicized decisions around renewable energy. This landscape is contrasted with Germany and Texas, where stable regulatory frameworks and specific commitments encouraged the development of wind energy.

The political realm is tied into many of the challenges in other realms. The regulations and frameworks around renewable development set the requirements for community engagement that occurs where renewable projects are developed, impacting the fairness of impacts and benefits, trust, and renewable support. Rigorous policies for processes like land negotiation and decommissioning can help affirm public support for renewable projects. Under-engagement of residents can lead to opposition, while overregulating development can discourage developers. Policies also impact the economic feasibility of projects by determining the subsidies and financing behind these projects. Alagappan et al. (2011) find that jurisdictions with a Feed-In Tariff system have greater renewable adoption. The political realm of renewable development often serves to amplify or mitigate the economic, environmental, and social barriers of renewable development.

Environmental and technical challenges

A barrier often mentioned in the discussion of wind power is wildlife impacts, especially harm to avian and bat populations. Wind farms do have the potential to harm ecosystems, both due to collisions with turbine blades and supporting infrastructure, like roads and transmission lines, causing habitat fragmentation (Kuvlesky et al., 2007). Literature on wind turbines impacts show high variability in avian and bat deaths per turbine, depending on a number of factors, such as linear versus cluster arrangements, proximity to migratory routes, and lighting, among others. Kuvlesky et al. (2007) identify more substantial ecosystem impacts from the construction of new power lines and roads that fracture habitats, threatening biodiversity. To minimise environmental damage from wind infrastructure, the authors recommend that wind turbines be located on agricultural land, as they are disturbed lands where native vegetation has mostly been removed and therefore less likely to attract birds and there are existing road and transmission infrastructure that can be utilised for wind energy (Kuvlesky et al., 2007). The authors also provide policy recommendations that can resolve environmental issues around wind developments; including incentivising developers to avoid high-risk areas and to encourage stronger impact assessment and mitigation policies (Kuvlesky et al., 2007).

Integrating renewable energies into existing grids can pose a number of technical barriers, including affecting the ability of the electricity supply to match demand and impacting the quality of the energy provided. One concern about renewable power is intermittency, especially in reference to wind and solar power. Intermittency refers to issues of power generation being reliant on non-controllable factors, like how fast the wind is blowing or how cloudy the skies are (Georgilakis, 2008). Legislators, analysts, and renewable critics often cite this as a reason to oppose renewable energy (Sovacool, 2009). Often, energy regulators believe there is a need to include back up generation, treating wind like supplemental generation (Sovacool, 2009). Sovacool (2009) assessed the accuracy of such beliefs, based on technical information and speaking with energy experts. In the US, renewable sources have demonstrated an ability to replace baseload generation, defined as generators that are always operating to provide the minimum amount of energy required to support a given jurisdictions minimum demand. A paper from Oregon found that every 50 MW of renewable energy would displace approximately 20 MW of baseload resources (Governor’s Renewable Energy Working Group, 2006). The shorter construction times for wind and solar thus makes more renewable portfolios better able to respond to demand changes. Wind turbines and solar panels are capable of operating reliably 97.5% of the time. Sovacool’s (2009) findings suggest that renewable energy is very effective when developed in large numbers across geographically spaced locations, resolving some intermittency concerns.

Georgilakis (2008) examines technical challenges for wind power integration, citing numerous drawbacks including variability and intermittency. Wind energy can produce lower quality power, affecting the ability of end-user appliances to operate effectively. Integrating wind energy can also affect system balance. However, Georgilkas (2008) also found that these challenges can be overcome through a combination of technology and wind forecasting. As wind turbine technology and wind forecasting improves, the technical challenges of wind integration can be significantly reduced.

Renewable projects require grid connections to be able to distribute the electricity they produce. Unfortunately, many grid systems are designed to accommodate large central generators. Renewable energy is typically distributed and located around natural feasibility, and this may be incompatible with existing grid architecture. Ferguson-Martin & Hill (2011) used a historical institutionalist approach to evaluate the differences in wind energy deployment in Alberta, Manitoba, Ontario, and Saskatchewan. They find transmission capacity that favour a central producer can challenge the development of distributed energy technologies like wind turbines. Transmissions challenges are also identified by Alagappan, Orans, and Woo (2011), who claim anticipatory transmission planning encourages renewable developers with greater certainty.

Summary of barriers

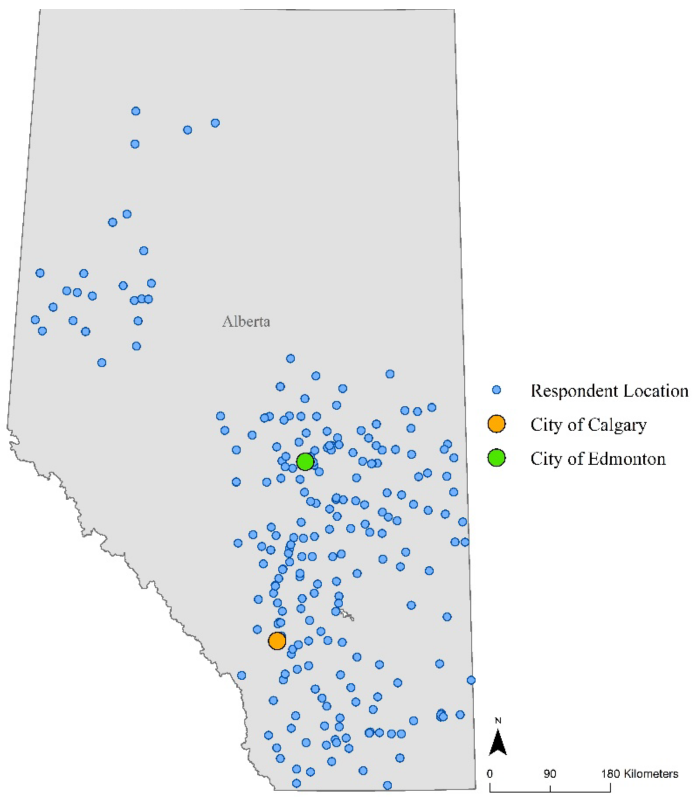
The literature review reveals numerous barriers across several dimensions; social acceptability, economic, transmission, and policy challenges. These barriers are interconnected and influence each other. Public opinion influences the election and direction of government, who in turn have the ability to influence the economic feasibility of wind projects through policies like carbon pricing and renewable subsidies, as well as through transmission planning. The policy framework also influences the level of procedural and distributive fairness that projects demonstrate, by requiring developers go through adequate engagement and assessment processes when developing projects. The continued demonstration of fairness in projects can transform the understanding of projects from place disruptive to place building and influence public opinion. The interconnection of barriers provides several opportunities to encourage renewable development by introducing favourable changes, like providing more robust information on wind farms or requiring rigorous assessment and engagement, but also can create a negative feedback loop, where the introduction of unsupportive agents, like an anti-renewable government or inconsistent policy, can result in increased barriers across multiple dimensions.

Survey research methods

Given the unique context of energy development in Alberta, with a strong historical focus on oil and gas, as well as oilsands development, we assume there will be unique challenges in developing renewable energy within the province. Many of the barriers to renewable energy noted above are relevant to the Alberta context, but to date, there is limited research on these issues within the province. To gain further understanding about the challenges of energy transition in Alberta, in early 2019, our research team conducted a survey of rural Alberta farmers. This survey was implemented with the approval of the University of Alberta Research Ethics Board. Drawing on insights from this survey, we seek to understanding the extent to which landowners support different types of energy technologies and potential reasons for these preferences. The survey was distributed online by an agricultural market research firm

(Kynetec), reaching 401 rural landowners in Alberta. Landowners were asked to provide their postal codes, which are mapped in Figure 1. Landowners were predominantly located in the southeastern area of the province, with a smaller number of landowners located in the northwestern part of the province.

Figure 1 Map of rural landowner survey respondents in Alberta, Canada



The sample for this survey was formed from an online panel that is maintained by Kynetec, representing large-scale crop and livestock operations in Alberta. Although we do not have precise information on the attributes of panelists, the sample represents a group of large-scale farmers and landowners in Alberta, many of which would be in a position to host wind turbines and other energy infrastructure on their property.

The survey included several questions, asking respondents their opinions about energy sources, knowledge about wind infrastructure, opinions about institutions and business models, and concerns about wind projects. In addition to reporting descriptive statistics, we conducted binary logistic regressions to identify predictors of support or opposition to wind energy development. These predictors are largely consistent with assumptions in the literature, as noted earlier in this report.

In particular, we utilize regression analysis to answer two questions from the survey:

1. In general, to what extent do you support or oppose the further development of wind energy in Canada?
2. How much do you agree or disagree that there should be more wind turbines in Alberta?

Responses to these questions were recorded on a five-point scale from strongly oppose to strongly support. One of the key objectives in our analysis is to understand the factors contributing to variation in support for wind power. As such we developed a regression analysis to build further insights into the multiple drivers of support and opposition. Since our survey responses are ordinal (i.e., Likert scales), in order to conduct the regression analysis, we converted these variables to binary variables (1= support, 0= no support) and conducted binary logistic regressions with attention to the most significant factors associated with support and opposition to wind energy development. Descriptive statistics and regression results are presented in the section below.

Results

Characteristics of the sample

Descriptive statistics for key sample characteristics are provided in Table 2. Examining the descriptive statistics reveals a large range in farm size, with a mean size of 2,983 acres. Respondents were mostly male and the average age was between 45 and 54. The average political orientation of the sample was somewhat conservative. For the average respondent, farming provided over 50% of household income. The majority of farms are crop based, while over 35% are mixed operations between crops and livestock.

Table 2 Descriptive statistics for sample characteristics

Variable and *response options*	N	Mean	SD	Min	Max
Farm size *(acres)*	401	2982.53	4063.85	13	30500
Gender *1= male 0=female*	400	0.90	0.30	0	1
Age *1=18-24; 2=25-34; 3=35-44; 4=45-54; 5=55-64; 6=65-74; 7=75 or over*	397	4.84	1.20	2	7
Political Orientation *-5=very liberal to 5=very conservative*	345	1.68	2.12	-5	5
% of household income from farming *1=0%; 2=1-25%; 3=26-50%; 4=51-75%; 5=76-100%*	401	4.46	0.89	1	5
Farm type					
Crops	206				
Livestock	47				
Mixed	146				

Energy beliefs

The survey introduced several variables that explore beliefs about the energy sector, renewable energy, and specifically wind turbines in these areas. These survey results are presented below.

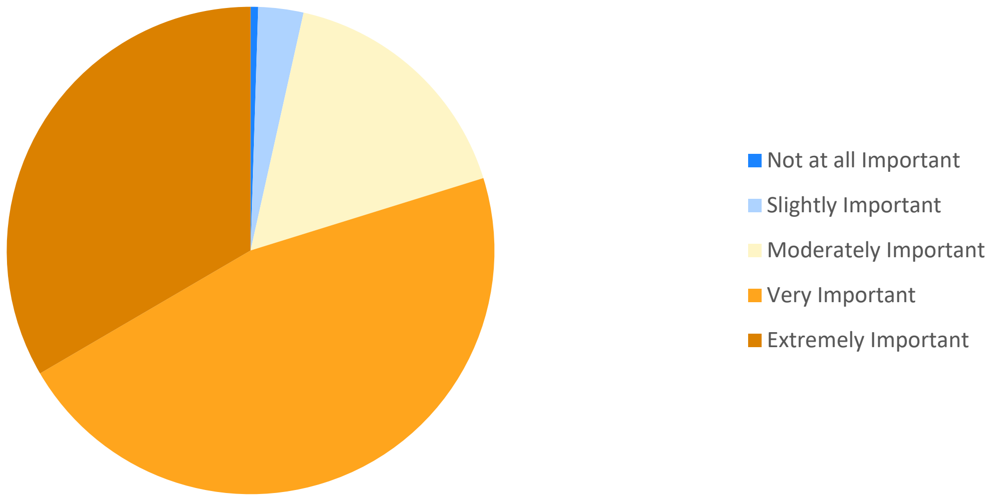
Respondents were asked whether they had existing energy installations on their land. Over half of respondents had some type of oil and/or gas infrastructure on their land. Roughly 13% of respondents had solar panels, while only 10 (2.5%) respondents had wind turbines on their land. Frequencies for the presence of energy infrastructure on land are presented in Table 3. Those individuals that did not have either wind turbines or solar panels were then asked their likelihood of installing renewable energy infrastructure on their land. The majority of respondents without renewable technologies said that it was unlikely that they would install renewable energy infrastructure.

Table 3 Presence of energy infrastructure on respondents' land and likelihood of installing renewable infrastructure if not present already

Variable	Frequency	Percent of total responses (%)
Presence of energy infrastructure (n=401)		
Wind turbines	10	2.3
Solar panels	51	11.8
Oil and gas infrastructure	244	56.2
None of above	129	29.7
Likelihood of installing renewable infrastructure if not present already (n=342)		
Very likely	24	7.0
Likely	118	34.5
Unlikely	117	34.2
Very unlikely	83	24.3

When asked about the importance of the Alberta energy sector to them, nearly 80% stated that it was extremely or very important, as seen in Figure 2. This is unsurprising, given the number of individuals that have some type of energy infrastructure on their land and the importance of the energy sector to the economic and cultural fabric of the province.

Figure 2 Importance of Alberta's energy sector to the respondent (n=401)



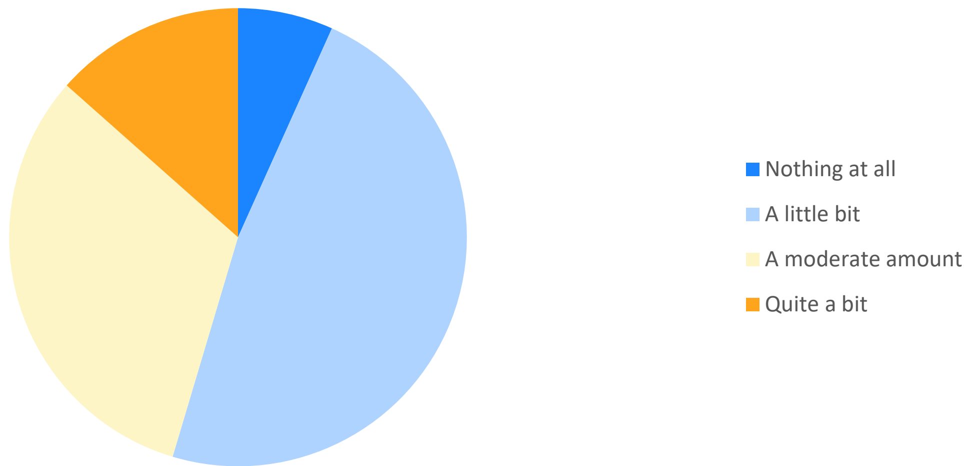
Sherren et al. (2014) demonstrate that exposure to renewable infrastructure can predict greater support for renewables. To examine if this relationship exists within the rural Alberta sample, the survey asked respondents six yes or no questions about their exposure to wind turbines, presented in Table 4. While most respondents have seen wind turbines before (88%), few claim to see or hear turbines often (23%) and even fewer consider there are wind turbines near their farm (18%). Over half of respondents believe that wind turbines are often discussed in the news (53%) and nearly a third have heard a lot about turbines from friends, family, and the community (32%). Few respondents have been approached by wind developers (18%).

Table 4 Respondents exposure to wind infrastructure

Wind turbine exposure	Frequency	Percent of total responses (n=401)
I have seen or heard a wind turbine before	353	88.0
I have been approached by a wind developer	72	18.0
There are wind turbines near my farm	73	18.2
I see or hear wind turbines often	92	22.9
I have heard a lot about wind turbines from the news	211	52.6
I have heard a lot about wind turbines from friends	129	32.2

Despite most respondents having experience with wind turbines, when asked about their knowledge about wind farms, just over half of respondents (55%) claim to know ‘a little bit’ or ‘nothing at all’ about wind energy/turbines. Figure 3 displays how respondents self-identified their knowledge of wind energy and wind turbines.

Figure 3 Knowledge of wind energy and turbines (n=401)



Beyond self-reporting knowledge, respondents were also given a number of knowledge statements about wind energy that they could say were true or false. They were then asked to state their confidence in their answer. Response frequency, percent of correct responses, and confidence are presented in Table 5. Respondents were most confident that the statement “In Alberta, wind is the cheapest way to generate electricity, even cheaper than natural gas” was false. Respondents were least confident about whether wind farms will produce more energy than they would require to erect them. The fewest number of respondents also correctly identified this statement as false.

Table 5 Understanding of the impacts of wind infrastructure (n=401)

Statements	Frequency		Percent of respondents correct	How confident are you in your answer?	
	True	False		Low confidence[a]	High confidence
10% of bird deaths are caused by wind turbines	130	271	67.6%	78%	22%
In their lifetime, wind turbines will only produce the amount of energy as it took to manufacture, transport, and build them.	146	255	63.6%	83%	17%
In Alberta, wind is the cheapest way to generate electricity, even cheaper than natural gas	104	297	74.1%*	66%	34%
The majority of Canadians do not support wind energy development	142	259	64.5%	82%	18%

[a] sum of somewhat confident and not at all confident response
*the cost of energy generation is dependent on policies, markets, and several other factors at any given time, as well as what the respondent considers to be costs (i.e. environmental impacts)

In a hypothetical scenario in which a wind farm is to be erected within one kilometre of the respondent's property, the respondents were asked to state their level of concern with various project impacts. The ten-point scale of the question was converted to three measures: little concern, somewhat concerned, and very concerned, displayed in Table 6. Respondents were most concerned about the fairness of the compensation payments, while the fairness of the development process was the fourth most concerning impact. The second most concerned element was impact on property values, highlighting the importance of economic issues for respondents. Respondents were least concerned about the impact of wind farms on electricity prices, however the average level of concern was still above the halfway point of the scale.

Table 6 Levels of concern for a hypothetical nearby wind farm (n=401)

	Mean	SD	Min	Max
Fairness of compensation payments	7.53	2.76	0	10
Effect on property values	7.26	2.81	0	10
Visual impacts	7.25	2.78	1	10
Noise or auditory impacts	7.14	2.87	0	10
Fairness of development process	7.13	2.83	0	10
Decommissioning of old/aging turbines	6.78	3.10	0	10
Community/neighbour conflict	6.74	2.77	0	10
Impact on farming/ranching practices	6.60	2.94	0	10
Health and/or safety	6.32	3.08	0	10
Effects on local environment/ecosystem	6.30	3.03	0	10
Changes to electricity prices	5.92	3.01	0	10

Note: Measured on a scale, 0 = not at all concerned, 10 = extremely concerned.

Personal beliefs and norms

The survey also collected information about respondents' beliefs, in hopes of identifying a relationship between energy attitude and components of personal identity. Respondents were given a number of statements about the energy industry and were asked to state their level of support, presented in Table 7. Over 80% of respondents stated their support for continuing the growth of the oil and gas industry. Comparatively, just over 60% of respondents stated their support for more renewable energy in Alberta. The majority of respondents believed that public spending and regulation in the energy sector is not preferred. However, respondents also felt that people near energy projects should always have the right to reject those projects. A minority of people claimed they would support policies that are not optimal for them if it is best for everyone. Only 20% of respondents support big, fast changes to Alberta's energy system, while the majority opposed this statement.

Table 7 Support for beliefs about the energy sector in Alberta (n=401)

Statements	Mean	SD
I support policies that do what is best for everyone, even if it means I get a slightly worse deal	2.98	1.14
People should always have the right to refuse nearby energy projects, especially if it could impact them	3.65	1.11
Alberta should continue to grow the oil and gas industry	4.32	0.82
The forces of supply and demand work best, so government regulations should be kept to a minimum in the energy industry	3.72	1.10
As a general rule, less spending of public money in the energy sector will be better	3.77	1.06
Alberta should strive to have more renewable energy	3.64	0.98
I support big, fast changes to Alberta's energy system	2.48	1.13

Note: Measured on a scale, 1 = Strongly oppose, 5 = Strongly support

Respondents were also asked to rank their trust in various institutions. Descriptive statistics for statements about trust are provided in Table 8. The most trusted institution was the local community (6.37), while both the oil and gas industry and scientists/academics were less trusted than the baseline measure of "people, in general" (6.19). The renewable energy industry and government were less distrusted than the baseline measure, with nearly a quarter of respondents stating they fully distrust the government and 64% consider government distrustful. Note that at the time of survey distribution, the provincial government of Alberta was led by the New Democratic Party and the federal government was led by the Liberal Party. Neither of these parties align with the average political orientation of the sample. It may be the case that trust in government would increase if the party in power reflected the right-leaning viewpoint of the sample. While the renewable energy industry is perceived as untrustworthy (58% of respondents are neutral or distrustful), 59% of respondents trust the oil and gas industry. The renewable energy sector is a more novel industry and may have had less ability to develop trust amongst Albertans and negative opinions may have been influenced by publicised negative cases of renewable projects.

Table 8 Trust in energy related groups or institutions (n=401)

Group or Institution	Mean	SD
Local community	6.73	1.93
People, in general (baseline)	6.19	1.90
The oil and gas industry	6.08	2.12
Scientists/academics	5.43	2.35
Renewable energy industry	5.15	2.07
Government	3.58	2.13

Note: Measured on a scale, 1 = fully distrust, 10 = fully trust

Community attachment and community norms were explored with several questions asking about their relationship to their community, presented in Table 9. An overwhelming majority of respondents felt strongly attached to their community, had positive opinions about their community, considered it part of their identity, and felt they were similar to their community. Regarding community values, respondents highlighted the importance of land stewardship and just over half of respondents believed the community frowns on people who take more than their fair share. Respondents also felt their community cared about procedural fairness and cared about supporting local enterprises. Only 20% of respondents believed their community would be excited about a new wind farm, suggesting that respondents have a strong sense of community, but struggle to see a wind farm integrating into that community identity.

Table 9 Descriptive statistics for personal and community norms (n=401)

Statements	Mean	SD
I feel strongly attached to the community I live in	4.06	0.70
Poor stewardship of one's land is greatly frowned upon here	4.00	0.71
I often talk about my community as a great place to live	3.99	0.80
There are many people in my community who are similar to me	3.95	0.80
My local community is an important part of who I am	3.94	0.82
I would be considered rude if I didn't talk to my neighbours before making decisions about my land that could affect them	3.78	0.91
Farmers in this county greatly disapprove of people who take more than their fair share	3.51	0.81
In this community, it doesn't matter as much about how a decision is made, rather only that the outcome is fair	3.11	0.93
People here are indifferent about supporting local enterprises	2.70	0.93
For the most part, my local community would be excited about a new wind farm	2.58	1.02

Note: Measured on a scale: 1 = strongly disagree, 5 = strongly agree

The survey asked about respondents' opinions about various business models and types, presented in Table 10. The majority of respondents believed that big businesses did not care about individual people, however, the majority of respondents also saw no issue with buying energy from private utility companies. While the majority of respondents believed that the local government should not be getting involved in risky projects like energy infrastructure, the majority of respondents also stated that local projects should involve the local government. These results suggest respondents see a role for local governments in energy but not as owners. Fewer than 40% of people stated they would rather buy from a local cooperative than a big company, even if it was more expensive. Respondents did believe that cooperatives were efficient business models in the marketplace, suggesting that respondents believe that cooperatives can participate in the energy market but in competition with private energy companies.

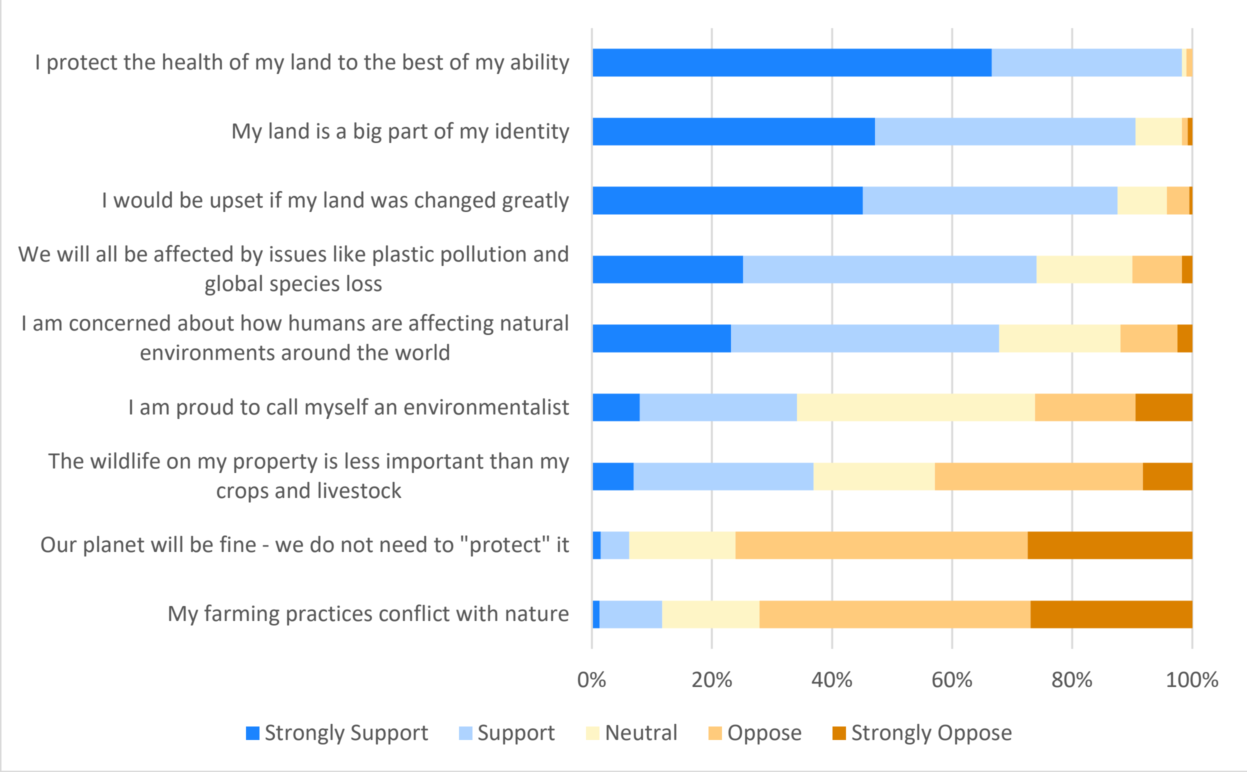
Table 10 Opinions about energy business models (n=401)

Statements	Mean	SD
The bigger the business, the less they care about the little guy	3.70	0.98
My local government should not take on any big projects that might be risky, like owning energy infrastructure	3.49	1.04
I don’t see any issue with getting our energy from a private utility company, even if it isn’t as good of a deal for me	3.46	0.95
Local energy projects should involve our local government so that the county as a whole can benefit	3.40	0.93
I’d rather be part of a cooperative than buy from a private company, even if it wasn’t as good a deal for me	3.06	0.95
Cooperatives are an inefficient business model in today’s marketplace	2.46	0.96

Note: Measured on a scale, 1 = strongly disagree, 5 = strongly agree

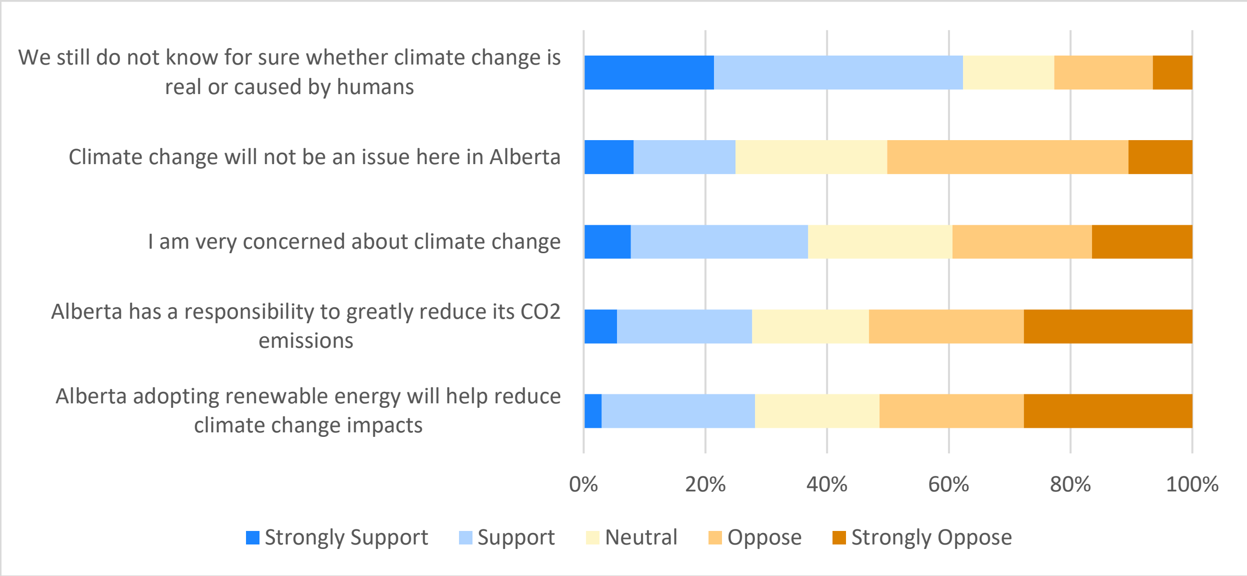
Given the role of renewable energy in the low carbon transition, the survey also asked opinions about environmentalism and opinions about climate action. Questions about local environmentalism were explored with a series of Likert scale questions gauging support for a number of statements. Local environmentalism was strongly supported, with the majority of respondents believing their land was an important part of their identity, and believing that they would be upset if their land changed and believing they protect their land to the best of their ability. Less than 10% of respondents believed their farming practices were in conflict with nature, believing their livelihood was harmonious in nature. The majority of respondents also expressed their concern about global environmentalism issues, stating their concern for human impacts on nature. Very few people admitted their support for the statement that the earth does not need protection. Despite this, less than half of respondents were proud to call themselves environmentalists. The data from this question is visualised in Figure 4.

Figure 4 Support for statements regarding environmentalism (n=401)



The sample demonstrates less concern about climate change. Just over 35% of respondents claimed to be very concerned about climate change, and fewer than a third of respondents believe Alberta is responsible for reducing their carbon emissions and that the adoption of renewable energy will reduce climate change impacts. Over 60% of respondents believe there is uncertainty about the existence of anthropogenic climate impacts. Despite this, fewer than a third of respondents believe climate change will not be an issue in Alberta. The data, presented in Figure 5, demonstrates the sample does not consider climate change to be a concern nor the responsibility of Alberta to address.

Figure 5 Support for statements regarding climate change (n=401)



Explaining support for wind energy procurement in Canada

This study explores how rural Albertan landowners perceive wind energy and how much they support the further development of wind energy in Canada and more specifically in Alberta. The survey asked respondents to state their support for the further development of various fossil fuel and renewable energy sources in Canada. The descriptive statistics for this survey are presented in Table 11. The most supported energy sources are fossil fuels; in order, natural gas, oil from oil sands, and oil from other sources. The only fossil fuel that is less supported than some renewable technologies is coal, which is still supported over wind and nuclear energy. Among renewable sources, the most supported are hydroelectric, bioenergy, and solar energy, with support ranging from 75% to 78%. Wind energy is the least supported renewable energy source, at only 57% percent. The only energy source less supported is nuclear energy, with under 40% support.

The respondents of the survey display a clear preference for non-renewable sources, with the exceptions of coal and nuclear power. Alberta's fossil fuel support may be a result of the historic and economic ties to the fossil fuel sector, including oil from the Athabasca Oil Sands. Despite this, the majority of respondents do support all renewable sources (i.e., mean support is above 3.0).

Table 11 Descriptive statistics on further development of energy sources in Canada

Energy Source	N	Mean	SD	Min	Max
Natural gas	401	4.51	0.60	2	5
Oil from oil sands	400	4.43	0.71	1	5
Oil (from sources other than the oil sands)	399	4.27	0.73	1	5
Hydroelectricity	396	4.07	0.91	1	5
Bioenergy	389	3.98	0.79	1	5
Solar	401	3.94	0.97	1	5
Geothermal	383	3.92	0.86	1	5
Coal	394	3.62	1.13	1	5
Wind	397	3.44	1.21	1	5
Nuclear	383	3.05	1.27	1	5

Note: Measured on a scale, 1 = strongly oppose, 5 = strongly support

Support for further development of wind in Canada

To explore further the factors associated with support and opposition to wind power, we developed several regression models. Binary logistic regression required modifying several variables. The support for wind development variable was transformed from a five point Likert scale with the options of strongly oppose, oppose, neutral, support, and strongly support to a binary variable where 1 is equal to support (strongly support or support) and 0 is equal to opposition (neutral, oppose, and strongly oppose). All independent variables were tested for collinearity; none of the variables reported a variance inflation factor above 10. Independent variables were chosen based on the literature reviewed and theoretical expectations for factors that would influence support for wind energy in Canada. Several control variables were chosen, reflecting characteristics of the landowner. These include age, farm size and type, and political alignment. The model reported in Table 12 resulted in a Nagelkerke R^2 value of 0.62, indicating the model can predict 62% of the variance in the support for the further development of wind energy in Canada.

Table 12 Binary logistic regression predicting support for further wind energy development in Canada

Variables	B	Sig.	Exp(B)
Environmental Considerations			
Wind turbines are an environmentally-friendly technology	0.61	0.00	1.84
Alberta has a responsibility to greatly reduce its carbon emissions	0.34	0.02	1.40
I would be upset if my land was changed greatly	0.13	0.56	1.13
Economic Concerns			
A wind farm would be a good thing for my county's local economy	0.73	0.00	2.07
Alberta should continue to grow the oil and gas industry	0.22	0.35	1.24
Because the wind is not always blowing, we should not waste our time putting up turbines	-0.89	0.00	0.41
Wind Infrastructure Concerns			
Turbines spoil the beauty of natural landscapes	-0.24	0.11	0.78
I am concerned about the fairness of the development process for wind turbines near me	-0.03	0.79	0.97
I am concerned about the fairness of the compensation payments for wind turbines near me	0.09	0.37	1.09
I trust the renewable energy industry	0.13	0.14	1.14
Exposure to Wind Turbines			
There are wind turbines near my farm	-0.20	0.63	0.82
I consider myself knowledgeable about wind energy/turbines	0.12	0.59	1.13
Characteristics of the Respondent			
Age	0.13	0.32	1.14
Percent of income that comes from farming	0.27	0.13	1.31
Type of farm			
Primary Crops	-0.15	0.67	0.86
Primarily Livestock	0.61	0.25	1.85
Conservative Political Affiliation	-0.21	0.55	0.81
Constant	-5.51	0.01	0.00

N=372

Nagelkerke $R^2 = 0.624$

In the model, several variables predicted support for the further development of wind energy in Canada. Believing that wind turbines are environmentally-friendly (Exp(B) = 1.84) and that Alberta has a responsibility to reduce their carbon emissions (Exp(B) = 1.40) significantly increased the probability of a respondent stating their support for further wind energy development in Canada. Examining economic concerns, for every unit increase in the scale measuring the belief that wind turbines were good for the local economy, the respondents were twice as likely to support the further development of wind turbines in Canada (Exp(B) = 2.07). However, believing that the intermittency of wind was a reason to avoid building wind turbines was a negative predictor, where for every unit increase in the scale measuring this belief, the average respondent was less than half as likely to support wind development in Canada (Exp(B) = 0.41). None of the remaining variables were significant.

Support for wind energy procurement in Alberta

Support for further wind development was also explored at a more local scale; within the Province of Alberta. The survey asked respondents to indicate their support for the statement: "There should be more wind turbines in Alberta". Thirty-seven percent of respondents agreed with this statement, less than the number of respondents that believe there should be more wind energy development in Canada. This question also presented a number of additional statements about the characteristics of wind farms. Notably, more respondents believed wind farms were environmentally friendly (45%) and believed that turbines would be good for the local economy (40%) than believed there should be more turbines in Alberta. Over half of the respondents (52%) felt that turbines spoiled the natural beauty of the landscape. Other concerns about wind power related to noise (39% agree that wind turbines are too noisy) and concerns about intermittency (30% agree that the intermittency of wind is a reason to not build turbines). Descriptive statistics for these statements are presented in Table 13.

While less than 50% of the sample agreed that there should be more turbines in Alberta, the number of individuals that support that statement exceed those that disagree (34%), while a substantial number are neutral about the statement.

The data illustrates that, while several respondents believed wind turbines were environmentally friendly and an economic boon, concerns about the impacts of wind infrastructure on natural beauty (52% believe it spoils the natural landscape), noise impacts (39%

believe turbines are too noisy), and concerns about the intermittency of wind (30% believe intermittency is a reason not to build turbines) may have resulted in mixed opinions about whether there should be more wind turbines in Alberta.

Table 13 Descriptive statistics for statements about wind turbines

Variables	N	Mean	SD
Turbines spoil the beauty of rural landscapes	398	3.49	1.20
Wind turbines are too noisy	360	3.31	0.95
Wind turbines are an environmentally-friendly technology	396	3.13	1.22
A wind farm would be a good thing for my county’s local economy	389	3.10	1.21
There should be more wind turbines in Alberta	387	2.96	1.28
Since the wind is not always blowing, we should not waste our time putting up turbines	392	2.92	1.14

Note: Measured on a scale, 1 = strongly oppose, 5 = strongly support

A second binary regression model was developed to determine if and to what extent beliefs and values influence support for wind development in Alberta. The dependent variables, a five point scale asking about support for the statement “There should be more wind turbines in Alberta”, was transformed into a binary variable, where the responses of strongly support and support were recoded as 1 and the responses of neutral, oppose, and strongly oppose were recoded as 0. Predictor variables were introduced, based on the literature reviewed and expectations for factors that would influence support for the further development of wind turbines in Alberta (Table 14).

This model resulted in a Nagelkerke R^2 value of 0.69, indicating the model can explain 69% of the total variance for support for wind turbines in Alberta. The results of the model are presented in Table 14.

Table 14 Binary logistic regression predicting support for more wind turbines in Alberta

Variables	B	Sig.	Exp(B)
Environmental Considerations			
Wind turbines are an environmentally-friendly technology	0.72	0.00	2.06
Alberta has a responsibility to greatly reduce its carbon emissions	0.31	0.05	1.36
I would be upset if my land was changed greatly	0.17	0.43	1.19
Economic Concerns			
A wind farm would be a good thing for my county's local economy	1.18	0.00	3.26
Alberta should continue to grow the oil and gas industry	-0.24	0.35	0.79
Because the wind is not always blowing, we should not waste our time putting up turbines	-0.53	0.01	0.59
Wind Infrastructure Concerns			
Turbines spoil the beauty of natural landscapes	-0.44	0.01	0.64
I am concerned about the fairness of the development process for wind turbines near me	-0.21	0.10	0.81
I am concerned about the fairness of the compensation payments for wind turbines near me	0.17	0.16	1.18
I trust the renewable energy industry	0.15	0.14	1.16
Exposure to Wind Turbines			
There are wind turbines near my farm	0.78	0.11	2.18
I consider myself knowledgeable about wind energy/turbines	0.34	0.15	1.41
Characteristics of the Respondent			
Age	-0.10	0.51	0.91
Percent of income that comes from farming	-0.19	0.34	0.82
Type of farm			
Primary Crops	-0.36	0.33	0.70
Primarily Livestock	0.02	0.97	1.02
Conservative Political Affiliation	-0.16	0.68	0.85
Constant	-4.81	0.04	0.01

N=369

Nagelkerke $R^2 = 0.688$

In this model, for every unit increase in the scale measuring the belief that wind turbines are environmentally-friendly, respondents were twice as likely to support the further development of wind turbines in Alberta (Exp(B) = 2.06). Also, believing that Alberta is responsible for reducing their carbon emissions was a significant positive predictor, where a unit increase in the scale predicted the respondent was 1.36 times more likely to support further development of wind turbines in Alberta. Believing that a wind farm would benefit the local economy was the strongest positive significant variable in the model, where a unit increase in the scale measuring this increases the odds of supporting the further development of wind turbines in Alberta by 3.26 times. However, concern about the intermittency of wind is a significant negative predicting variable, where a unit increase in the scale measuring support for the statement "Because the wind is not always blowing, we should not waste our time putting up wind turbines" reduced the odds of supporting the further development of wind in Alberta by 40% (Exp(B) = 0.59). Another significant concern in the model came from the visual impacts of wind turbines. A unit increase in the scale measuring support for the statement "Wind turbines spoil the beauty of rural landscapes also reduced the odd of supporting the wind turbine development in Alberta by 36% (Exp(B) = 0.64). The remaining variables and the respondent characteristics were not significant at a p-value less than 0.05.

The two models reveal similar variables that are influencing support for wind development in both Canada and Alberta. As expected, one of the strongest variables that predicts support for wind develop are the environmental benefits. Climate concerns were significant positive variables in both models, reflecting the benefits of wind energy as a way to produce energy without carbon emissions. Similarly, believing that wind turbines were an environmentally-friendly technology was also a significant positive variable in both models. However, the strongest positive variable in both models was the belief that wind turbines were beneficial for the local economy.

In both models, concerns about intermittency were the largest significant negative variable. This is variable is somewhat unexpected, but reflects a concern that turbines and inefficient and unreliable. The only variable that was unique to one of the models was the belief that turbines spoil the beauty of rural landscapes, which was a significant negative variable in the model examining support for wind turbines in Alberta. Visual intrusions are a local concern, and thus understandable as a significant concern for developments near the respondent.

Discussion

This report illustrates some of the challenges facing wind energy development in Alberta. The narratives around wind development discovered in Alberta are summarised below.

Social acceptability

As explored in the literature review, public support is crucial for renewable development. Albertans, especially rural residents that live in and use the same land wind projects typically locate in, are more likely to oppose specific projects if they cannot justify the importance and values of a wind project, or feel the negative impacts outweigh any benefits.

These beliefs also flow upward to the government level, where it is reflected in policy that supports or limits renewable energy development. In Alberta's 2019 election, many rural districts elected a UCP representative. One of the new government's first actions was to repeal the carbon tax administered under the previous provincial government (Bennett, 2019). This policy not only reduces the economic competitiveness of low carbon projects, but also eliminates the funding for the REP program, further discouraging renewable development. The UCP's renewable energy policy can be viewed as a representation of the anti-renewable energy priority of their political base, supported by many rural Albertans. The models constructed demonstrate the factors that influence public support for wind energy.

Perspectives on climate change and the environment

Renewable energy is often touted for importance as a low carbon sources of energy. The Intergovernmental Panel on Climate Change (IPCC) identifies a need to significantly reduce carbon emissions to minimize disastrous impacts (IPCC, 2018). Renewable energy provides an opportunity to reduce carbon emissions while still supporting Canadian lifestyles and quality of life. This is one of the most substantial benefits of renewable energy. However, this also presents a challenge in communicating the need for renewable energy to a population that is divided about the need to act to mitigate climate change.

Proponents can be understood to ask three questions about the value of wind farms as a climate action measure: (1) Is climate action necessary? (2) Should Alberta do something about it? (3) Is building more wind turbines an effective climate action measure? Our data reveals that these concerns are not sufficiently held by the majority of respondents.

Believing that wind turbines are environmentally-friendly is a significant positive predictor of support of wind development, both in Canada and Alberta. However, only 45% of the sample agree that wind farms are environmentally friendly, reflecting an environmental debate around renewables. This belief may indicate the green on green debate discussed by Warren et al. (2005) and Woods (2003). Thirty-two percent of the sample greatly overestimate the impact of wind turbines on bird fatalities and the average respondent is slightly more than somewhat concerned about impacts of a wind turbine to the local ecosystem. The sample expressed strong local environmentalism, place identity, and place attachment. While the global environmental measures were supported by the majority, the support was not as high as local environmental measures. This suggests the local land and ecosystem impacts of wind turbines may be a potential reason to oppose the further development of wind energy. However, being concerned about their land changing greatly was insignificant in both models, suggesting that local environmentalism does not appear to be a significant reason to oppose wind turbines.

The other potential explanation for mixed beliefs about the environmental value of wind turbines comes from the mixed acknowledgement of the veracity of climate change and the need for Alberta to act. In both models, the belief that Alberta is responsible for reducing its carbon emissions was a significant positive prediction variable. However, the sample of rural landowners is quite divided on the issue of climate action; less than 70% of the sample is unconvinced that anthropogenic climate change is real. Less than 30% of the sample believes Alberta has a responsibility to reduce their carbon emissions and a similar number believes that Alberta adopting renewable energy will reduce climate change impacts.

As identified in the literature review, disbelief about scientific agreement on climate change and the urgent need to act can result in less support for climate action measures, including renewable energy (van der Linden et al., 2017). The presence and activities of advocacy groups that are sharing climate change misinformation can therefore have a substantial impact on community understandings of climate science and the near scientific consensus on climate change. This ambiguity about climate change is evident in the responses and can be considered one reason why climate action is not a substantial motivation for supporting renewable energy.

While believing that wind turbines were environmentally friendly did predict support for the further development of wind turbines, respondents were unconvinced that wind turbines did have an environmental benefit. One of the reasons the environmental benefits of wind turbines is contested is the lack of acknowledgement for the need for climate action.

Procedural and distributive fairness

Much of the literature presented in this report spoke to the importance of procedural and distributive fairness to mitigate local concerns and opposition. The data collected also reveals the importance of these two factors. Among the sample, fairness of compensation was considered the most concerning impact for a hypothetical project near the respondent while fairness of the development process was the fourth most concerning impact. The majority of respondents believed that people should be able to refuse nearby energy projects, especially if it could impact them, which would be characterized as greater public involvement in energy decision-making (Jami and Walsh, 2014).

Despite these factors being the focus of many of the papers reviewed and present in the descriptive statistics, concerns about fairness of development and compensation variables in the renewable industry were insignificant in both models. This is a surprising finding, but it bears noting that the fairness of the development and compensation will influence other beliefs that were significant in the model, such as the perception of the economic benefit of wind turbines and the environmental impact of wind farms. The degree of engagement in the development process provides the opportunity to address and hopefully resolve community concerns, such as avoiding key habitats or preserving valued vistas. This process also can contribute to the adoption of a fair compensation scheme, determining where benefits of the project go and addressing issues of environmental injustice. Shaw et al. (2015) identify the importance of community engagement by demonstrating that a lack of communication can exacerbate concerns. Jami and Walsh (2014) also speak to the importance of collaborative approaches. Shaw et al. (2015) also notes that the lack of strenuous environmental impact assessments also contributed to community opposition. To mitigate concerns about wind infrastructure, project proponents would do well to improve community consultation and communication and undertake more complete impact assessments, addressing and responding to local concerns.

Institutional trust and governance models

Closely related to issues of fairness is the concept of trust, built over multiple interactions and considered to demonstrate fairness. Trust colours the responses individuals will have to proposed projects and is crucial to the socially sustainable development of wind energy in Alberta.

In the sample, proponents of renewable development, the government, renewable energy industry, and scientists/academics, are the least trusted institutions, less trusted than the baseline measure of “people in general”. The relatively low levels of trust suggest a history of projects and interactions the community considered unfair. This lack of trust will be a barrier for the further development of renewable projects. However, when placed into the models, trust in the renewable industry was insignificant in both models. Similar to issues of fairness, trust remains a crucial consideration for wind energy proponents. It will affect the success of efforts to communicate values that are significant to Albertans, such as economic benefits and environmental values.

The survey also captured opinions about the business models that govern and manage renewable projects. The majority of respondents believed that local government should not be involved in risky endeavors like owning energy infrastructure and stated their support for reducing regulation in the energy sector and reducing public investment. However, the majority of respondents felt energy projects should involve local government so that the county as a whole can benefit (Table 10). Respondents seem to prefer a scenario where the local government is consulted and receives benefits from local renewable projects, but is not the owner of the project.

While the majority of respondents believed that bigger businesses do not care about “the little guys”, the majority also saw no issue with getting their energy from private companies (Table 10). However, respondents also seem in favour of cooperatively owned businesses. The majority of respondents believed that co-operatives were efficient business models and stated they would like to be part of one. This outcome suggests the potential for community energy development, where wind energy projects and designed, owned, and operated by the local community. Community energy has increasingly been researched and pursued as a method for advancing the development of renewable energy, entwining social, environmental, and economic goals.

Concerns about wind infrastructure

Harnessing wind energy to generate electricity requires the development of intrusive infrastructure, which impacts adjacent properties. When respondents were questioned about their level of concern, there were five concerns that the majority of respondents ranked as very concerning (average concern over 7.00; Table 6); fairness of compensation payments, effect on property values, visual impacts, fairness of development process, and noise or auditory impacts. In the statistical models constructed, believing that wind turbines spoil the beauty of natural landscapes predicted less support for wind energy in Alberta, but was insignificant in the model measuring support for the further development of wind energy in Canada. This may reveal what several authors dubbed NIMBYism, or an acceptance of a development, so long as it is not near the individual. Believing that wind turbines ruin rural landscapes present significant challenges for the development of wind turbines in Alberta, as the statement "Turbines spoil the beauty of rural landscapes" was strongly supported in the sample (Table 13).

Another significant concern came in the form of the inconsistency of electricity output from an intermittent source. While only 30% of respondents believed that the intermittency of wind means erecting wind turbines is a waste of time, this variable was a significant predictor of less support for further wind energy development in both Alberta and Canada. This outcome reveals that respondents are particularly concerned about the reliability of wind energy, a justifiable concern considering the lack of storage capacity in the Alberta grid but one that has several potential technical solutions (Georgilkas 2008).

Stakeholder interviewed by Richards et al. (2012) demonstrated knowledge barriers, due to the various and sometimes inaccurate understanding of the abilities of wind turbine technology. This confusion is also apparent in our sample, where 55% of respondents claim they either know nothing at all or only a little bit about wind turbines, while only 13% claim to know quite a bit. When asked true/false questions about wind turbine impacts, the percentage of correct responses range from 64% to 74%. This lack of knowledge about the wind turbine technology may be contributing to the concerns about wind turbine impacts and the proliferation of false information. The regression analysis reveals that self-identified wind knowledge is not a significant predictor for wind support. However, whether a self-identified score is an accurate indication of wind knowledge is unknown. A respondent may have seen or heard information about wind turbines, but this information could be inaccurate or outdated, especially considering the number of groups looking to discredit renewable energy development.

Also considered in the model is whether the respondent believes they live near a wind farm, which attempts to capture whether wind attitudes vary with prior experience to wind farms near them. This relationship could be in either direction; supportive if the respondent found that wind turbines near them had little negative impact on them or negative if the respondent had a bad experience with a local project. This variable was insignificant in both models. Like knowledge of wind energy, respondents were asked to self-identify if they were near a wind turbine. This means the variable lacks consistency, as there was no definition provided as to what constitutes being near a wind turbine.

Perceived economic benefits

One of the most significant predictors of support for the further development of wind energy in Canada was support for the statement “A wind farm would be a good thing for my county’s economy”. While only 40% of the sample agrees with the statement, the models indicate that this variable is the strongest predictor for support for the further development of wind energy in Alberta and Canada, even more so than the environmental variable. Wind energy proponents thus have an opportunity to promote wind development by focusing on communicating the economic benefits of the wind farm.

Characteristics of the farm were also included in the model, expected to potentially impact the support for further development of wind. The percent of the respondents’ income that comes from farming was considered as a potential control variable, land owners that primarily relied on farming for their income would be more supportive of the further development of wind energy as an economic diversification tool for farmers. Similarly, the type of farm was considered, testing if crop or livestock farmers were more interested in wind energy. Both of these variables were insignificant in both models.

Also considered in the model is support for the oil and gas industry in Alberta. The industry is a significant economic engine in the province, generating revenue and creating employment. The majority of the sample has some type of oil and gas infrastructure on their land, providing economic benefit to the landowners. Support for the oil and gas sector was placed into the models in order to determine whether respondents would oppose renewable energy as competition to the fossil fuel industry in Alberta. However, in both models, this variable was insignificant, suggesting that supporting the oil and gas industry in Alberta does not result in opposition to wind energy development. There are several possible explanations for the lack of a significant relationship. One of the potential explanations is that oil and gas and renewable electricity are not perfect substitutes; oil and gas are used for services like gasoline, home heating, and cooking. These services are only starting to be electrified, and remain dominated by fossil fuel use. Additionally, even under the former NDP government's Climate Action Plan, wind energy was intended to be less than 30% of the total energy mix. Finally, a significant portion of the oil and gas produced in the province is for export to jurisdictions like the United States, Eastern Canada, and Asia. While electricity is traded between Alberta and its adjacent jurisdictions, the nature of transmission losses and grid connections means electricity in Alberta is rarely generated with the intention of export. These three factors demonstrate there are numerous markets for Alberta's oil and gas resources that the renewable electricity markets cannot compete with or displace. This may be the reason that respondents do not appear to consider supporting the oil and gas industry as a reason to oppose wind energy development.

Political and economic conditions

The political party in power from 2015 to 2019 (NDP), made significant steps to address the economic challenges for renewable energy. The Renewable Electricity Program provided financial security for renewable projects, and utilized an Indexed Renewable Electricity Credit that provides price certainty for developers (AESO, n.d.b). The REP was highly successful, with the first round attracting the lowest renewable electricity pricing in Canada at the time of competition (AESO, 2019b). Alberta also introduced a carbon price, instituting a $30/ton tax on carbon emitters, part of the revenue of which funded the Renewable Electricity Program. During this period, the Program procured substantial renewable capacity.

However, following the 2019 election, the new majority government, the UCP, passed a bill terminating both the next round of REP and the Alberta Carbon Tax (Bennett, 2019 and Stephenson, 2019a). These policy changes are one reason the AESO has forecast that Alberta will not reach 30% renewable capacity by 2030 (Stephenson, 2019b). The NDP government proved the economic barriers that renewable projects face are surmountable with the right policies. To procure further wind development in Alberta, most stable government policy is required over the long term, creating a business environment in Alberta that attracts renewable developers.

Alberta's renewable governance policies present similar challenges that were identified in the literature. Both Ferguson-Martin and Hill (2011) and Jami and Walsh (2014) speak about issues with the stability of renewable policy challenging renewable development. Alberta's cancellation of the REP and inconsistent government approaches to carbon pricing provide inconsistent price signals to developers and communities. With the recent removal of the provincial carbon tax and court challenges to the federal carbon tax there remain ongoing uncertainties about the economic feasibility and competitiveness of renewable energy projects.

The regulatory environment also has a crucial impact on the social acceptability to develop projects. Provincial regulation can impact the level of community fairness that projects demonstrate. Shaw et al. (2015) demonstrate that weak regulation around the duty to consult, incorporation of local government, and requirements for strenuous environmental impact assessment can result in social opposition to renewable projects. Gaps in the policy framework are already resulting in concerns from the public: renewable project developers are not required to require licensed land agents to negotiate with landowners, resulting in a potential lack of credibility and consistency with renewable project negotiations (Seskus, 2018a). Landowners have also expressed their concern over decommissioning and reclamation efforts, to avoid being burdened with taking down abandoned wind farms (Seskus, 2018b). Setting specific guidelines for the reclamation of renewable lands would provide consistent standards to return the land to its former state, alleviating one of the community's concerns.

Conclusion

The results of this report identify some of the contributing factors that explain the slow uptake of wind development in Alberta. By comparing the literature reviewed to the existing market and survey of rural landowners, a number of social, economic, transmission, and political challenges were identified with some possible solutions seen in the literature.

Findings from this report suggest Alberta's largest challenges are in acquiring social acceptability for renewable projects. Addressing the barriers to wind energy development requires efforts to change the perception of the rural farmers of Alberta, where the wind infrastructure is typically located. Opposition to renewable projects can also be seen emerging in changes to government policy and the regulatory framework around renewable projects, challenging their economic and social viability.

Among the rural sample for this survey, wind was the second least favoured energy type, with just over half of respondents believing there should be further development in Canada. When the scale of the question is changed to Alberta, fewer than 40% of respondents are in favour of the further development of wind farms. Binary logistic models were constructed to evaluate which factors were influencing opinions about the further development of wind energy in Alberta and Canada. The results show that wind turbines are supported for their environmental benefits and economic value. However, the sample remains quite split on whether wind turbines are environmentally friendly and provide economic benefits to the local community.

Opposition to wind turbines was significantly predicted by concerns about the reliability of wind energy due to the intermittency of wind. In Alberta, concern about the visual impact of wind turbines was also a significant variable that predicted opposition to the further development of wind.

Results from the statistical models present opportunities for wind energy proponents to encourage support for wind energy. Proponents can focus on communicating the environmental benefits of wind turbines, focusing on communicating the need to address climate change. However, the largest opportunity to encourage support is to promote the economic benefits of wind turbines for the local community while attempting to mitigate concerns about the visual intrusion of wind turbines by working with the community to locate the farms and modify the characteristics of the wind farm, such as turbine height, colour, and concentration.

However, here lies a challenge with encouraging renewable energy. Renewable proponents include governments, scientists/academics, and the renewable industry, who are the least trusted institutions in the sample. An additional challenge is the presences of interest groups spreading misinformation. Proponents thus need to work on enhancing the procedural and distributive fairness of wind energy projects to rebuild trust and work collaboratively to further the development of wind energy in Alberta.

This paper presents a relatively straightforward regression model and the results of this report can be further explored through more in-depth statistical analysis. Additionally, more in-depth qualitative work can confirm the presence of connections and narratives suggested in the survey data. While a panel was developed to administer the survey, respondents chose to take part in the study, resulting in a voluntary bias that challenges the ability to generalise the data to the population being analysed.

Further work by the research team will to continue to explore the perspective of rural landowners regarding wind and other types of renewable energy. Included in the survey was a series of vignette experiments, expected to be reported in a forthcoming publication, that will expand on the factors influencing support for wind development.

Wind remains a contentious yet much needed source of power in energy to reduce carbon emissions in Alberta. A significant challenge to wind development is acquiring the support of the local community, rural landowners and farmers. Acquiring support requires greater consideration of fairness in the development of wind turbines, and in doing so emphasise the environmental and economic benefits of wind energy. However, without consideration for building trust with the rural community, wind energy will continue to be challenged by social opposition.

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