Exhibit A4-5

Thirty years of North American wind energy acceptance research: What have we learned?

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Abstract

Thirty years of North American research on public acceptance of wind energy has produced important insights, yet knowledge gaps remain. This review synthesizes the literature, revealing the following lessons learned. (1) North American support for wind has been consistently high. (2) The NIMBY explanation for resistance to wind development is invalid. (3) Socioeconomic impacts of wind development are strongly tied to acceptance. (4) Sound and visual impacts of wind facilities are strongly tied to annoyance and opposition, and ignoring these concerns can exacerbate conflict. (5) Environmental concerns matter, though less than other factors, and these concerns can both help and hinder wind development. (6) Issues of fairness, participation, and trust during the development process influence acceptance. (7) Distance from turbines affects other explanatory variables, but alone its influence is unclear. (8) Viewing opposition as something to be overcome prevents meaningful understandings and implementation of best practices. (9) Implementation of research findings into practice has been limited. The paper also identifies areas for future research on wind acceptance. With continued research efforts and a commitment toward implementing research findings into developer and policymaker practice, conflict and perceived injustices around proposed and existing wind energy facilities might be significantly lessened.

Keywords:
Wind energy; social acceptance; support and opposition; attitudes

1. Introduction

1.1 Background and Motivation

Over the last 30 years, wind energy in North America has evolved from a fringe, isolated, experimental concept into a mainstream and viable source of electricity, meeting about 5% of U.S. electricity demand (6% in Canada) and representing the largest source of new electric capacity additions in many recent years (CanWEA, 2016; Wiser & Bolinger, 2016). Wind energy is widely seen as an abundant electricity source with the potential to provide a wide range of environmental and social benefits (Intergovernmental Panel on Climate Change (IPCC), 2011). State/provincial-level mandates, federal incentives, declining wind energy costs, and relatively favorable economics have spurred the aggressive North American wind deployment of the past 10–15 years (Wiser & Bolinger, 2016).

This rapid growth in wind energy deployment will likely continue. In the United States, for example, recent market analysis suggests that annual wind power capacity additions are expected to continue rapidly in the coming five years (Wiser & Bolinger, 2016, p. 1) driven by expected lower prices (Wiser et al., 2016). Meanwhile, the U.S. Department of Energy's recent *Wind Vision Report,* which outlines pathways for wind energy to provide up to 35% of the nation's electrical demand by 2050, suggests that the "low hanging fruit" wind sites (those that have good wind resources and are close to loads and transmission, yet far from communities) have largely been developed, implying that future wind development likely will happen increasingly near communities. As such, the report underlines the need for a better understanding of the drivers of wind facility acceptance among affected communities (USDOE, 2015). This recommendation echoes the calls of numerous social scientists, who have suggested that successful implementation of U.S. wind projects relies on a deeper understanding of local stakeholders (e.g., Petrova, 2013).

Multiple facets of acceptance can impact the deployment of renewable energy projects. Wüstenhagen et al. (2007) point to three dimensions: *Sociopolitical acceptance* (acceptance of policymakers and key stakeholders), *market acceptance* (acceptance of investors and consumers), and *community acceptance* (pertaining to procedural justice, distributional justice, and trust). However, as Sovacool (2009, p. 4511) points out, these social, technical, economic, and political dimensions of acceptance all influence each other in an integrated, "pernicious tangle." For example, community acceptance of wind energy can affect market acceptance and vice versa. Indeed, this has been the case when local opposition has delayed or derailed proposed wind projects (Corscadden et al., 2012; Fast, 2015; Shaw et al., 2015). For years, debates around wind energy acceptance in North America focused on sociopolitical and market acceptance, pertaining largely to technological innovation, economic incentives, and impacts on the operations and resiliency of the electric grid, with less attention paid to societal impacts (Lantz & Flowers, 2011; Phadke, 2010). However, the rapid growth of North American wind energy has increased the footprint of wind developments, increasing local conflicts and bringing the issue of community acceptance to the forefront (Lantz & Flowers, 2011).

Despite broad public support for wind energy in general, local wind developments have been challenged by vocal opposition within host communities (Bidwell, 2013; Bohn & Lant, 2009; Lantz &

Flowers, 2011). In the early days of U.S. wind power, opposition and negative attitudes dismayed the industry, who expected local acceptance to be consistent with the favorable opinions toward wind power generally (Pasqualetti, 2001). Ever since opposition and negative attitudes emerged around some of the earliest experimental wind farms in California, researchers have tried to understand and characterize wind energy acceptance (see Bosley & Bosley, 1988; Pasqualetti & Butler, 1987; Thayer & Freeman, 1987). Community acceptance is now widely perceived by wind energy practitioners as a significant barrier to deployment of renewable energy (Lantz & Flowers, 2011).

Research interest in the public acceptance of wind energy has surged along with surging wind energy growth in North America. After three decades (1987–2017) of North American scholarship in this field, what have we learned, how can these lessons be applied, and what aspects should researchers focus on next?

This review synthesizes the findings from more than 100 papers on wind energy acceptance published over the past 30 years, with a specific focus on the North American set of literature.

1.2 Justification for North American Focus

The North American[1] body of wind energy acceptance literature merits this its own review, distinct from the literature of Europe (which represents a vast body of literature; see, e.g. Ellis & Ferraro (2016)) and other regions. Social acceptance is highly context dependent, and Canada and the United States share many aspects of culture, national energy policy and economics, population density, land use policy, wind energy development processes, and wind project ownership models that are distinct from Europe and the rest of the world.

North America currently represents nearly 1/5 of global installed wind energy capacity (Global Wind Energy Council (GWEC), 2017), and the growth rate of that capacity over the past 15 years is markedly faster in North America than in Europe. Since 2002, installed capacity has increased nearly twenty-fold in North America, compared to a seven-fold increase in Europe (AWEA, 2003; Global Wind Energy Council (GWEC), 2017). This rapid growth of land-based wind energy in North America may result in amplified impacts to host communities that should be studied independently from the European context, where onshore development has been slower in recent years. Similarly, the sluggish growth of offshore wind energy in North America may also indicate economic, environmental, cultural, and visual concerns that are unique from European experience and worthy of independent study. The first offshore wind farm in North America, a 30-Megawatt project, was installed in 2016, while over 12.6 Gigawatts had been installed in Europe by the end of the same year (Global Wind Energy Council (GWEC), 2017). The density of population in Europe, coupled with the density of land-based wind turbines, places a greater proportion of the European population in closer proximity to turbines compared to North America, which may conceivably influence aspects of acceptance.

North America is largely electricity independent with domestic reserves of coal, natural gas, uranium,

[1] Very few studies from Mexico were found when preparing this review. The vast majority of papers reviewed herein focus on Canada and the United States.

hydropower, and other energy resources, whereas Europe is a net importer of fuels for electricity generation. These relatively cheap, domestic energy resources create steeper market competition and different economic conditions for wind deployment in North America compared to Europe. The European Union's Emissions Trading Scheme (EU ETS) represents an EU-wide, comprehensive climate policy; quite distinct from the state- or province-level energy and climate policies previously seen in North America. These are important differences in aspects of market and sociopolitical acceptance (both of which influence community acceptance, as described above) between North America and Europe.

Finally, community ownership and investment models are much less common in North America than in Europe (Bolinger, 2005; Ferguson-Martin & Hill, 2011; Sovacool & Ratan, 2012). In the United States, federal production incentives for wind energy have required a significant tax liability, tipping the scales toward large private developers of wind projects (Bolinger, 2005). Some studies have demonstrated that community ownership is correlated to higher support and more positive attitudes toward wind energy in Europe and other regions (Krohn & Damborg, 1999; Maruyama et al., 2007; Petrova, 2013; Warren & McFadyen, 2010). One may reasonably expect some differences in perceptions and acceptance of wind energy in North America in relation to the low level of community ownership in the region.

Despite this explicit geographic focus, a number of European papers are included in this review where those papers either introduce a novel concept or explanation that has since been studied in the North American context (e.g., place attachment theory), or point out broad aspects of the field of study of wind energy acceptance such as biases and limitations in previous research (see Section 4).

The following section outlines the methodological approach to reviewing the North American body of wind acceptance research. Section 3 provides a brief history of North American wind acceptance research to frame the papers discussed in this review. Section 4 discusses the limitations of previous research that have hindered meaningful understandings. Section 5 examines in detail the dominant explanations and overarching aspects of wind energy acceptance in the North American context. Section 6 provides a high-level summary of lessons learned from 30 years of research. Finally, Section 7 identifies gaps and areas where future research on the public acceptance of North American wind energy should focus.

2. Method of Literature Review

2.1 Selection of Publications to Review

The goal of this review was to broadly represent the body of research on wind energy acceptance undertaken in North America. Papers were initially solicited from a panel of five researchers in the field of wind energy acceptance in October, 2014. Additional papers were selected from internet searches using Google Scholar and Scopus[2] and from those cited in the papers (i.e. "snowballing"). Internet

[2] See https://www.elsevier.com/solutions/scopus

searches focused on the most recent studies, 2014 and later, which were less well represented in the panel solicitation.

The solicitation and searches focused on papers written by authors with North American affiliations and/or research pertaining to North American wind facilities. Although the United States and Canada are well represented in this review, very few papers from Mexico were found in the literature. The review focuses on peer-reviewed journal articles, but some books are included as well as some grey literature, primarily in the form of government-sponsored reports. There was no restriction placed on the date range of the papers selected for review. The earliest relevant North American studies were published in 1987, with a clear growing trend in publications per year in this field through 2016 (see Figure 1). Selected papers represent a broad range of published years in order to capture the evolution in this body of literature over time.

Papers were selected to represent a broad array of themes and variables that are examined by their authors, as well as diversity in the research approach and methods employed. The array of acceptance-influencing variables examined in these papers is outlined in Table 1 of the Appendix. The research methods and approaches utilized by the studies examined in this review are outlined in the Appendix Table 2. These tables not only summarize the literature reviewed in this paper, but also serve to clearly illustrate particular explanatory variables and research methods that have been applied in the North American literature, thus elucidating gaps.

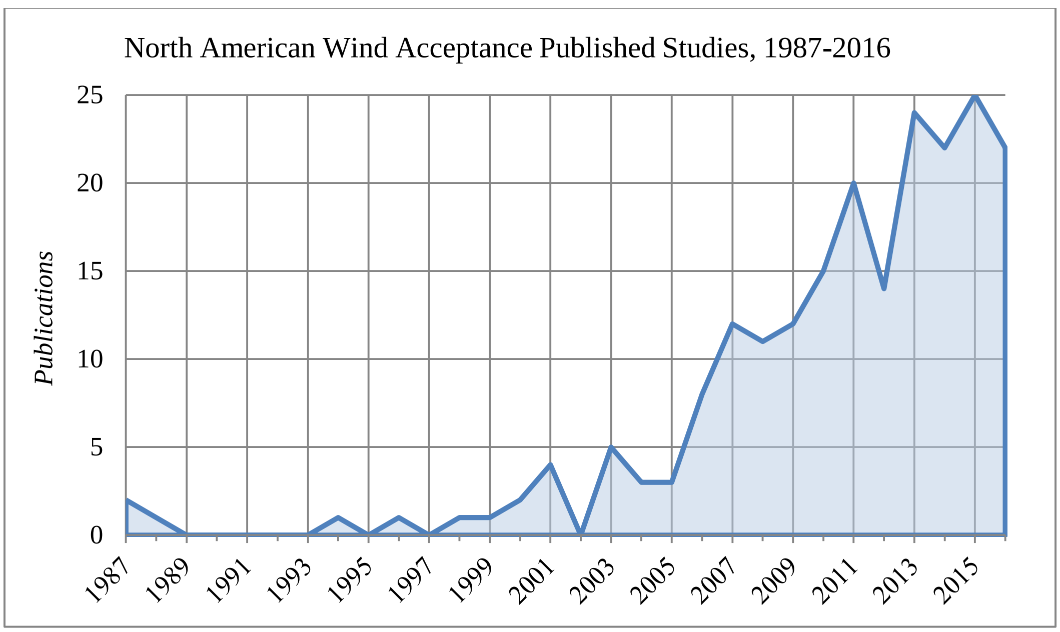

Figure 1: North American wind energy acceptance papers, 1987-2016. Data source: Scopus[3]

[3] This search was conducted using the Scopus database on April 25, 2017 using the following search string: TITLE-ABS-KEY ("wind energy" AND (public OR acceptance)) AND (LIMIT-TO (AFFILCOUNTRY , "United States ") OR LIMIT-TO (AFFILCOUNTRY , "Canada ") OR LIMIT-TO (AFFILCOUNTRY , "Mexico "))

2.2 Data Collection, Coding, and Qualitative Analysis of Papers

As each paper was read, it was entered into a detailed summary matrix to catalog the year, research questions, methods, analysis techniques, location, wind energy statistics (if applicable), sample size, explanatory variables examined, major conclusions, and additional research recommendations of each study.

These data became the framework for qualitative content analysis of the papers, which relied on interpreting the results, discussions, conclusions, and significant explanatory variables identified in the papers. This qualitative analysis led to the creation of the major themes detailed in Section 5, as well as the lessons learned outlined in Section 6, and the recommendations for further research discussed in Section 7 of this paper.

For quantitative studies, themes were identified by explanatory variables that were found to have a statistically significant effect on attitudes, support, or opposition. However, in some cases, a major contribution of particular papers was to *not* find a statistically significant effect of certain variables. Those were also included in the broad themes of this review. Similarly with qualitative and mixed-methods studies, the themes emerging from interviews, focus groups, and content analyses were categorized among the dominant themes identified in the broader body of literature. Table 1 of Appendix A summarizes these major explanatory themes that emerged from the literature, and identifies which papers from this review address each theme.

From the body of papers selected for this review, six overarching themes explaining attitudes and/or support and opposition toward wind energy emerged. Within each theme, a number of sub-themes also existed. These explanatory themes (along with their sub-themes) are analyzed and summarized in detail in Section 5 of this paper. The results and major conclusions of each paper are examined and contrasted to each other within each theme or explanatory group. The purpose of this analysis was to identify those explanatory variables with either broad agreement or considerable disagreement among the studies reviewed. Agreement among numerous studies would represent lessons learned (Section 6), where considerable disagreement (or a lack of research) may indicate a need for further research and/or suggestions for new methodologies (Section 7).

3. A Brief History of North American Wind Energy Acceptance Research

Academic research seeking to understand the acceptance of North American wind energy began in earnest shortly after some of the first experimental wind farms were installed in California in the 1980s. Surveys by Pasqualetti and Butler (1987) and Thayer and Freeman (1987) found a range of opinions among nearby residents, with negative attitudes most closely correlated with feelings of aesthetic degradation and frustration about non-functioning (i.e., non-spinning) turbines. Drivers of negative attitudes cited by Bosley & Bosley (1988) include a lack of knowledge about wind energy's "maturity" among opponents along with a failure on the part of the wind industry to communicate properly with affected parties. Gipe (1995) dedicated a full chapter to turbine aesthetics and community acceptance in his book, *Wind Energy Comes of Age.* Gipe specifically addresses aesthetic design, turbine reliability, the pace and process of planning and development, the distribution of costs and benefits (i.e., compensation), and community ownership models as potential determinants of acceptance (Gipe, 1995). These early studies led the way for three decades of scholarship in the field of wind energy acceptance.

According to this literature, wind energy has been viewed favorably throughout North America over the past 30 years, with 70%–90% of those surveyed approving of wind energy generally (Bidwell, 2013; Klick & Smith, 2010; Vyas & Hurst, 2013) and that approval remaining high over time (Vyas & Hurst, 2013). Support also has been high among residents of communities where wind projects have been proposed but not yet built (Firestone et al., 2009; Firestone et al., 2012a; Mulvaney et al., 2013b). In studies of people near existing wind facilities, 70%–90% of respondents express positive or neutral attitudes (Baxter et al., 2013; Fergen & Jacquet, 2016; Mulvaney et al., 2013b; Pasqualetti & Butler, 1987; Petrova, 2014; Slattery et al., 2012). Nonetheless, the 10%–30% of individuals who do *not* support proposed wind developments or hold negative attitudes toward existing facilities—as well as the factors influencing those positions—are of strong interest to the research community. Many researchers also seek to identify ways to minimize negative factors from existing and future wind developments.

In any case, opposition to wind development and negative attitudes toward existing wind installations are normal, and they likely will exist as long as wind facilities exist. The same can be said about other large construction projects. Transmission lines, landfills, and parks are among the types of projects that have been opposed (Gipe, 1995), and some people even protested the location and appearance of the Statue of Liberty (Petrova, 2013). Every component of our current electrical system was the product of social negotiation and compromise, including over “17,000 conventional generators, 250,000 miles of high voltage transmission lines, thousands of substations,” and much more (Sovacool, 2009, p. 4502).

The rich body of research on wind energy acceptance spans myriad disciplines, from psychology and health science to economics and political ecology. During the three decades of study that produced this literature, public acceptance of wind energy “has gone from a marginal and little studied point of discussion to be at the forefront of broader debates in the social sciences” (Fournis & Fortin, 2016, p. 1). The study of wind energy acceptance has evolved considerably over this time. While early studies were exploratory and anecdotal, the statistical rigor of analysis, the application of diverse methods, and the development of complex theoretical frameworks have all improved over time.

Accordingly, the North American literature has coalesced around the need to understand two primary dependent variables or outcomes of interest related to wind energy acceptance: level of support/opposition, and attitudes. This paper distinguishes these two variables by using the terms “support” and “opposition” when discussing *proposed* or *hypothetical* wind facilities (pre-construction) and "positive and negative attitudes" when discussing *existing* wind facilities (post-construction).[4] Each of these variables has a range (e.g., from support to oppose or from positive to negative) that are typically expressed in five-point Likert scales. The literature has similarly coalesced around a number of overarching explanatory variables, which influence or explain changes in these dependent variables. The major explanatory variables in the North American wind acceptance literature are detailed in Section 5.

4. Limitations of Previous North American Wind Acceptance Research

This section describes a number of fallacies, biases, and limitations that have pervaded previous North American wind acceptance research. In some cases, these biases and limitations have prevented meaningful understandings and obstructed implementation of research findings and recommendations among developers and policymakers. Where appropriate, recommendations for future research are noted briefly, which are later summarized in sections 6 and 7.

From early surveys of residents near California wind farms (Bosley & Bosley, 1988) until today, opposition and negative attitudes toward wind energy have commonly been described by developers, politicians, and researchers as not-in-my-backyard (NIMBY) resistance (Petrova, 2013). The NIMBY concept posits that individuals favor wind energy generally but not in their local context—not in their "backyard." NIMBY also has been studied for decades in the context of nuclear energy and other hazardous facilities as well as social facilities such as prisons and mental health institutions (Wolsink, 2000).

However, many researchers now agree that the NIMBY framework is overly simplistic and unable to explain the complex motivations, concerns, and perceptions that can lead to opposition and negative attitudes (Devine-Wright, 2005; Petrova, 2013). Firestone et al. (2012b) stress that NIMBY resistance may be a *result* of opposition, rather than an explanation of it. Moreover, the term is generally used pejoratively (Kempton et al., 2005). A study in Texas concludes that NIMBY is "politically inappropriate and can often lead to misunderstanding, adding little value to the decision-making process" (Swofford & Slattery, 2010, p. 2516).

Social science researchers now generally agree that the language and concept of NIMBY as an explanation for wind energy opposition should be abandoned altogether[5] (Devine-Wright, 2005; Petrova, 2013; Wolsink, 2006, 2012).

Another problem with the literature is positivist language toward wind energy, which some researchers

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[4] In some studies, residents near existing facilities are asked about their level of support for additional wind development in the area. The distinction between "attitudes" toward the existing facility and "support" for additional development still applies in these cases.

[5] Based on ample evidence that the NIMBY explanation is problematic and unhelpful, this paper discards the term and instead focuses on examining other proposed explanations and correlates of wind energy acceptance.

have argued may reduce the quality and reliability of research and may prevent meaningful understandings of public acceptance (Aitken, 2010; Ellis et al., 2007). European researchers such as Aitken (2010), Ellis (2007), and Taebi (2016) have criticized researchers who portray wind energy opponents as “deviant” and seek to understand opposition merely to “overcome” it, but this criticism of positivist research has not been highlighted or examined to the same degree by North American researchers. It has been suggested that instead of focusing on the reasons for negativity toward wind energy, some researchers have sought methods to ensure approval (Taebi, 2016). According to Ellis et al. (2007, p. 536), this positivist lens has led to “poor explanatory findings, which in turn has resulted in ineffective policy.” Songsore and Buzzelli (2014) stress that focusing only on mitigating resistance neglects important community concerns and may lead to negative consequences. Positivist language in the literature may include, for example:

- Statements that favor the needs of the wind industry over opponents, such as: “without public support in communities across the country, the industry's ability to build wind farms where it needs them may be hindered by nimbyism” (Klick & Smith, 2010, p. 1590)
- Statements that suggest opposition is a barrier that must be overcome and opponents are deviant, such as: “social barriers are blocking our way. That is to say, people are creating the problems, not technology” (Pasqualetti, 2011b, p. 202)
- Suggestions that the motivation of wind energy acceptance research is to help meet federal or state level renewable energy goals (e.g., Mulvaney et al., 2013)

Such positivist language has appeared regularly in the U.S. research to date (such as: Gipe, 1995; Klick & Smith, 2010; Olson-Hazboun et al., 2016; Pasqualetti, 2011b; Sovacool, 2009), but is less present in prominent Canadian research (such as: Baxter et al., 2013; Fast et al., 2016; Shaw et al., 2015; Walker et al., 2014b, 2014c), and rare in research rooted in humanistic geography (such as: Abbott, 2010; Phadke, 2013; Walker et al., 2014b), which tends to express more empathy toward affected communities. Researchers should cautiously avoid a positivist research lens.

Many North American wind energy acceptance studies have focused on hypothetical or proposed wind facilities, rather than existing facilities. Although asking individuals about their opinions toward hypothetical or proposed wind facilities can help answer certain research questions (e.g., about facilities, like offshore U.S. wind farms, that do not yet exist), these studies cannot reflect the unique feelings and experiences of residents living near existing turbines. Moreover, many studies around existing wind projects have not adequately examined the population living nearest to the turbines by oversampling and/or isolating the nearest residents for unique analyses (such as: Baxter et al., 2013; Bidwell, 2013; Fergen & Jacquet, 2016; Groth & Vogt, 2014; Olson-Hazboun et al., 2016; Pasqualetti & Butler, 1987; Petrova, 2014; Slattery et al., 2012; Thayer & Freeman, 1987). As such, numerous researchers have called for research focusing on residents closest to wind turbines (Hoen et al., 2011; Walker et al., 2014a). It is especially important that this group be represented in acceptance research, because it is most likely to be affected by wind facilities.

The vast majority of North American studies focus on only one or a few locations or wind facilities, so results cannot be generalized to the wider population living near wind turbines (e.g. Baxter et al., 2013;

Bidwell, 2013; Firestone & Kempton, 2007; Firestone et al., 2012b; Groothuis et al., 2008; Groth & Vogt, 2014; Olson-Hazboun et al., 2016; Pasqualetti & Butler, 1987; Petrova, 2014; Slattery et al., 2012; Thayer & Freeman, 1987). Some of these studies have used convenience samples rather than robust random samples, further limiting their external validity (e.g. Landry et al., 2012; Mulvaney et al., 2013b; Walker et al., 2014c). Fast and Mabee (2015, p. 27) suggest that this qualitative, case-study nature of wind acceptance research "does not translate well to conventional policy making." The dominance of these discrete case studies with poor comparability between them has recently led some European researchers to question whether wind acceptance research is "running out of steam" (Ellis & Ferraro, 2017).

There are considerable challenges and costs to developing and deploying research that is broadly representative across large regions like North America, making such studies out of reach for most researchers. Case studies may still add considerable insights and value in the North American context, but the value of these studies could be compounded through comparison. Future research might attempt to standardize some survey items and protocols in order to enable comparison of data across multiple case studies.

Nationwide surveys of wind acceptance in the United States and Canada ask only very broad questions, for example, about levels of support for wind energy generally. These broad surveys typically find high levels of support and positive attitudes (Ipsos, 2010; Leiserowitz et al., 2014; Vyas & Hurst, 2013), but they tell us little about *why* respondents feel the way they do. Some researchers have even called into question the validity of such general opinion polls (Aitken, 2010).

It would be useful to examine wind energy acceptance in concert with acceptance of other energy sources—like coal, nuclear, natural gas, and solar—but this has rarely been done. A notable exception is the work of Jeffery Jacquet, whose studies examine attitudes toward and perceived impacts of wind energy and natural gas developments, finding more polarized and negative attitudes and larger perceived impacts (both negative and positive) related to natural gas developments (Jacquet, 2012; Jacquet & Stedman, 2013).

The successful implementation of thirty years of research findings into developer and policymaker practice over the past has also been limited. As Zaunbrecher and Ziefle (2016, p. 312) state, "many factors that influence the social acceptance of wind power plants are already known. However, a conceptual framework for wind power plant planning that integrates these factors as well as the method of assessing them is still missing." Frameworks for wind project planning that increase community engagement and reduce conflict, such as those developed by Petrova (2016) and Jami & Walsh (2017), could continue to be developed and examined.

Despite these limitations, the North American wind acceptance literature has contributed significantly to the state of knowledge, and has evolved iteratively over the past 30 years, with improving rigor of research over time. The literature's major findings and contributions are summarized in the following section.

5. Overarching Aspects and Explanatory Variables in North American Literature

The North American literature reveals two primary dependent variables related to wind energy acceptance: level of support/opposition and attitudes among residents living near proposed or existing wind facilities. Among the explanatory variables that researchers correlate to those dependent variables, six overarching themes emerge: (1) socioeconomic aspects (including compensation); (2) sound annoyance and health risk perceptions; (3) visual/landscape aspects, annoyance, and place attachment; (4) environmental concerns and attitudes; (5) perceptions of planning process, fairness, and trust; and (6) distance from turbines (proximity hypothesis). Each theme is detailed below.

5.1 Socioeconomic Aspects

Individuals express a great deal of positive and negative concern over the socioeconomic aspects of wind facilities. Some studies find anticipated economic effects to be the variable most strongly influencing support or opposition to proposed wind developments as well as positive or negative attitudes toward existing sites (Bidwell, 2013; Brannstrom et al., 2011; Slattery et al., 2012; Songsore & Buzzelli, 2015).

5.1.1 Positive economic aspects

Positive economic aspects of wind energy development include rural economic development (Mulvaney et al., 2013b) including creation of jobs and other economic opportunities (Slattery et al., 2012), local tax revenue and/or lower tax rates for individuals (Slattery et al., 2012), increased tourism (Groth & Vogt, 2014), reduced electricity rates (Baxter et al., 2013) and landowner compensation (Jacquet, 2012). Landowner compensation, however, is not a universally positive socioeconomic impact for individuals living near turbines. It may create perceptions of “winners” and “losers” (Firestone et al., 2012b) and increase intra-community conflict (Baxter et al., 2013; Walker et al., 2014b). Compensation can even be seen as a form of bribery (Gipe, 1995). Having some form of compensation for nearby residents that are not hosting turbines on their land may lesson conflict and notions of winners and losers. For example, non-monetary, non-individual compensation such as the creation of dedicated wildlife habitats or support of community projects was supported by non-hosting community members in one study (Groth & Vogt, 2014). Other research suggests that non-hosting community members prefer public compensation over private compensation (García et al., 2016). Another form of compensation that has been examined is community investment in or ownership of wind facilities. Local ownership enables more equitable distribution of financial benefits as well as a higher degree of participation and influence in the development of a wind facility (Fast et al., 2016). This model has been shown to increase support in the European context, but little evidence exists in the North American context where community ownership remains rare (Bolinger, 2005; Ferguson-Martin & Hill, 2011; Sovacool & Ratan, 2012). In general, more research is needed to understand appropriate and acceptable compensation mechanisms for individuals and communities.

5.1.2 Negative economic aspects

Perceived negative socioeconomic impacts include reduced property values (Abbott, 2010; Firestone & Kempton, 2007; Hoen et al., 2015), decreased tourism (Landry et al., 2012; Lilley et al., 2010; Lutzeyer, 2013), increased traffic (Slattery et al., 2012), exacerbating economic inequality (Walker et al., 2014b, 2014c), impacts to fishing and other recreational opportunities (Firestone et al., 2009), and increased electricity rates (Baxter et al., 2013). Impacts on electricity rates are seen as a two-sided coin, with supporters citing reduced rates and opponents citing increased rates (Firestone et al., 2012a). Although nationwide and state-level studies in the United States have not found evidence of consistent, measurable, or significant reductions in home values near operating wind facilities (Hoen & Atkinson-Palombo, 2016; Hoen et al., 2015; Lang et al., 2014), the *perception* or belief of property value impacts may still affect acceptance of wind (Abbott, 2010; Walker et al., 2014a). Additionally, there is evidence that home-value effects might exist in the U.S. (Heintzelman & Tuttle, 2012) and Canadian (Fast et al., 2015) contexts, and there is growing evidence that effects exist in the European context (e.g. Dröes & Koster, 2016; Gibbons, 2015; Jensen et al., 2014). More research in this area could not only untangle conflicting results, but also increase understanding of how perceptions of property value impacts influence acceptance.

5.1.3 Distributional justice

The distribution of the costs and benefits of wind energy developments, broadly referred to as *distributional justice*, has been widely studied in the literature. Survey respondents consistently express concern that the energy and economic benefits produced from local wind facilities do not stay local and benefit local residents (Baxter et al., 2013; Groth & Vogt, 2014). Some studies have shown angst and opposition toward multinational corporate wind developers (Pasqualetti, 2011a; Petrova, 2013), and Firestone and Kempton (2007) demonstrate that support would increase for a proposed wind facility if it were being developed by the local government, rather than a private developer. The inability of local community members to invest or share ownership in wind energy developments has been cited as a factor in negative attitudes (Songsore & Buzzelli, 2015).

Unfair distribution of costs and benefits may lead to intra-community and/or rural-urban conflicts (Hirsh & Sovacool, 2013; Larson & Krannich, 2016; Pasqualetti, 2000; Phadke, 2013; Rule, 2014; Sovacool, 2009; Walker et al., 2014c) or injustices toward indigenous communities (Huesca-Pérez et al., 2016). Phadke (2013, p. 248) summarizes this conflict: "Rural communities at the forefront of new energy development are asking why they are disproportionately being asked to carry the weight of the new carbon economy while urban residents continue their conspicuous use of energy." Rural residents may also feel exploited by urban, multinational, corporate project developers seeking profits over public welfare (Petrova, 2013; Sovacool, 2009). Thus, some individuals who oppose or hold negative attitudes toward wind facilities may be fighting against a feeling of injustice as they find themselves on the front lines of development impacts while still on the margins of politics and economic opportunity. On the other hand, rural-urban conflicts may also propagate when the local, rural residents *support* the wind facility. Sovacool (2009, p. 4510) suggests that, in some cases, "rural [longstanding] residents want renewable power projects for their own use, as a vehicle for economic development, and resent what seems like meddling by urban [newly arrived] residents intent on preserving the countryside for its scenic and recreational value."

Perceived socioeconomic impacts are at the forefront of concerns for many individuals living near existing and proposed wind facilities, but those perceived impacts and the ways they influence acceptance are complex. More research is needed to understand inter- and intra-community conflicts, the effects of and community responses toward compensation mechanisms, and the relationships between perceived economic impacts and perceived fairness of planning processes and outcomes.

5.2 Sound Annoyance and Health Risk Perceptions

5.2.1 Annoyance from wind turbine sound

Some studies have correlated turbine sound with *annoyance*, which may be associated with sleep disturbance, negative emotions, or other health-related effects (Knopper & Ollson, 2011; Knopper et al., 2014; Michaud et al., 2016a). The annoyance experienced by people living near utility-scale wind facilities is correlated to more negative attitudes (Fast et al., 2016; Firestone et al., 2015). This annoyance, however, may be more strongly correlated to other characteristics rather than wind turbine sounds (McCunney et al., 2014). In Europe, Pedersen & Waye (2004), showed that residents' level of annoyance with wind turbine sound is strongly influenced by their level of annoyance with the visual impact of turbines (discussed in section 5.3.1), yielding higher annoyance with turbine sound compared with dose-response curves from other, non-turbine sound emissions, such as transportation noise. This result deserves further study in the North American context.

Some research has demonstrated that annoyance and complaints decline with increased distance from turbines (Kaliski & Neeraj, 2013; Nissenbaum et al., 2012), but there is no general consensus about the setback distance required to minimize or mitigate annoyance (Nissenbaum et al., 2012) as distance is just one component of how sound from turbines propagates to nearby residents. Accordingly, researchers (and stakeholders in general) often rely on a sound-specific threshold to reduce annoyance and stress impacts and concerns from local residents, which is commonly 40-45 dBA[6] (Knopper & Ollson, 2011; Knopper et al., 2014; Paller, 2014; Phadke, 2013). The World Health Organization recommended a maximum of 45 dBA outside of homes during night hours (World Health Organization, 1999), but that recommendation was revised for the European Union in 2009 to 40 dBA (World Health Organization, 2009). This sound level has been compared to the sound level of a quiet office, library, a computer, or a refrigerator in a nearby room[7]. In a recent comprehensive study of measured wind turbine sound levels and reported health effects, turbine noise reached a maximum of 46 dBA and a mean of 35.6 dBA for 1,238 residents living between 0.25 – 11.22 kilometers from operational wind turbines in Canada (Michaud et al., 2016b).

Although sound levels comparable to a quiet office or library may not be annoying to most people, studies have suggested that wind turbine noise is considered annoying at much lower sound levels than those causing annoyance from other sources (Janssen et al., 2011). Some recent research has attributed

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[6] dBA = A-weighted decibels, a measure of loudness as perceived by the human ear. Measurements are typically average nighttime levels outside homes, and do not include ambient noise.

[7] For example dBA comparisons, see e.g., http://www.rlcraigco.com/pdf/dba-comparison.pdf

this to the amplitude modulation (i.e. swishing or thumping) of turbine sounds (Yoon et al., 2016), however this has not been rigorously examined in the North American context.

5.2.2 Health effects of wind turbine sound

Recent epidemiological research concludes that wind turbine sound and infrasound[8] are not directly related to adverse human health effects (Knopper & Ollson, 2011; Knopper et al., 2014; Michaud et al., 2016a) or sleep quality (Michaud et al., 2016b). Some research attributes wind-related health symptoms to the "nocebo" hypothesis, in which the *expectation* of negative health effects influences symptoms experienced (Knopper et al., 2014).

Nonetheless, the *perception* of health risk clearly reduces support for wind facilities (Baxter et al., 2013; Magari et al., 2014), and some wind opponents may feel that potential health risks are not adequately addressed (Songsore & Buzzelli, 2014). Walker et al. (2014c, p. 1) suggest a move beyond debating "whether or not 'annoyance' represents a 'health impact' and instead focus[ing] on ways to minimize … feelings of threat and stress at the community level." Similarly, Fast et al. (2016, p. 3) conclude that "rather than dismissing health claims as groundless or inconsequential, policy-makers should take a precautionary approach so as to more thoroughly address the factors that contribute to frustration on the part of host communities." If community concerns and expectations regarding sound and health impacts are not adequately addressed, a portion of the population may remain annoyed even after noise limits are enforced (Knopper et al., 2014).

Although there is a demonstrated correlation between wind facility sound, annoyance, and negative attitudes, more research is needed to understand these relationships. Topics that must be explored include measured (or modeled) sound and reported annoyance levels; types of sounds that are particularly annoying; the relationships among sound, annoyance, and respondents' distance from turbines; and the influence of other variables such as visual annoyance, place attachment, procedural fairness, and respondent characteristics.

5.3 Visual/Landscape Aspects, Annoyance, and Place Attachment

Visual impacts and landscape change are some of the most frequently cited correlates to reduced support of proposed wind projects and negative attitudes toward existing wind facilities. In general, visual and landscape concerns relate to a desire of communities to protect local landscape quality and identity in the face of change (Phadke, 2010).

5.3.1 Aesthetics and Annoyance

Numerous studies have indicated that the diminution of scenic beauty due to existing or proposed wind facilities may contribute to annoyance and is often linked to negative attitudes or reduced support (Bosley & Bosley, 1988; Bush & Hoagland, 2016; Gipe, 1993, 1995; Jacquet & Stedman, 2013; Pasqualetti & Butler, 1987; Pasqualetti et al., 2002; Phadke, 2010; Rule, 2014). Visual annoyance may

[8] Infrasound is sound at frequencies lower than 20 Hz, which may be emitted by wind turbines as well as a number of other sources.

also result from “shadow flicker” created near turbines as sunlight passes through the blades of wind turbine in motion (Rule, 2014). Knopper & Ollson (2011) conclude that annoyance and self-reported health effects are more strongly related to visual impacts than to sound from wind facilities. Some researchers have suggested guidelines or best-practices for minimizing visual impacts of wind developments (Apostol et al., 2016; Pasqualetti et al., 2002); visual impact guidelines have also been suggested by U.S. (National Academy of Sciences (NAS), 2007; Sullivan et al., 2012) and Canadian (BC Ministry of Forests, 2016) government organizations.

New wind development in North America now routinely includes some form of visual impact assessment, typically in the form of computer-generated visual simulations of what a wind facility may look like from various vantage points (Apostol et al., 2016; Phadke, 2010). Phadke (2010, p. 17) argued that the visualizations created by wind energy developers and project opponents alike are an “immature policy craft”, are inherently political, and encoded with cultural values. As such, they may further polarize opinions rather than providing useful information to community stakeholders. However, Apostol et al. (2016) suggest useful guidance and techniques to improve such visualizations and enhance their usefulness.

Negative attitudes stemming from the visual impacts of wind turbines may not occur simply because people dislike how turbines look; people also have become accustomed to an electricity system that is essentially “invisible” to consumers owing to centralized infrastructure typically sited far from population centers (Pasqualetti, 2000; Sovacool, 2009). As Sovacool (2009, p. 4509) states, “the physical ‘removal’ of power stations from most cities and neighborhoods also ‘removes’ them from the minds of most Americans, and contributes to public apathy and misunderstanding.” Until recently, “electric generators were usually built in obscure locations, perceptible only to a few people. But wind turbines, by their very nature, require a highly dispersed and visible distribution, often in attractive and unspoiled areas” (Hirsh & Sovacool, 2013, p. 724).

On the other hand, visual impacts are not universally negative; there is some evidence for positive visual and symbolic perceptions from wind facilities (e.g., Brannstrom et al., 2011; Firestone et al., 2015; Mulvaney et al., 2013a; Phadke, 2010).

The rotational motion of wind turbines has been another topic of study. Early studies found that perceptions that turbines were “unreliable” or often not operating were correlated to negative attitudes and concerns about tax fraud (Gipe, 1993; Pasqualetti & Butler, 1987; Thayer & Freeman, 1987). More recently, Fergen and Jacquet (2016) found that respondents believed nearby turbines were more beautiful when the turbines were in motion, which they attribute to notions of economic productivity of turbines in motion compared to lost economic opportunity of motionless turbines.

5.3.2 Visual impacts and economics

Some researchers have highlighted visual impacts from wind turbines in choice experiments or other economic modeling techniques. For example, some property value impact studies use distance and views of the turbines as correlates (e.g. Hoen et al., 2011; Jensen et al., 2014). Some residents may be willing to pay to minimize the perceived negative visual impacts of proposed wind facilities (Boatwright, 2013; Groothuis et al., 2008; Krueger et al., 2011; Pasqualetti, 2001). Visual impacts have even been framed as a property-rights infringement in some cases (Abbott, 2010).

5.3.3 Place Attachment

Threats to *place attachment*—an emotional bond between individuals and the familiar locations they inhabit—are highlighted as a correlate in European literature (Devine-Wright, 2009; Devine-Wright & Howes, 2010). Under the place attachment theory, landscape impacts extend beyond aesthetics into the identities, connections, and meanings that individuals form with a particular location (Devine-Wright, 2009). Some North American studies also emphasize the role of place attachment in influencing wind energy acceptance (Bidwell, 2013; Fast & Mabee, 2015; Firestone et al., 2009), but Jacquet and Stedman (2013) found that place meanings seemed to have little or no association with acceptance of wind development in their Pennsylvania study. Future research in North America should continue to examine the influence of place attachment on acceptance.

Visual impacts are a widely studied, well-documented correlate to wind energy acceptance. Requiring further study, however, are the extent to which visual impacts influence other explanatory variables and vice versa (e.g., sound); the mechanisms behind *positive* visual perceptions; the effects of distance and physical geography on visual annoyance; the effect of different degrees of visual impacts (such as seeing the full sweep of turbine blades from the home vs. only a portion of the turbine); the frequency individuals see the turbines; and the role of planning process fairness and/or participation in diminishing or mitigating visual annoyance.

5.4 Environmental Concerns and Attitudes

Numerous researchers have noted that, in wind power siting debates, both supporters and opponents base their arguments on environmental concerns. These so-called “green vs. green” debates typically revolve around local environmental harms (e.g., wildlife, landscape, and noise impacts) versus regional or global benefits (e.g., climate change mitigation and air pollution reduction) (Firestone et al., 2009; Warren et al., 2005). As such, some studies have found pro-environmental beliefs and values to correlate positively with support for wind energy (Larson & Krannich, 2016; Mulvaney et al., 2013b), while others have found the opposite (Fergen & Jacquet, 2016). Research has also shown that environmental beliefs may correlate to support for wind energy broadly, but that support may not exist when the same individuals are asked about local wind energy development (Larson & Krannich, 2016). In some cases, individuals with stronger environmental attitudes may prioritize the conservation of “natural” landscape over the benefits of renewable energy (Fergen & Jacquet, 2016). Abbott (2010, p. 971) concludes that these multiple conservation priorities perpetuate environmental conflicts in local contexts.

5.4.1 Wildlife concerns

Since the earliest wind facilities in North America began operation, the potential threats of wind energy to wildlife, particularly birds and bats, have been of significant concern. A 2013 study estimated that between 140,000 and 328,000 birds are killed annually by collisions with wind turbine towers in the contiguous United States (Loss et al., 2013). This is a notable impact that may reduce support for wind energy in some individuals. However, Sovacool (2013) estimates that wind energy kills approximately 13 times fewer birds than fossil fueled power plants per kilowatt-hour of electricity generated. Similarly, a recent Canadian study found that avian mortality due to wind turbines was relatively small compared to other sources of human-influenced avian mortality (Zimmerling et al., 2013). These factors may induce some individuals to prefer the avian impacts of wind energy in comparison to alternatives (thus increasing support). Perhaps due to these conflicting considerations, previous research does not demonstrate a clear influence of wildlife impacts on onshore wind energy acceptance. Summary statistics have shown between 18-24% of local residents consider onshore wind turbines dangerous to wildlife (Mulvaney et al., 2013a; Slattery et al., 2012; Thayer & Freeman, 1987), and few studies have found this concern to statistically affect acceptance (e.g., Larson & Krannich, 2016).

Experience from the Cape Wind project suggests that wildlife concerns may significantly influence acceptance of *offshore* wind energy. Firestone et al. (2012a), for example, found that 48% of respondents believed Cape Wind would cause harm to bird life, and 44% thought it would harm marine life (those percentages decreased slightly in a repeat survey in 2009). Firestone and Kempton (2007) reported that if Cape Wind were found to harm marine or bird life, the majority of respondents would be less likely to support the project. In their book on Cape Wind, Williams and Whitcomb (2007) also emphasize the role of perceived impacts to birds, fish, and whales in shaping public opinion.

5.4.2 Climate change concerns

Wind energy's potential to mitigate climate change is a benefit often cited by supporters (Petrova, 2013), but concern for climate change alone does not fully explain support for wind. Accordingly, efforts to encourage support by emphasizing climate benefits may be met with indifference (Bidwell, 2015; Firestone et al., 2009; Petrova, 2016; Swofford & Slattery, 2010). Olson-Hazboun et al. (2016, p. 168) further suggest that emphasizing environmental and climate benefits may actually *increase* opposition in some contexts owing to the politically polarizing nature of such topics; they conclude that "the framing of renewable energy as an environmental issue could have unintended and adverse effects in certain social and political contexts." Other research has found that even people who are unconcerned about the environment or the use of fossil fuels may strongly support wind energy development based on potential economic opportunities (Slattery et al., 2012).

Overall, a number of researchers have found that support for wind energy is less correlated to environmental beliefs than to other factors such as economic and landscape impacts (Olson-Hazboun et al., 2016). Nonetheless environmental concerns clearly play a role in attitude formation for many individuals living near turbines, and more research could add nuance to the perceived environmental trade-offs of wind energy. Future work should continue to examine the role of environmental motivations for wind energy attitudes in different socio-political contexts.

5.5 Perceptions of Planning Process, Fairness, and Trust

The processes around wind project planning and development can significantly affect public acceptance (Firestone et al., 2012b), and a lack of opportunity for local residents to engage meaningfully in the planning process may reduce support or increase local conflict (Bohn & Lant, 2009; Huesca-Pérez et al., 2016; Phadke, 2011). In some wind development models, local citizens have been entirely removed from the planning and design of wind developments (Phadke, 2013). This may lead to feelings of injustice among local residents, who perceive that "government and corporate decision-making … takes place in faraway boardrooms disconnected from the people and landscapes that will be directly affected" (Phadke, 2013, p. 247). This perception of injustice may be especially severe among already disadvantaged communities (Huesca-Pérez et al., 2016).

A more participatory, collaborative planning process may reduce conflict and promote positive community outcomes (Groth & Vogt, 2014; Jami & Walsh, 2017; Songsore & Buzzelli, 2015; Walker et al., 2014c). Some scholars have suggested moving away from a "decide-announce-defend" model of wind facility planning toward a more collaborative, "consult-consider-modify-proceed" process (Phadke, 2013, p. 250). Indeed, Jacquet (2015) found that landowners participating and negotiating in the development process were better informed and more supportive than non-participating landowners. Some researchers, however, have demonstrated significant barriers to genuinely participatory, consensus-based planning processes, which may prevent widespread implementation of such strategies (Jami & Walsh, 2014). The numerous calls from researchers to increase public participation rarely include detail on how to implement participatory methods or measure their success (Bidwell, 2016b). In response to this need, a recent paper developed a recommended framework for meaningful community engagement and outlined a number of suggested strategies to increase public participation and reach consensus, including: early involvement of the community, being available, proactive, and present within the community, building relationships and trust, and offering financial investment in the project to the local community (Jami & Walsh, 2017). Nonetheless, questions still remain about how and when to engage the public and encourage participation in the planning process. Despite the challenges, it is seen as counterproductive to exclude participation based on the assumption that local community members lack the necessary information to make informed decisions (Petrova, 2016).

A planning process perceived as "fair" can lead to greater toleration of the outcome, even if it does not fully satisfy all stakeholders (Firestone et al., 2012b), whereas processes perceived as "unfair" can result in conflict, damaged relationships, and divided communities (Fast et al., 2016). However, greater toleration is not necessarily synonymous with support or "successful coexistence" (Songsore & Buzzelli, 2014). In other words, individuals may tolerate an outcome they perceive as fair, even if they did not get exactly what they wanted. Owing to this distinction, some researchers have begun to study support and toleration as separate dependent variables (Petrova, 2013).

The perceived fairness of the planning process is linked to *trust* between the local community and the project developers, and some researchers consider this trust important for project support (Dwyer, 2016; Fast & Mabee, 2015). Shaw et al. (2015) conclude that public trust has been eroded by governments that have not effectively engaged communities in fair decision-making processes. Aitken (2010, p. 1840) stresses that a pro-wind bias among developers and policymakers can undermine trust among stakeholders: "In order for this trust to be meaningful it cannot be conceived as a means to a particular end—i.e. less opposition and more wind farms."

Although numerous studies have shown correlations among perceived inclusiveness, fairness, trust, toleration, and support, more research is needed to understand when and how actually to *implement* more collaborative, democratic planning processes. Future research should also further examine the relationships between perceived procedural justice and socioeconomic impacts of wind development.

5.6 Distance from Turbines (Proximity Hypothesis)

Since the earliest studies on this topic, researchers have consistently examined the hypothesis that those living closest to turbines will have the most negative attitudes about the local wind facility. These studies, however, have produced no clear consensus. Some studies confirm the notion that positive attitudes increase with distance from the nearest turbine (Swofford & Slattery, 2010; Thayer & Freeman, 1987), while others show the exact opposite: that those living nearest turbines have more positive attitudes and are less concerned about potential negative impacts of the turbines (Baxter et al., 2013; Groth & Vogt, 2014; Warren et al., 2005). However, it is unclear whether such results adequately account for confounding variables, such as landowner compensation and other economic benefits accruing to nearby residents.

Olson-Hazboun et al. (2016) studied a different, related variable in addition to distance from the nearest turbine: how frequently respondents see (or expect to see) wind turbines, which they call “visual accessibility.” These authors found no significant relationship between distance and attitudes toward the wind facility, but they did find that residents who see wind turbines more frequently were less likely to express positive attitudes toward the facility. Other studies have proposed that impacts from wind facilities may be cumulative, increasing with the size of turbines, the number of turbines visible, and the clustering of turbines (Petrova, 2013; Walker et al., 2014c). However, some European studies have not found a significant correlation between the number of turbines and negative attitudes (Krohn & Damborg, 1999; Pohl et al., 2012). Questions around cumulative impacts and visual accessibility merit additional study in the North American context.

Some researchers have hypothesized that, over time, individuals will “self-sort,” as those with more positive attitudes move closer to turbines and those with more negative attitudes move away (Hoen et al., 2015; Tiebout, 1956). This effect, however, has not been rigorously examined.

Although many researchers have found a correlation between distance from an individual to the nearest turbine and attitudes toward wind energy, the direction and strength of that correlation remains in question, as does the extent to which regional, demographic, or other factors may influence this correlation. More research is also needed to understand relationships between distance and other correlates to acceptance, such as sound and visual impacts.

5.7 Other Proposed Correlates of Acceptance

Aside from the six dominant themes discussed in the preceding sections, the literature identifies a number of other potential correlates of wind energy acceptance. Some researchers have proposed that a lack of knowledge about energy generally or wind energy specifically may explain opposition or negative attitudes (Bosley & Bosley, 1988; Bush & Hoagland, 2016; Klick & Smith, 2010; Sovacool, 2009), but this “information deficit” explanation has been largely discredited. Opponents and those with negative attitudes are not ignorant of wind energy facts (Fast, 2015), and high levels of knowledge about energy do not necessarily correlate with support or positive attitudes (Baxter et al., 2013). On the other hand, Bidwell (2016a) did find a relationship between an informational intervention and increased support, and suggests that the information deficit model should not be dismissed.

Demographic data are also routinely collected and examined as possible correlates to wind energy acceptance in survey research. However, throughout the literature, demographic variables such as gender, income, and education level do little to explain variation in wind energy support or attitudes. Where reported, the effects of demographic variables on acceptance are typically not statistically significant (e.g., Firestone et al., 2015; Jacquet & Stedman, 2013; Mulvaney et al., 2013b).

Other proposed explanations for acceptance include concerns about dependence on foreign energy sources (Firestone et al., 2009), personal and moral values (Bidwell, 2013, 2015), attitudes toward local or federal government policy (Fast & Mabee, 2015; Petrova, 2014; Songsore & Buzzelli, 2014), and the degree to which expectations about a development are met (Fergen & Jacquet, 2016).

Many of these additional variables may relate to and be influenced by the six major themes previously discussed. In addition to clarifying the influence of the six major themes, future research should explore the influence of these other variables.

6. Lessons learned in 30 years of wind acceptance studies

Over the past three decades, scholars have substantially advanced the state of knowledge about wind energy acceptance in North America. Each new study has added evidence to existing hypotheses, proposed new hypotheses, presented new methods for engaging stakeholders in research, used new methods for data analysis, and/or incorporated new geographic areas under the umbrella of research. The studies have collected data spanning the period before any local development to well after the wind facilities began operating. Drawing from the sections above, the lessons learned over the past 30 years are summarized here:

Overall, support is high, and attitudes are largely positive. The North American literature consistently finds favorable views of wind energy; 70%–90% of North Americans approve of wind energy generally, and support has been high for specific existing and proposed wind facilities as well.

Researchers should cautiously avoid a positivist research lens. Viewing opposition merely as something to be *overcome* reduces the quality of research and prevents meaningful understandings and implementation of best practices. The motivation of wind energy acceptance research should not be exclusively to ensure approval of wind energy developments.

NIMBY is invalid. The NIMBY explanation has been widely discredited as simplistic, pejorative, politically inappropriate, and unhelpful as a framework to explain public attitudes toward wind facilities both before and after they are built. Nonetheless, use of the term persists among the wind industry, policymakers, even researchers.

Incorporating research into practice has lagged. Research over the past 30 years has produced many important insights, but these lessons have been slow to transition into practice among developers and policymakers.

Perceptions of turbine performance and reliability matter. Early studies revealed widespread concerns about turbine performance and reliability. More recently, studies have found a preference for turbines in motion compared to static turbines.

Demographics do not explain much. Throughout the literature, demographic variables such as gender, income, and education level do little to explain variation in wind energy attitudes; some studies have shown contradictory evidence related to these variables.

Socioeconomic impacts are very important. Local stakeholders are concerned with various socioeconomic impacts, and some researchers have found socioeconomic concerns to be paramount among local residents. In general, those living near wind facilities want benefits that stay in the local community, and they feel a sense of injustice about bearing the burden of costs when consumption of and profits related to the power are enjoyed elsewhere.

Sound and visual impacts are strongly tied to annoyance and opposition. Annoyance and opposition related to actual or expected sound and visual impacts are well documented throughout the literature. In some cases, annoyance and other impacts are ignored, downplayed, or assumed to be absent or inconsequential by developers and policymakers, which may exacerbate conflict and distrust among community members.

Environmental concerns matter, though perhaps less than other factors. Environmental concerns correlate with wind energy acceptance, but the strength of that correlation may be lower than that of other factors like socioeconomic impacts. Also, the direction of the correlation remains unclear.

Process fairness, participation, and trust can influence acceptance. A planning process that is perceived as “fair” can lead to greater toleration of the outcome, even if it does not fully satisfy all stakeholders. More participatory processes may increase trust and support, and ongoing post-construction community stewardship should be maintained.

Distance from turbines affects other variables, but alone its influence is unclear. The “proximity hypothesis” has yielded confounding findings in the literature. What is known is that an individual’s distance from existing turbines affects a number of other correlates, including visual, sound, and socioeconomic impacts.

Other variables also affect acceptance, and the understanding of these is evolving. Researchers have proposed a wide range of other variables potentially correlated to wind energy acceptance, many of which deserve further study. Over time the addition of more possible correlates adds to the depth of understanding in this field.

7. Knowledge gaps after 30 years: Areas for future research

A number of questions remain unresolved after three decades of research in this field. The following are specific areas for future research.

A widespread, representative, random survey should be conducted in North America. Previous studies on acceptance of wind energy in North America have focused on only one or a few wind facilities. A more geographically representative survey examining the variables discussed in this paper would greatly advance the state of knowledge in this field.

Individuals living closest to turbines should be oversampled. The detailed experiences and attitudes of those living closest to turbines (i.e., within half a mile) have not been well captured. Future research should oversample this group and analyze their responses as a group that is distinct from those living further away.

Comparability of case studies should be enhanced. Discrete case studies should utilize some standardized survey items and protocols to facilitate comparison with data collected at different sites by other researchers.

Causation should be identified, where possible. Many studies have used regression techniques to tease out competing correlates of acceptance, but in many cases the *direction* of influence (i.e., causality) of these correlates is not understood.

Wind energy acceptance should be compared with acceptance of other energy sources. Only a few North American studies have examined wind acceptance in concert with acceptance of other energy sources (e.g. Jacquet, 2012). Future research should attempt to do so to provide a mechanism for comparison.

Change in acceptance over time should be studied. Longitudinal studies of acceptance over time (i.e., before, during, and after wind project construction) have revealed interesting changes in the European literature (e.g. Wolsink, 2007), but they have rarely been conducted in North America—a notable exception being Firestone et al. (2012a), but that study only covered the development and planning periods, leaving construction and post-construction periods in question. Similarly, the attitudes among respondents who moved into an area *after* the wind facility began operation have not been studied in depth.

Annoyance survey data should be combined with measured or modeled sound-level data. A number of surveys have asked respondents about their level of annoyance and perceived health impacts from wind turbine sound, but very few (e.g. Magari et al., 2014) have correlated those data to measured or modeled sound-level data.

Varying development-process models and experiences should be studied. Participation in, perceptions of, and resident preferences for the wind facility development process are not well understood.

Compensation mechanisms should be compared more rigorously. More research is needed to understand appropriate and acceptable compensation mechanisms for individuals and communities, such as local ownership and investment opportunities, community compensation schemes, and non-monetary community benefits.

Resident perceptions of property-value impacts should be studied in greater depth. Although recent large-scale research has not found a significant property-value impact on homes near wind facilities, those impacts may exist in some cases, and the *perception* of value impacts among local residents could exist, but is not well understood.

Implementation of research recommendations should be studied. Research is needed to understand the effects and implementation of strategies proposed in the literature during the development and policy-making process. Researchers should continue to develop frameworks for wind project planning that increases community engagement and reduces conflict and injustice.

8. Conclusion

The efforts of wind energy acceptance researchers over the past 30 years have yielded many important lessons and insights, but much work remains to be done in this space—particularly in the North American context. Thirty years from today, wind energy could conceivably generate over 30% of North America's electricity, representing a significant increase over the current installed capacity. More turbines will result in more nearby "neighbors," increasing the population that experiences the direct impacts of wind energy. Opposition and negative attitudes will, undoubtedly, still exist. However, with continued research and a commitment to implement research findings into developer and policymaker practice, conflict and perceived injustices might be significantly reduced.

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Appendix A

Table 1: Explanatory variables in N.A. wind acceptance literature & research suggestions

Explanatory Variable	Sub-variable	North American Citations	Further Research
Socio-economic aspects	Landowner compensation	*Baxter et al., 2013* *Firestone et al., 2012b* *Garcia et al., 2016* *Gipe, 1995* *Groth & Vogt, 2014* *Jacquet, 2012* *Walker et al., 2014b*	What do hosting and non-hosting neighbors perceive to be the most appropriate forms of compensation? What forms of community-level compensation are preferred?
	Community investment & ownership models	*Bolinger, 2005* *Brannstrom et al., 2011* *Fast et al., 2016* *Ferguson-Martin & Hill, 2012* *Songsore & Buzzelli, 2015* *Sovacool & Ratan, 2012*	More research is needed on this topic in the North American context. How to enable community investment in private developer-led wind projects?
	Property value impacts	*Abbott, 2010* *Fast et al., 2015* *Firestone & Kempton, 2007* *Heintzelman & Tuttle, 2012* *Hoen et al., 2011; 2015* *Hoen & Atkinson-Palombo, 2016* *Walker et al., 2014a*	What source of information is trusted for property value impacts? Are there community compensation mechanisms that could assuage concerns about property value impacts?
	Tourism impacts	*Firestone et al., 2009* *Landry et al., 2012* *Lilley et al., 2010* *Lutzeyer, 2013*	Are there methods to enhance tourism near wind projects? Does this impact differ between onshore and offshore projects?
	Impacts on electricity rates	*Baxter et al., 2013* *Firestone & Kemption, 2007* *Firestone et al., 2012a* *Petrova, 2016*	
	Jobs and local economic development	*Bidwell, 2013* *Larson & Krannich, 2016* *Mulvaney et al., 2013a; 2013b* *Olson-Hazboun et al., 2016* *Slattery et al., 2012* *Songsore & Buzzelli, 2015*	How are local economic impacts perceived under more participatory development processes?
	Distributive justice / costs and benefits	*Baxter et al., 2013* *Brannstrom et al., 2011* *Groth & Vogt, 2014* *Huesca-Pérez et al., 2016* *Hirsh & Sovacool, 2013* *Jami & Walsh, 2017* *Kempton et al., 2005* *Larson & Krannich, 2016* *Pasqualetti, 2011a* *Petrova, 2013; 2016* *Phadke, 2011; 2013* *Rule, 2014* *Shaw et al., 2015* *Slattery et al., 2012* *Sovacool, 2009*	What do developers and communities perceive as best practices for distributive justice? What are the preferred community compensation mechanisms to improve distributive justice? How are feelings of distributive justice influenced by participation in the planning process? How to enable community investment in private developer-led wind projects?

Sound Aspects	Health impacts	*Baxter et al., 2013* *Knopper & Ollson, 2011* *Knopper et al., 2014* *Magari et al., 2014* *Michaud et al., 2016a; 2016b* *Songsore & Buzzelli, 2014* *Walker et al., 2014c*	What types of sounds cause the most stress or sleep disruption?
	Annoyance	*Kaliski & Neeraj, 2013* *Knopper & Ollson, 2011* *Knopper et al., 2014* *Nissenbaum et al., 2012* *Petrova, 2016* *Phadke, 2013*	What types of sounds are most annoying? Is measured or modeled sound correlated to levels of annoyance? If not, how can the sound models be improved?
Visual & Landscape Aspects	Aesthetic aspects, beauty, & annoyance	*Apostol et al., 2016* *Brannstrom et al., 2011* *Bush & Hoagland, 2016* *Fast et al., 2015* *Fergen & Jacquet, 2016* *Firestone & Kemption, 2007* *Firestone et al., 2015* *Gipe, 1993; 1995* *Hirsch & Sovacool, 2013* *Jacquet & Stedman, 2013* *Krueger et al., 2011* *Larson & Krannich, 2016* *Olson-Hazboun et al., 2016* *Pasqualetti, 2000; 2001; 2011a* *Pasqualetti & Bultler, 1987* *Pasqualetti et al., 2002* *Petrova 2016* *Phadke, 2010* *Rule, 2014* *Thayer & Freeman, 1987*	What are the motivations for positive visual perceptions? Does physical geography influence attitudes or visual annoyance? Does the number of turbines or frequency of seeing turbines influence attitudes? How do visual simulations influence support/opposition? How can simulations, and how they are presented, be improved to better reflect actual developments?
	Economic effects of visual impacts (e.g. willingness to accept view)	*Boatwright, 2013* *Groothuis et al., 2008* *Jensen et al., 2014* *Krueger et al., 2011* *Pasqualetti, 2001*	
	Place Attachment	*Bidwell, 2013* *Fast & Mabee, 2015* *Firestone et al., 2009* *Jacquet & Stedman, 2013*	More research on place attachment is needed in the North American context.
Environmental concerns and attitudes	Environmental attitudes and perceived impacts	*Abbott, 2010* *Fergen & Jacquet, 2016* *Firestone et al., 2009; 2012a* *Firestone & Kempton, 2007* *Kempton et al., 2005* *Larson & Krannich, 2016* *Mulvaney et al., 2013a; 2013b* *Olson-Hazboun et al., 2016* *Petrova, 2016* *Thayer & Freeman, 1987*	How do environmental concerns and motivations vary in different socio-policitical contexts?

	Climate change	*Bidwell, 2015* *Olson-Hazboun et al., 2016* *Petrova, 2013; 2016* *Slattery et al., 2012* *Swofford & Slattery, 2010*	Do residents believe the local wind project makes a difference with respect to climate change?
Planning process, fairness, trust	Community participation in development process	*Bidwell, 2016b* *Bohn & Lant, 2009* *Corscadden et al., 2012* *Fast et al., 2016* *Firestone et al., 2012b* *Groth & Vogt, 2014* *Huesca-Pérez et al., 2016* *Jacquet, 2015* *Jami & Walsh, 2014; 2017* *Phadke, 2011; 2013* *Shaw et al., 2015* *Songsore & Buzzelli, 2015* *Sovacool & Ratan, 2012* *Walker et al., 2014c*	How should developers implement a more participatory, collaboartive planning process? What communication practices and techniques are most effective between stakeholders? What do project developers consider best practices?
	Fairness, trust, and relationships	*Dwyer, 2016* *Fast, 2015* *Fast & Mabee, 2015* *Fast et al., 2016* *Firestone et al., 2012b* *Shaw et al., 2015* *Songsore & Buzzelli, 2014*	Do perceptions of fairness influence perceptions of economic impacts or reported health impacts?
Distance from turbines	Proximity hypothesis	*Baxter et al., 2013* *Groth & Vogt, 2014* *Swofford & Slattery, 2010* *Thayer & Freeman, 1987*	Do residents move in and out over time based on attitudes (Tiebout sorting)? Do individuals living closest to turbines have distinct attitudes or impacts?
	Cumulative impacts	*Olson-Hazboun et al., 2016* *Petrova, 2013* *Walker et al., 2014c*	The influence of cumulative impacts on communities needs further study in North America
Other	Knowledge / information deficit	*Baxter et al., 2013* *Bidwell, 2016a* *Bosley & Bosley, 1988* *Bush & Hoagland, 2016* *Corscadden et al., 2012* *Fast, 2015* *Klick & Smith, 2010* *Sovacool, 2009* *Swofford & Slattery, 2010*	What kinds of entities are trusted sources for information about wind energy? What are preferred methods for presenting information? How can a bi-lateral exchange of information between the hosts and developers be encouraged?
	Influence of local or federal policy on local acceptance	*Fast & Mabee, 2015* *Petrova, 2014* *Songsore & Buzzelli, 2014; 2015*	Compare policies that have increased acceptance to those that have decreased it
	Compare attitudes toward wind with other energy sources	*Jacquet, 2012* *Jacquet & Stedman, 2013* *Shaw et al., 2015*	More comparisons of preferences/attitudes toward different energy sources are needed.

Table 2: Research approaches and methods in North American wind acceptance literature

Research Approach	Specific Method	North American Citations
Quantitative Methods	One-time case study, statistical survey near existing wind facility	*Baxter et al., 2013* *Fergen & Jacquet, 2016* *Firestone et al., 2015* *Groth & Vogt, 2014* *Jacquet, 2012; 2015* *Jacquet & Stedman, 2013* *Magari et al., 2014* *Mulvaney et al., 2013* *Nissenbaum et al., 2012* *Olson-Hazboun et al., 2016* *Paller, 2014* *Pasqualetti & Butler, 1987* *Petrova, 2014; 2016* *Slattery et al., 2012* *Swofford & Slattery, 2010* *Thayer & Freeman, 1987*
	One-time case study, statistical survey; hypothetical wind facility	*Bidwell, 2013; 2015; 2016a* *Boatwright, 2013* *Corscadden et al., 2012* *Firestone & Kempton, 2007* *Firestone et al., 2009; 2012b* *Groothuis et al., 2008* *Landry et al., 2012* *Larson & Krannich, 2016* *Lutzeyer, 2013*
	Longitudinal case study survey (over time)	*Firestone et al., 2012a*
	Nationally representative opinion poll	*Ipsos, 2010* *Klick & Smith, 2009* *Leiserowitz et al., 2014* *Vyas & Hurst, 2013*
	Economic modeling and choice experiments	*Garcia et al., 2016* *Groothuis et al., 2008* *Heintzelman & Tuttle, 2012* *Hoen et al., 2011; 2015* *Hoen & Atkinson-Palombo, 2016* *Kreuger et al., 2011* *Landry et al., 2012* *Lang et al., 2014* *Lilley et al., 2010* *Lutzeyer, 2013*
	Epidemiological studies	*Michaud et al., 2016a; 2016b* *Nissenbaum et al., 2012*
Mixed Methods	Interview and Survey	*Bosley & Bosley, 1988* *Kreuger et al., 2011* *Mulvaney, 2013a; 2013b* *Walker et al., 2014a; 2014b; 2014c*
	Interview and Content Analysis / Literature Review	*Fast et al., 2015* *Sovacool & Ratan, 2012*
	Q-method	*Brannstrom et al., 2011*

Qualitative Methods	Literature review	*Fast, 2015* *Fournis & Fortin, 2016* *Huesca-Pérez et al., 2016* *Knopper & Ollson, 2011* *Knopper et al., 2014* *Lantz & Flowers, 2011* *Pasqualetti, 2011b* *Petrova, 2013* *Rule, 2014*
	Content analysis	*Abbott, 2010* *Bohn & Lant, 2009* *Bolinger, 2005* *Ferguson-Martin & Hill, 2012* *Pasqualetti, 2011a* *Phadke, 2010* *Shaw et al., 2015* *Songsore & Buzzelli, 2014; 2015*
	Interview / Focus Group	*Dwyer, 2016* *Fast & Mabee, 2015* *Jami & Walsh, 2017* *Kempton et al., 2005* *Pasqualetti, 2001* *Phadke, 2013* *Shaw et al., 2015* *Sovacool, 2009*
	Comment / Perspective / Qualitative case study	*Bidwell, 2016b* *Fast et al., 2016* *Hirsch & Sovacool, 2013* *Jami & Walsh, 2014* *Pasqualetti, 2000* *Phadke, 2011*
	Expert elicitation	*Bush & Hoagland, 2016*