ANALYSIS OF FACTORS THAT INFLUENCE DEVELOPMENT OF WIND POWER IN ATLANTIC CANADA: APPLICATION OF DISCRETE REGRESSION MODELLING

by

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DEDICATION

This thesis is dedicated to my parents, Yanxian Chen and Lijin Wang, and my lovely sisters, Bingchao Chen and Qiaona Chen, whose support and advice give me hope of a brighter future. It is also dedicated to my close friends and all my loved ones who have supported me in various ways.

This thesis is also dedicated to everyone who strives for the development of renewable energy.

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ABSTRACT

Widespread development of wind energy in Canada can not only increase energy savings to consumers, but also help reduce the negative environmental impacts of generating electricity from non-renewable sources. Although the general public tends to prefer "green" electricity generated using wind systems, there are also reported "not-in-my-backyard" concerns with the siting of wind turbines. This study investigated public attitudes and perceptions about "green" energy generated from renewable energy sources. The study focused on wind power, and is based on a sample of respondents from NB, NS, and PEI. The findings suggest that residents highly support electricity generated from wind power, but were also concerned with turbine effects on bird fatality. Important determinants of consumer acceptance of wind power technologies and development included level of education, proximity of dwelling to wind turbine installations, perceptions of the planet as a self-cleaning biological system, and concerns with visual intrusion.

LIST OF ABBREVIATIONS USED

GHG	Green House Gas
CO_2	Carbon Dioxide
NO_X	Nitrogen Oxides
SO_2	Sulphur Dioxide
COMFIT	Community Feed-In Tariff
FIT	Feed-In Tariff
NIMBY	Not In My Backyard
AWEA	American Wind Energy Association
SSHRC	Social Sciences and Humanities Research Council
NS	Nova Scotia
NB	New Brunswick
PEI	Prince Edward Island
UK	United Kingdom

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CHAPTER 1: INTRODUCTION

1.1 Introduction

Global oil price shocks and growing public pressure on environmental stewardship (Najam and Cleveland, 2003; Worrell et al., 2009) have renewed interest and a need for a sustainable energy strategy in Canada (Liming et al., 2008; Islam et al., 2004). Climate change and global warming are major threats to economic development and growth (Bond, 2008; Organization for Economic Cooperation and Development, 2009). Under the 2009 Copenhagen Accord, Canada is committed to reducing greenhouse gas (GHG) emissions to 607 Mt by 2020 (Environment Canada, 2011a). Provincial and federal governments' strategies to mitigating global warming and climate change include increasing the share of renewable energy in electricity production (Environment Canada, 2011a).

Canada's electricity sector is the single largest source of carbon dioxide (CO_2) emissions, and accounted for about 14% of GHG emissions in 2010 (Environment Canada, 2011b). In addition, electricity generated from fossil fuel sources account for a major proportion of regulated emissions such as fine particulate matter, nitrogen oxides (NO_x), and sulphur dioxide (SO_2), which contribute to smog and acid rain (Environment Canada, 2011c). About 90% of all anthropogenic GHG emissions in Canada are linked to use of fossil fuels (Liming et al., 2008). Thus, there is a need for the various levels of government in Canada and other economic agents in the energy industry to develop new technologically-efficient and economically-viable sustainable energy technologies and systems to reduce GHG emissions.

Electricity from wind energy is one of the fastest growing renewable energy sectors in the world (Natural Resources Canada, 2009a). Widespread development of wind energy in Canada can not only increase energy savings to consumers, but also help reduce the negative environmental impacts of generating electricity, including reduction in GHG emissions and other pollutants (Natural Resources Canada, 2009a; Canadian Wind Energy Association, 2008). For example, Natural Resources Canada (2009a) reported that installation of six 65 kW wind turbines in Newfoundland led to production of about 1 million kWh of electricity a year, and also reduced CO_2 emissions by about 750 tonnes. Under Canada's Wind Power Production Incentive program, 924 MW of additional wind energy capacity developed since 2008 helped to reduce GHG emissions by approximately 1.5 megatonnes per year (Natural Resources Canada, 2009a).

Canada is among the world leaders in the production of energy from renewable resources (Natural Resources Canada, 2009b). Seasonal changes and regional variations in climatic conditions contribute in part to a relatively high wind energy potential (28,000MW) for Canada as a whole (Islam et al., 2004). Total installed capacity of wind power in Canada at the end of 2011 was 5,265 MW, and accounted for 20% of the total national wind energy potential (International Energy Agency, 2012). Installed wind power capacity for Canada as a whole has been increasing since 2001 (Figure 1.1).

The Constitution Acts of 1867 and 1982 provide for sharing of political power between Canada's federal and provincial governments (Baier, 2005). Under the constitutional provisions, responsibility for natural resources, and electricity development and production rests with individual provincial governments (as opposed to the federal government) (Baier, 2005; Valentine, 2010). Baier (2005) noted that Canada lacks a

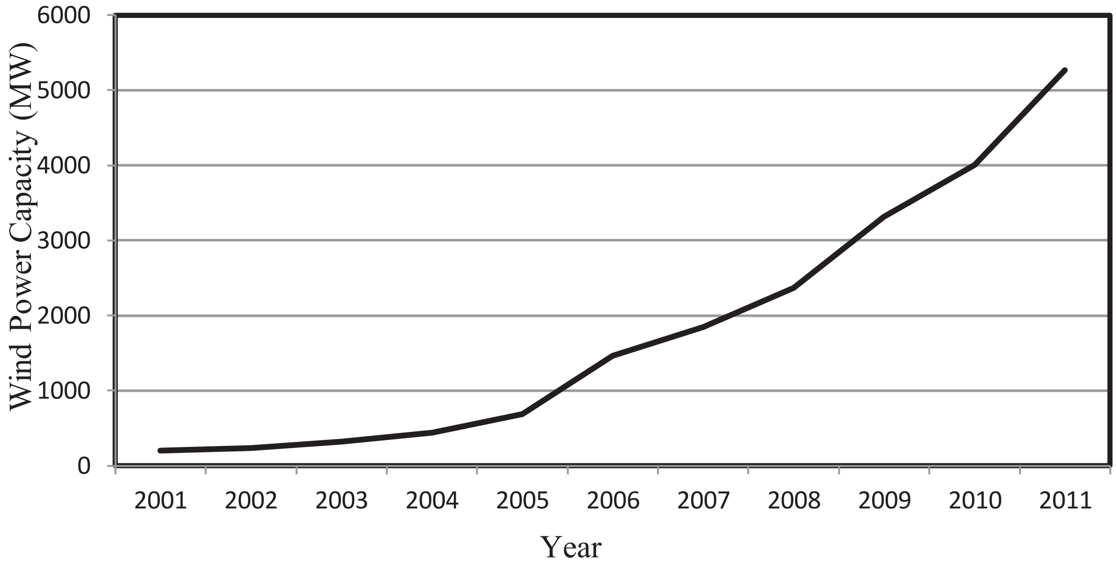

Figure 1.1 Total Installed Wind Energy Capacity in Canada, 2001-2011
Data Source: Global Wind Energy Council (2012)

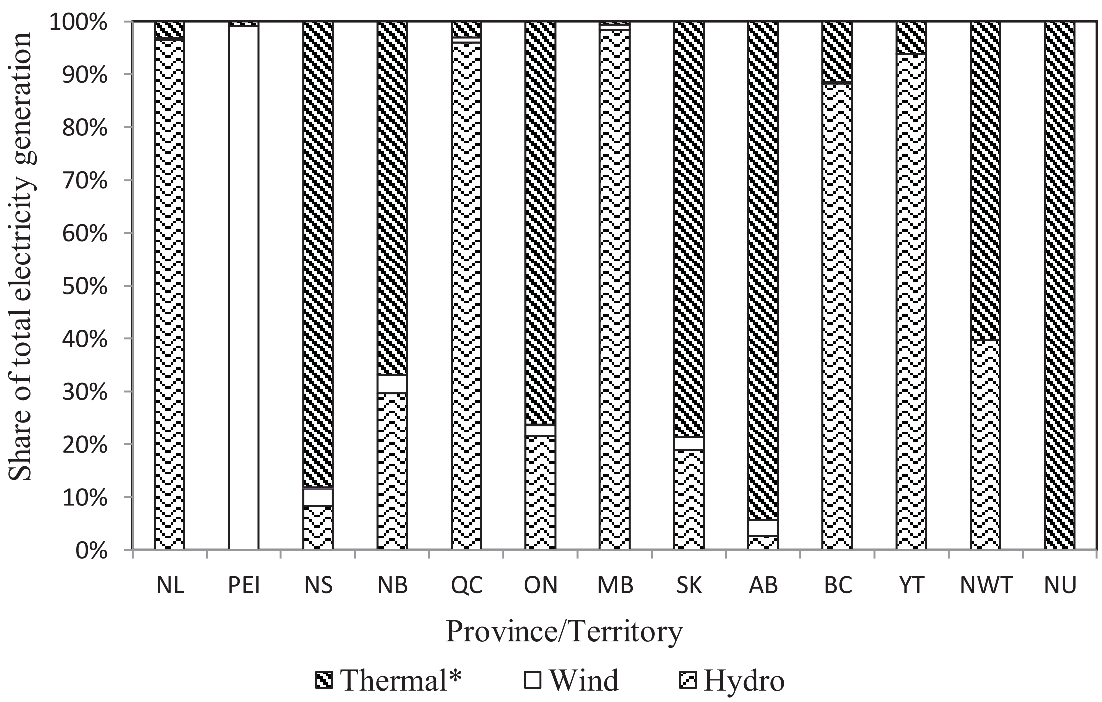

Figure 1.2 Sources of Electricity Generation in Canada, 2010
*Thermal includes coal, natural gas, oil, wood and spent pulping liquor and other fuels.
Data Source: Statistic Canada (2012)

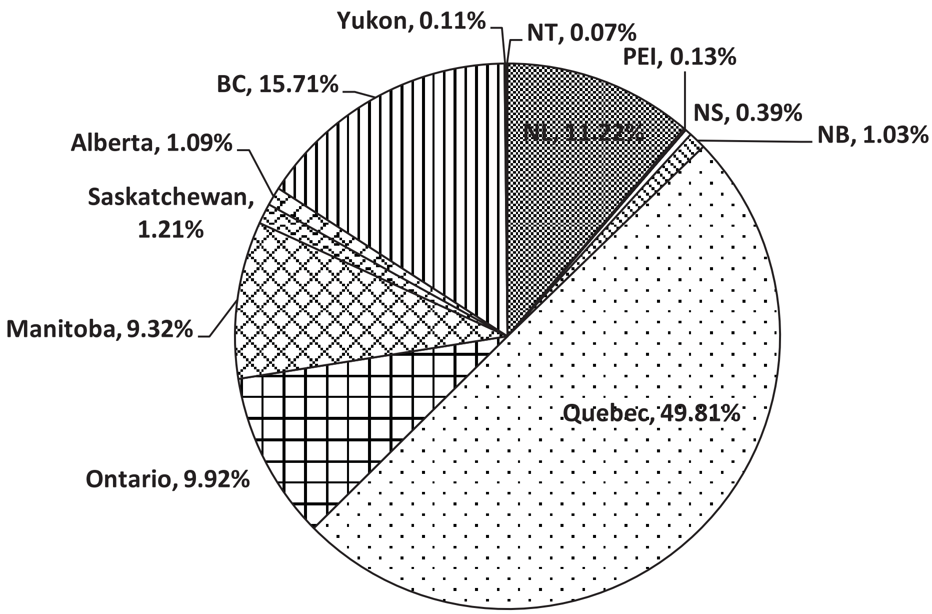

Figure 1.3 Share of Renewable Energy in Canada by Province, 2010
Data Source: Statistic Canada (2012)

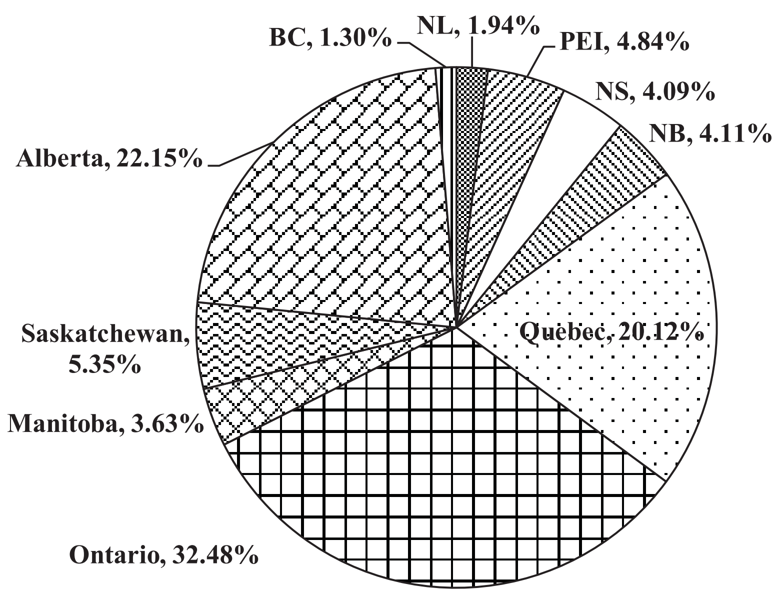

Figure 1. 4 Share of Wind Power Capacity by Province, 2010
Data Source: Statistic Canada (2012)

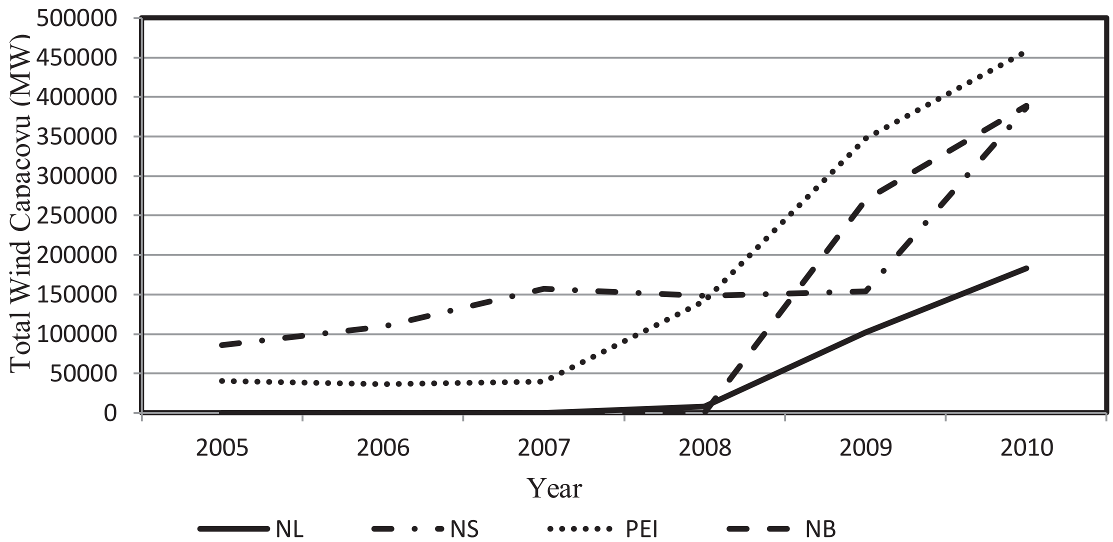

Figure 1.5 Total Installed Wind Power Capacity in Atlantic Canada, 2005-2010
Data Source: Statistic Canada (2012)

national electricity generation strategy. The various provinces are in search of policies and strategies for promoting development and growth of renewable energy systems (Liming et al., 2008).

There is currently a wide variability in wind resource endowment and installed wind power capacity (Figure 1.2), and the share of renewable energy in the total electrical energy mix across provinces (Figure 1.3). In 2010, for example, Quebec generated about 50% of total electricity supply from renewable sources, and 20% of the national wind power production. By comparison, Ontario generated 10% of total electricity supply from renewable energy sources, and 33% of Canada's total wind capacity in 2010 (Figure 1.3 and Figure 1.4).

The individual provinces in Atlantic Canada have established targets for renewable energy production, as part of plans to address climate change and global warming, and environmental stewardship and sustainability goals (International Energy

Agency, 2011; Nova Scotia Department of Energy, 2008; New Brunswick Department of Natural Resources and Energy, 2009; PEI Department of Environment Energy and Forestry, 2008). For example, in 2011, Nova Scotia introduced a Community feed-in tariff (COMFIT) scheme, which is the world's first feed-in tariff (FIT) scheme specifically for small-scale community-based wind power projects (International Energy Agency, 2011; Nova Scotia Department of Energy, 2012). About 90% of current electricity supply in Nova Scotia comes from fossil fuels such as coal, which is imported mainly from the United States, Colombia, Venezuela and Russia (International Energy Agency, 2011; Natural Resources Canada, 2010). To help address the threats of negative environmental impacts from electricity generation from coal, Nova Scotia has committed to meet 25% of electricity supply from renewable sources by 2015, and 40% by 2020 (International Energy Agency, 2011; Nova Scotia Department of Energy, 2008; Government of Nova Scotia, 2007). Similar trends and renewable energy targets have been established for New Brunswick (New Brunswick Department of Natural Resources and Energy, 2009) and PEI (PEI Department of Environment Energy and Forestry, 2008). Potential benefits from wind power production include reduction of contaminants associated with coal mining, air pollution, and greenhouse gas emissions associated with non-renewable energy sources (Board on Environmental Studies and Toxicology, 2007).

Although there is consumer and industry interest in electricity from "green" sources, there are also concerns with wind power production (Bond, 2008; Álvarez-Farizo and Hanley, 2002; Board on Environmental Studies and Toxicology, 2007; EDS Consulting, 2009). Some of the reported concerns include externalities linked to visual aesthetics (Sibille et al., 2009; Johansson and Laike, 2007; Wüstenhagen et al., 2007;

Good, 2006; Tsoutsos et al., 2009), turbine noise (Pedersen and Waye, 2004; Oerlemans et al., 2007; Rogers et al., 2006), light flicker (Thiringer et al., 2004; Larsson, 2002; Harding et al., 2008), electromagnetic interference (Cardoso et al., 2008; Zhang and Tseng, 2008; Sengupta, 1999), loss of wildlife habitat, and wildlife species (especially bird) fatalities (Kunz et al., 2007; Johnson et al., 2002; Smallwood, 2007; Kuvlesky et al., 2007). In addition, there are concerns with negative impacts of anthropogenic activities linked to wind power production, including erosion from construction of roads and other civil construction and installations (Álvarez-Farizo and Hanley, 2002), and reduction in property values (Gross, 2007; Sims and Dent, 2007; Laposa and Mueller, 2010; Sims et al., 2008). Consumer and residents' concerns with wind power technology can significantly hamper more widespread development and growth of wind energy production, through for example, complications with licensing and siting permits for wind power projects (Bond, 2008; Álvarez-Farizo and Hanley, 2002). Wiser et al. (2006), for example, estimated that about 30 to 50% of wind power project contracts fail because of siting and permitting issues.

1.2 Economic Problem

Important market agents connected with renewable energy development include government policy makers, and entrepreneurs contemplating investing in wind power systems, along with environmentalists and consumer groups (Álvarez-Farizo and Hanley, 2002). Government policy makers in Atlantic Canada are interested in strategies to overcome barriers to more widespread development and adoption of renewable energy technologies. Although the general public tends to have a high support for "green" electricity generated using wind energy systems (Sterzinger et al., 2003; Watts et al., 2005; Kristina, 2005; Canadian Wind Energy Association and Environmental Monitor, 1995.), there are also NIMBY (or not-in-my-backyard) concerns with the siting of wind turbines (Bell et al., 2005; Kaldellis, 2005; Wolsink, 2000). Thus, prospective entrepreneurs and local government officials need to understand and address any such negative attitudes in order to increase wind power project success (Bond, 2008). Provincial government strategies and policies that do not adequately address any negative public perceptions and attitudes can have negative consequences for implementation rates and ultimately, on success with developing sustainable energy market regulations (Wolsink, 2007; Bond, 2008).

On the other hand, consumers can choose their preferred electricity supplier under a liberalized electricity market (Álvarez-Farizo and Hanley, 2002). Electricity consumers' choice of energy source is influenced by their perceptions and attitudes towards renewable energy (Bond, 2008). Local community opposition to wind power development is an important major issue that can result in project delays or complete abandonment of wind projects (Bell et al., 2005; Pasqualetti, 2011). Visual externalities and other environmental concerns influence consumers' preferences (Álvarez-Farizo and Hanley, 2002). Yet, there is a lack of scholarly research on public attitudes and perceptions about the development of wind power systems in Atlantic Canada.

1.3 Research Problem

Empirical studies on the NIMBY syndrome typically investigate a "proximity hypothesis" that residents living nearest to wind power systems tend to have the most negative attitudes and perceptions about wind power systems (Devine-Wright 2005). On the other hand, studies for the UK (Stevenson, 1995) and the US (Thayer and Freeman, 1987) suggest that resident concerns depend on their knowledge and familiarity about wind power technologies (Devine-Wright 2005). Indeed, a 2000 study for Scotland reported that residents living nearest to wind turbines, and those who frequently see wind farms had more positive attitudes about wind power projects, compared with residents who lived further away from the wind farms (Dudleston, 2000).

Research inquiries into public perceptions about wind power systems typically focus on personal salience factors connected with wind farms and related installations, and less so on physical variables (such as turbine size and distance) (Devine-Wright 2005). Perceptions about the visual impacts of wind farms and perceived benefits of renewable energy are strongly influenced by social factors and attitudes, and also vary across different regions (Álvarez-Farizo and Hanley, 2002). Quantification of environmental and health impacts are complicated compares with the estimation of economic benefit and cost of wind energy (Álvarez-Farizo and Hanley, 2002). One of the most difficult to quantify negative impacts from wind energy is visual externality (Álvarez-Farizo and Hanley, 2002).

1.4 Purpose and Objectives

The overall purpose of this study was to investigate public attitudes and perceptions about "green" energy generated from renewable energy sources. The study focused on wind power, and respondents from NB, NS, and PEI.

Specific objectives of the study are:

1) *To compare the attitudes of Maritime residents towards selected attributes of renewable energy systems.*

Important attitudes of renewable energy systems considered in this study included consumer preference ranking of power from renewable energy sources, and concerns commonly associated with wind power technologies (see, for example, Bond 2008). Understanding consumer preference of renewable energy sources is important for local government and power companies to meet renewable energy targets (Bond, 2008). Addressing consumers' concerns associated with wind power systems is necessary in the planning and siting process of wind farm development (Bond, 2008). Power consumers' environmental concerns tend to influence their behavior and decisions regarding choice of power supply.

2) *To evaluate important determinants of consumers' support (i.e. acceptance) of on-land wind turbines and associated technologies.*

A discrete regression model was developed and then used to evaluate important determinants of the attitudes of Atlantic Canada residents toward development of wind power systems. To accomplish this objective, the analysis focused on land-based (as opposed to off-shore) wind power projects.

3) *To investigate the factors influencing consumer preferences for "green" electricity generated using wind technology.*

A logistic regression model was used to evaluate important determinants of power from a renewable energy source, using wind power as a case study. The factors commonly investigated in the literature may be grouped into: i) individual or personal characteristics; ii) factors related to externalities and other environmental concerns with wind turbines; and iii) public environmental stewardship and behavior characteristics. However, the actual effects of such factors may vary by geographic region due to cultural differences, and government environmental policies and regulations.

1.5 Outline of the Thesis

This thesis consists of five chapters. Chapter one introduces the background, economic and research problem, and outlines the purpose and objectives of this study. Chapter two reviews literature on concerns associated with wind turbines, and selected factors that affect public and private perceptions toward wind as a source for electricity generation. The study method and survey design are presented in Chapter 3. Chapter 3 also describes the profile of survey respondents, and provides a description of regression models used in the models used in the analysis. Chapter 4 presents and discusses the results of the empirical analysis. Chapter 5 summarizes the research findings and provides conclusions from the study.

CHAPTER 2: FACTORS WHICH INFLUENCE DEVELOPMENT OF RENEWABLE ENERGY

2.1 Outline

This chapter provides a review of key factors that affect public perceptions towards electricity generated from renewable sources, with a focus on wind power. The review starts with general societal concerns with wind turbines and wind project development. To provide a theoretical basis for the econometric analysis, the review also includes an understanding of how specific individual characteristics and personal belief and environmental behavior factors influence wind power development.

2.2 Concerns with Wind Power Projects

Although wind power is a popular source of “green” energy, there are also environmental or ecological and health concerns associated with wind turbines. The public concerns, include turbine noise pollution (Oerlemans et al., 2007; Rogers et al., 2006), visual interference and externalities (i.e., light flicker, and aesthetic effects) (Sibille et al., 2009; Tsoutsos et al., 2009; Harding et al., 2008) and negative impacts on bird and other wildlife (Kunz et al., 2007; Kuvlesky et al., 2007). In addition, there are also reported concerns with electromagnetic interference (Cardoso et al., 2008; Zhang and Tseng, 2008), soil erosion (Álvarez-Farizo and Hanley, 2002), and reduction in property values (Laposa and Mueller, 2010; Sims et al., 2008). The impacts of the negative concerns by residents have led to reported public opposition to wind projects (Wolsink, 2007; Warren et al., 2005; Agterbosch et al., 2007), and objections to wind power project approvals (Wolsink, 2000; Jones and Eiser, 2010). In the rest of this section, the nature of the public concerns and opposition are described.

One of the most commonly reported resident opposition to wind turbine installations in linked to turbine noise (Oerlemans et al., 2007). In general, noise nuisance in linked to interference with speech, sleep, and learning. In addition, noise can result in anxiety, tinnitus or hearing loss (Rogers et al., 2006). Indirect effects of wind turbine noise include reported lowering of residential property values (Saidur et al., 2011).

In general, noise from wind turbines may be mechanical or aerodynamic in nature (Rogers et al., 2006). Mechanical noise may be produced by moving or rotating wind turbine components, such as gear box, electrical generator, and bearings. The level of mechanical noise tends to increase with normal wear and tear, poor component designs or lack of preventative maintenance (Julian et al., 2007). Mechanical noise can be reduced, depending on technical design of wind turbine, and by installing acoustic insulation inside the turbine housing, or acoustic insulation curtains and antivibration support footings (Julian et al., 2007). Aerodynamic noise, on the other hand, can result from moving air over turbine blades, and interaction of wind turbine blades with atmospheric turbulence, thereby producing a "whooshing" sound (Oerlemans et al., 2007). Lowering the speed of turbine rotors and blades can lower the noise level (Gauld, 2007). Technological improvements continue to address wind turbine noise concerns, although noise emission from wind turbines continues to pose problems with wind power project licensing and approvals (Swofford and Slattery, 2010; Groothuis et al., 2008; van der Horst, 2007).

Visual externalities associated with wind turbines include light flicker and landscape aesthetics (Harding et al., 2008; Tsoutsos et al., 2009). Flicker emissions are generated both during turbine start-up, and continuous operation of the wind turbine

(Larsson, 2002). In general, shadow flickering is produced by reflection of sun rays on moving wind turbine blades. Moving blades can affect light intensity, and result in shadows on the ground and buildings (Saidur et al., 2011). Flicker shadows caused by reflection of sun rays and periodic flashes of light can be minimized by a more smooth rotor blade surface or coating the turbine blades with less light reflecting material (Saidur et al., 2011).

Sibille et al. (2009) noted that a common opposition to wind farm projects is linked to poor aesthetic integration into rural landscapes. Some previous literature suggest that visual impact is the most important environmental issue related to wind energy and has been considered as one of the most problematic issues relating to wind farm siting (Pasqualetti et al., 2002; Wolsink, 2000; Wolsink, 2007). Pasqualetti et al. (2002) indicated that wind turbines are unavoidably visible, may be intrusive and interfere with local landscape aesthetics.

Birds and other wildlife can be killed through direct collision with wind turbines (Drewitt and Langston, 2006) or indirectly affected by wildlife habitat disruption and displacement (Kuvlesky et al., 2007). Factors which affect avian mortality associated with wind turbine installations include the layout or design of wind farms, turbine design, tower design, topography, bird species and behavior, lighting and weather conditions (Drewitt and Langston, 2006; Santos et al., 2010). For example, wind farms located along migratory routes or in habitats frequented by birds can result in higher bird collision rates (Erickson et al. 2002). In addition, collision mortality tends to be higher with turbines installed linearly in long rows than clusters of turbines. Turbine hub heights, blade lengths, turbine speeds, blade appearance to birds, and presence and type of lighting can also affect bird collision (Kuvlesky et al., 2007).

On the other hand, some studies suggest that the impact of wind turbines on wildlife is generally small, compared with other sources of energy and human activities (Magoha, 2002; Sovacool, 2009). Climate change appears to have a significant threat to wildlife. For example, fossil fuels cause about 20 times more deaths of birds than wind turbines (Sovacool, 2009). Furthermore, it was estimated by American Wind Energy Association (AWEA) that if wind energy were used to generate 100% of United States' electricity needs, wind energy would only cause one bird death for every 250 human-related bird deaths (Saidur et al., 2011).

Social acceptance and local community opposition has become a major concern of wind project development and wind power investments. Public perception was identified as the main issue which obstructs establishment of new wind farms, and hampering wind energy penetration rate (Bell et al., 2005; Pasqualetti, 2011; Kaldellis, 2005). Devine-Wright (2005) noted that "it is widely recognized that public acceptability often poses a barrier towards renewable energy development".

Social acceptability and local community opposition to wind development has been a major concern for new wind project development (Bell et al., 2005; Pasqualetti, 2011). For example, the negative local reactions led to complete cancellation of wind power projects in mainland Greece during 1999 to 2002 (Kaldellis, 2005). People often show positive attitudes and strong support for the implementation of wind power until they are actually confronted with the project. It was estimated that over 80% of the population in the United Kingdom showed positive support for wind energy, while less than quarter of these were actually willing to have the projects located in their neighborhoods (Bell et al., 2005).

The perceptions towards wind farms are different in difference countries, different regions in a country, or even different periods within a region. Some studies suggest that individual countries showed an overall positive support for wind power technology (e.g., US, New Zealand) (Sterzinger et al., 2003; Hoen and Wiser, 2007; Watts et al., 2005), while some countries had a mixed support (i.e. United Kingdom, and Greece) (Braunholtz and McWhannell, 2003; Dudleston, 2000; Haughton et al., 2004; Khatri, 2004; Warren et al., 2005; Kaldellis, 2005). In Greece, for example, public attitudes toward wind farms are significantly different between mainland Greece compared with other Greek islands (Kaldellis, 2005).

In mainland Greece, the public attitude was either divided or definitely against wind power projects, while attitudes in other Greek regions showed over 80% support for existing and new wind turbine projects (Kaldellis, 2005). Also, studies for the United Kingdom suggest that wind farms caused negative public attitudes and resulted in decreased the property prices (Saidur et al., 2011). However, the attitudes and property prices showed a recovery after the wind farms start operating, and communities learned more about the actual impacts of wind power projects (Braunholtz and McWhannell, 2003; Dudleston, 2000; Haughton et al., 2004; Khatri, 2004; Warren et al., 2005).

2.3 Related Studies and Research Hypotheses

2.3.1 Introduction

In general, the factors which influence public preference and attitude toward renewable energy may be grouped into (personal) social and demographic attributes, household and family characteristics, and general consumer attitude towards environmentally-friendly product, and renewable energy systems.

2.3.2 Effect of Demographic Factors

Various studies suggest that consumers' preference for renewable energy is influenced by personal demographic variables, such as age, gender, level of education, and income (Roe et al., 2001; Batley et al., 2001). In a survey of consumer demand for electricity from renewable sources, Zarnikau (2003) found that the degree of support for renewable energy declined with age, varied with gender, and positively related to income, and education.

Age

Zarnikau (2003) reported that respondents over 56 years old were least willing to pay a premium for renewable energy, compared with those aged 18 to 55. In a similar study, Poortinga et al. (2003) reported that younger respondents between 20 and 39 years tended to have a more positive attitude toward, and support, for renewable energy than elderly respondents (more than 65years old). In an earlier study, Nord et al. (1998) also found a strong relationship between age and consumer environmental attitudes. In general, younger people tend to be less integrated into existing social order than older people (van

Liere and Dunlap, 1980). In addition, Howell and Laska (1992) noted that younger individuals tend to care more about the environment than older individuals because older adults generally have less easy access to information about environmental issues.

Hypothesis 1.1 The probability of public acceptance of on-land wind turbines decreases with the age.

Hypothesis 1.2 The probability of consumer preference for electricity generated using wind technology decreases with the age.

Education

Some studies report a positive association between the level of education and individuals' attitudes toward the environment, and their environmental behaviors (Weber and Perrels, 2000; Barr et al., 2005; Arcury and Christianson, 1990; Black et al., 1985). Formal education is one of the tools for invoking behavioral change (Clark et al., 2003). In addition, McKenzie-Mohr et al. (1995) noted that family status (as influenced by education, and income), influence the likelihood of individuals engaging in responsible environmental behavior.

A plausible explanation for the association between education and attitude towards environmental stewardship is that education can shape human behavior through increased knowledge and awareness about the environment and related issues (Hungerford and Volk, 1990). Informed individuals may be more motivated to act in responsible ways toward the environment (Hungerford and Volk, 1990). According to the value-belief-norm theory of Stern (2000), individuals place a value on protecting the environment for its own sake, or because they understand its benefits to society. In addition, such individuals may believe that their actions (or inactions) can have an effect on environmental issues of concern to society.

Hypothesis 2.1 The probability of public acceptance of on-land wind turbines increases with the level of education.

Hypothesis 2.2 The probability of consumer preference for electricity generated using wind technology increases with the level of education.

Income

Income has direct and indirect effects on perceptions and preferences toward the environment. Individuals with higher incomes reported a greater willingness to pay for renewable energy because of higher social status and expectation of better life quality (Batley et al., 2001; Rogers, 1995). On the other hand, income and education influence social class. Maslow (1970) applied a theory of need hierarchy to explain that upper and middle class members of society generally tend to focus on satisfying 'higher' (as opposed to basic material) needs. The poor in society generally tend to focus on satisfying basic or critical human survival needs.

Hypothesis 3.1 The probability of public acceptance of on-land wind turbines increases with household income.

Hypothesis 3.2 The probability of consumer preference for electricity generated using wind technology increases with household income.

Gender

Previous research suggests that people's attitudes toward environmental issues may differ by gender. However, there are mixed findings about the gender effect. For example, some studies reported that males tend to be more concerned about the environment and renewable energy than females (Arcury and Christiansion, 1990; van Liere and Dunlap, 1980; Zarnikau, 2003), while other studies found that females are more concerned about the environment and renewable energy (Han et al., 2009; Wiser, 2007; Laroche et al., 2001; Ezzati and Kammen, 2002). Zarnikau (2003) reported that adult males had a higher support for renewable energy than female respondents. In a separate study, Arcury and Christiansion (1990) noted that men were more concerned about the environment than women. On the other hand, Berr et al. (2005) reported that most non-environmentalists tend to be males, and were less likely to purchase renewable energy products. In an earlier study, Stern et al. (1995) reported that women acted in more environmentally friendly ways than males because such adult females tended to have stronger beliefs about the detrimental consequences of environmental degradation.

Hypothesis 4.1 The probability of public acceptance of on-land wind turbines is higher for males than for females.

Hypothesis 4.2 The probability of consumer preference for electricity generated using wind technology is higher for males than for females.

2.2.3 Effect of Family and Household Characteristics

The number of children and general household size positively affects preference for renewable energy and energy efficient products (Mills and Schleich, 2010). Larger households tend to use more energy than small size families. The number and age of children in a household influence the purchase behaviors of families (Mangleburg and Tech, 1990). Parents with younger children tend to be more concerned about exposing such infants to pollutants in the environment, and therefore are more likely to prefer renewable energy sources than families with adult children (Mills and Schleich, 2010).

Hypothesis 5.1 The probability of public acceptance of on-land wind turbines is higher for households with children than households without children.

Hypothesis 5.2 The probability of consumer preference for electricity generated using wind technology is higher for households with children than households without children.

2.2.4 Consumer Knowledge, Attitude and Concerns of Wind Energy System

Attitude

In general, consumers' attitude toward the environment also affects their choice of electricity supply source. Literature suggest attitudes as predictors of behavior and behavioral intentions (Ajzen and Fishbein, 1980; Ajzen, 1988; Heberlein, 1989; Ajzen and Driver, 1991; Ajzen and Driver, 1992). Ek (2005) and Shen and Saijo (2009) reported in separate studies that consumers with higher concern and interest about environmental issues tend to purchase electricity produced using methods with lower environmental impact than consumers who reported lower levels of concern. Some previous studies found that a person's attitude toward energy conservation strongly influence their protective action (Hines et al., 1987; Stern and Oskamp, 1987). Ek (2005) also noted that individuals who prefer renewable energy were also more likely to be in favor of wind power.

Hypothesis 6.1 The probability of public acceptance of on-land wind turbines is higher for individuals who care more about the environment.

Hypothesis 6.2 The probability of consumer preference for electricity generated using wind technology increases with individuals who care more than with those who care less about the environment.

Knowledge

Knowledge of "green" energy and environmental stewardship issues is also an important factor which affects consumer's attitude toward renewable energy (Mills and Schleich, 2010). Ek (2005) reported that consumers with high knowledge and information about "green" energy were more willing to pay for renewable energy and energy efficiency options than their counterparts with low knowledge and information. Individuals with less knowledge about "green" energy issues and renewable energy technologies were less likely to support renewable energy (Ward et al., 2010; Linden et al., 2006). Stern (1992) and Simmons and Widmar (1990) found that knowledge about the specific problem and the most effective action for solving that problem is the main factor of people's action and behavior to the environmental issues. Hines et al. (1987) suggest that knowledge is a prerequisite to environmental action. Similarly, McKenzie-Mohr et al. (1995) found that lack of knowledge is one of the most important reasons for respondents' environmental inactivity.

Hypothesis 7.1 The probability of public acceptance of on-land wind turbines increases with level of knowledge about environmental issues and related energy conservation.

Hypothesis 7.2 The probability of consumer preference for electricity generated using wind technology increases with level of knowledge about environmental issues and related energy conservation.

Responsible Environmental Behavior

Environmentally-friendly behavior is influenced by a person's values, attitudes, and awareness of the consequences of one's actions (Thogersen and Grunert-Beckman, 1997; Hopper and Nielsen, 1991). In addition, Rokeach (1973) and Schwartz and Bilsky (1987) argue that values inform individual beliefs and attitudes, while attitude and beliefs guide their formation. A high awareness of the consequences of one's actions tends to prompt individuals to act in more environmental-friendly ways than those with low knowledge and awareness.

Hypothesis 8.1 The probability of public acceptance of on-land wind turbines is higher for individuals who act in more environmentally-friendly ways.

Hypothesis 8.2 The probability of consumer preference for electricity generated using wind technology is higher for individuals who act in more environmentally-friendly ways.

Concern with Wind Turbines

Environmental and visual concerns of wind turbines can strongly influence individual's attitude toward wind power development (Kaldellis, 2005). Several studies suggest that local residents' acceptance of wind power installations tend to be lower compared with the general public attitude (Bell et al., 2005; Pasqualetti, 2011). The NIMBY (Not-In-My-Back-Yard) phenomenon provides a plausible explanation of the reported differences (Kaldellis, 2005).

Hypothesis 9.1 The probability of public acceptance of on-land wind turbines decreases with negative concerns with wind power systems.

Hypothesis 9.2 The probability of consumer preference for electricity generated using wind technology decreases with negative concerns with power systems.

2.2.5 Concerns with Using Coal to Generate Electricity

Coal is a primary source of electricity produced in the Maritime Provinces of Canada (Natural Resources Canada, 2010), and is also linked to reported consumers' environmental concerns with electricity supply in the region, including coal tar ponds contamination clean-up problems in Cape Breton area (Furimsky, 2002; Haalboom et al., 2006). Bond (2008) and Ek (2005) reported that respondents preferred electricity from wind and other renewable sources while coal was the least preferred power source. Ek (2005) noted that individuals who dislike coal as power source tend to be more concerned about environmental quality. Greenberg (2009) also reported that individuals who dislike coal as a power source tended to prefer electricity generated using wind technology.

Hypothesis 10 The probability of consumer preference for electricity generated using wind technology is higher for individuals who dislike coal.

CHAPTER 3: RESEARCH METHODS

3.1 Outline

This chapter describes the overall research methods used in the study. It starts with a description of the survey design and sampling methods, and survey questionnaire used. The chapter also provides an overview of the theoretical logistic regression model used in the analysis.

3.1 Survey Design and Sampling

The survey instrument for this study was developed as part of a larger research project under a Social Sciences and Humanities Research Council (SSHRC)-funded project. The sample was drawn from the Maritime Provinces of NB, NS, and PEI. A stratified random sampling scheme was used, with each of the three provinces representing a stratum (Collins et al., 2006). Contact information for potential respondents was purchased from InfoCanada, a reputable Canadian company that conducts various types of marketing research, and also has a comprehensive database of Canadian residents.

Research ethics approval was obtained in May 2012, and the self-completed mail survey packages distributed through Canada Post in June, 2012. A total of 3000 potential survey responses were mailed out with the following breakdown: NS = 1100, PEI = 800, and NB = 1100. A total of 377 questionnaires were undeliverable and returned. Reasons why the survey packages were not deliverable included: resident had moved or died, or individual not known at the address. Details of the completed or useable surveys for each province are summarized in Table 3.1.

3.2 Design of Survey Instrument

The questionnaire comprised six sections. Section I had questions to elicit information about respondent knowledge of environment stewardship. Section II contained questions regarding people's attitudes towards the environment, while section III had questions to collect information on constraints on environmental stewardship. Section IV asked questions related to respondent's environmental behavior, and section V had questions related to residents' attitudes towards renewable energy systems, particularly wind energy. The last section elicited information on typical socio-economic information about respondents.

3.3 Response Rate

From the 2623 potential respondents surveyed, 389 useable questionnaires were returned, representing an overall response rate of 14.83% (Table 3.1). The response rates according to province were: NS = 17.11%; PEI = 13.77%; and NB = 13.25% (Table 3.1). NS had the highest response rate, while the rate for NB was 0.53% lower than that of PEI. The overall response rate seems low compare with other wind power studies. Holburn et al. (2010) obtained a response rate of 49% in an online survey of policy risk and private investment in wind power in Ontario. Nyboer et al. (2004) obtained a response rate of 58% in a mailed survey of renewable energy in Canada. In addition, the general response rates for selected mailed survey studies on renewable energy in the U.K. ranged from 43% to 56% (Bergmann et al., 2006; Ek, 2002; Hanley et al., 2001). However, the sample sizes for the above studies were generally smaller than for this study. For example, the total sample size for Holburn et al. (2010) was 63, with only 29 useable responses, while

Table 3.1 Response Rate of Mailed Survey

Province	Total Invited to Participate	Mails Not Delivered	Effective Surveys Mailed	No. of Useful Responses Received	Response Rate (%)
NS	1100	118	982	168	17.11
PEI	800	110	690	95	13.77
NB	1100	149	951	126	13.25
All respondents	3000	377	2623	389	14.83

Nyboer et al. (2004) surveyed 734 facilities, and Bergmann et al. (2006) surveyed 547 households. The 15% response rate for this study has potential to generate useful empirical results (Collins et al., 2006; Yiridoe et al. 2010).

3.4 Socio-Economic Profile of Survey Respondents

Nova Scotia provided 43% of the total survey respondents, followed by NB (32%) and then PEI (24%) (Table 3.2). The mean age of the survey respondents was 64 years. For Canada as a whole, the individuals in the 60-64 age group is the fastest growing category, and increased by 29.1% between 2006 and 2011, while also accounting for more than 20% of the national population in 2011 (Statistics Canada, 2012). The average age of respondents was similar among the three provinces. Statistical test of differences in average age across the three provinces showed that there was no difference in the average age of respondents from the three provinces ($F=2.028$, $p = 0.133$, $N=373$).

The majority of respondents were males (67.1%). Within each province, the number of male respondents was almost twice as females, except for NB where 77% were males. In addition, the majority of respondents (95%) were white, with the remaining 5% consisting of respondents identified with various minority racial groups (Table 3.2).

Table 3.2 Profile of Survey Respondents, 2012 Survey

Variable	NS	PEI	NB	Total
a) Age (*AVG, STD; N_1 =161, N_2 =90, N_3 =122, N = 373*)[1]				
	64.32A[2] (12.01)	65.23A (14.57)	61.89A (12.70)	63.74 (12.92)
b) Gender Distribution (*number, and %: N_1=165, N_2 = 94, N_3 = 123, N = 383*)				
Male	102 (61.8)	60 (63.2)	95 (77.2)	257 (67.1)
Female	63 (38.2)	34 (35.80)	28(22.8)	125 (32.6)
c) Race (*number, and %: N_1=163, N_2 = 95, N_3 = 123, N = 381*)				
Aboriginal	1 (0.6)	-	1 (0.8)	2 (0.5)
Asian	-	-	1 (0.8)	1 (0.3)
Black	2 (1.2)	-	-	2 (0.5)
Latin American	-	-	1 (0.8)	1 (0.3)
White	152 (93.3)	93 (97.9)	118 (95.9)	363 (95.3)
Other[3]	8 (4.9)	2 (2.1)	2 (1.6)	12 (3.15)
d) Marital Status (*number, and %; N_1=163, N_2=95, N_3=124, N=382*)				
Single (never legally married)	14 (8.6)	9 (9.5)	13 (10.5)	36 (9.4)
Common law relationship	8 (4.9)	2 (2.1)	1 (0.8)	11 (2.9)
Legally married (not separated)	100 (61.3)	65 (68.4)	91 (73.4)	256 (67.0)
Separated, but still legally married	3 (1.8)	1 (1.1)	2 (1.6)	6 (1.6)
Divorced	12 (7.4)	5 (5.3)	8 (6.5)	25 (6.5)
Widowed	22 (13.5)	13 (13.7)	8 (6.5)	43 (11.3)
Other	4 (2.5)	-	1 (0.8)	5 (1.3)
e) Household Size (*AVG, STD; N_1= 165, N_2 = 93, N_3 = 123, N= 381*)				
	2.06 (0.96)	2.03 (0.86)	2.19 (0.93)	2.09 (0.93)
f) No. of Children Under 18 (*AVG, STD/ number and %; N_1= 155, N_2 = 90, N_3 = 119, N = 364*)				
Total Average and STD	0.21 (0.61)	0.20 (0.60)	0.25 (0.65)	0.22 (0.62)
0 children	135 (87.1)	80 (88.9)	100 (84)	315 (86.5)
1 children	11 (7.1)	3 (3.3)	10 (8.4)	24 (6.6)
2 children	7 (4.5)	6 (6.7)	8 (6.7)	21 (5.8)
3 children	1 (0.6)	1 (1.1)	-	2 (0.5)
4 children	1 (0.6)	-	1 (0.8)	2 (0.5)
Children in family (average)	1.6 (0.82)	1.8 (0.63)	1.58 (0.77)	1.63 (0.76)
g) Education Completed (*number, %; N_1 = 161, N_2 = 92, N_3 = 121; N = 374*)				
Did not complete high school	19 (11.8)	11 (12.0)	15 (12.4)	45 (12.0)
Completed high school	35 (21.8)	23 (25.0)	27 (22.3)	85 (22.7)
Completed trade school or community college	53 (32.9)	24 (26.1)	39 (32.2)	116 (31.0)
Completed university	30 (18.6)	19 (20.6)	24 (19.8)	73 (19.6)
Completed post-graduate degree (masters or doctorate)	24 (14.9)	15 (16.3)	16 (13.3)	55 (14.7)

Table 3.2 (Continued): Profile of Survey Respondents, 2012 Survey

Variable	NS	PEI	NB	Total
h) Employment Status (*number, %;* $N_1 = 163, N_2 = 94, N_3 = 122, N = 379$)				
Employed with a salary	40 (24.5)	24 (25.5)	54 (44.3)	118 (31.1)
Self-employed	20 (12.3)	8 (8.5)	7 (5.7)	35 (9.2)
Unemployed	3 (1.8)	-	1 (0.8)	4 (1.1)
Retired	94 (57.7)	57 (60.6)	58 (47.5)	209 (55.1)
Student	-	1 (1.1)	-	1 (0.3)
Other	6 (3.7)	4 (4.3)	2 (1.6)	12 (3.2)
i) Household Income for 2011 tax year (*number, %;* $N_1 = 134, N_2 = 76, N_3 = 102, N = 312$)				
Under $10,000	5 (3.7)	2 (2.6)	2 (2.0)	9 (2.9)
$10,000 - $19,999	9 (6.7)	5 (6.6)	3 (2.9)	17 (5.4)
$20,000 - $29,999	13 (9.7)	7 (9.2)	11 (10.8)	31 (9.9)
$30,000 - $39,999	15 (11.2)	10 (13.2)	9 (8.8)	34 (10.9)
$40,000 - $49,999	16 (11.9)	9 (11.8)	15 (14.7)	40 (12.8)
$50,000 - $59,999	26 (19.4)	15 (19.7)	22 (21.6)	63 (20.2)
$70,000 - $79,999	7 (5.2)	5 (6.6)	7 (6.9)	19 (6.1)
$80,000 - $89,999	5 (3.7)	7 (9.2)	6 (5.9)	18 (5.8)
$90,000 - $99,999	7 (5.2)	4 (5.3)	5 (4.9)	16 (5.1)
$100,000 or more	31 (23.1)	12 (15.8)	22 (21.6)	65 (20.8)
j) Housing Type (*number, %;* $N_1 = 163, N_2 = 93, N_3 = 123, N = 312$)				
Owned by someone in the household	148 (90.8)	85 (91.4)	105 (85.4)	338 (89.2)
Rented	14 (8.6)	6 (6.5)	12 (9.8)	32 (8.4)
Occupied without payment	-	2 (2.2)	5 (4.1)	7 (1.8)
Other[4]	1 (0.6)	-	1 (0.8)	2 (0.5)

Note: [1]Values for *Ni* differ between sections because some respondents declined to answer some questions.
[2]Mean ages across the three provinces with the same letter are not significantly different.
[3]Other includes: Irish, English and native; Anglo-Welsh; Canadian; English Canadian; French Canadian; bi-racial, white, black, native.
[4]Other includes: condominiums.

Overall, 67% of respondents indicated that they were legally married, 11% were widowed, and 9% identified themselves as single. Others indicated that they were divorced (6.5%), in common law relationships (2.9%), or separated (1.6). The marital status pattern in the survey was similar to the patterns reported in the 2011 Census (Table 3.3).

Table 3.3 2011 Census of Canada Data On Selected Variables for Atlantic Canada

Variable	NS	PEI	NB	Canada
a) Marital Status (*number, and %*)				
Never legally married (single)	209,180 (26.70)	30,495 (26.03)	159,760 (25.06)	7,816,045 (28.05)
Common law relationship	77,075 (9.84)	9,175 (7.83)	72,000 (11.29)	3,142,525 (11.28)
Legally married (not separated)	376,020 (47.99)	60,625 (51.75)	310,310 (48.67)	12,941,960 (46.44)
Separated, but still legally married	23,545 (3.01)	3,285 (2.80)	21,035 (3.30)	698,240 (2.51)
Divorced	46,065 (5.88)	6,065 (5.18)	32,930 (5.16)	1,686,035 (6.05)
Widowed	51,625 (6.59)	7,505 (6.41)	41,560 (6.52)	1,584,530 (5.69)
b) Household Size (average)				
Average number of persons in household	2.3	2.4	2.3	2.5
c) No. of Children in Family (average)				
Average number of children at home	0.9	1.0	0.9	1.1

Data source: Statistic Canada (2012)

On average, there were 2 individuals per household, which is similar to the 2011 Census of Canada data (Table 3.3). The majority of respondents (87%) reported that they had no children under 18 years of age, while 13% had between 1 and 4 children. This is to be expected because the mean age of survey respondents was 64.

The majority of respondents reported that they had completed some form of trade school or community college (31%). Another 22.7% reported that the highest level of education completed was high school, while 19.6% completed university education. The proportion who reported having a post-graduate degree was 14.7%. The lowest proportion (12%) did not complete high school.

Consistent with the age distribution of the survey respondents, the majority (i.e., 55%) reported that they were retired. The proportion of retired respondents was highest for PEI (i.e., 61%) and lowest for NB (48%). The second largest employment status category was for individuals who were salaried workers (i.e., 31%), while another 9% identified them as self-employed. The proportion of respondents who were "employed with a salary" was highest for NB (44%), and lowest for NS (25%) (Table 3.2). Overall, the highest proportion of respondents (20.8%) reported that they had annual household income of $100,000 or more for 2011 tax year, followed closely by another 20.2% with reported annual household income between $50,000 and $59,999. By comparison, about 3% of respondents reported that their 2011 tax year annual household income was under $10,000. The majority of the respondents (90%) lived in a dwelling owned by the household, while another 8% of respondents reported living in rental units.

3.5 Logistic Regression Model

Logistic regression is commonly used for describing and testing hypotheses about relationships between a categorical outcome variable and one or more categorical or continuous predictor variables (Peng et al., 2002). Binary logit or multinomial logit models can be applied depending on the nature of the dataset (Allison, 2001).

A logistic regression model characterizing consumer acceptance of wind turbine systems and consumer preference for electricity generate using wind technology can be expressed as:

$$\ln\left[\frac{P_i}{1-P_i}\right]=\alpha+\beta_1 x_{1i}+\beta_2 x_{2i}+\dots\dots\dots+\beta_k x_{ki} \qquad (1)$$

Where i presents the i-th observation in the sample, P is the probability of the outcome, α is the intercept term, and β_1, β_2,…, β_k are coefficients associated with each explanatory variable X_1, X_2, …, X_K. Thus, P_i is the probability that Y_i takes the value 1, $(1-P_i)$ is the probability that Y_i is 0, and e is the exponential constant.

The Logistic regression model can be derived as:

$$P_i = \text{Prob}(Y_i = 1) = \frac{1}{1+e^{-(\alpha+\beta_1 X_{1i}+\ldots+\beta_k X_{ki})}} = \frac{e^{(\alpha+\beta_1 X_{1i}+\ldots+\beta_k X_{ki})}}{1+e^{(\alpha+\beta_1 X_{1i}+\ldots+\beta_k X_{ki})}} \tag{2}$$

Similarly,

$$\text{Prob}(Y_i = 0) = 1-(Y_i = 1) = \frac{1}{1+e^{(\alpha+\beta_1 X_{1i}+\ldots+\beta_k X_{ki})}} \tag{3}$$

Dividing Equation (1) by Equation (2) generates:

$$\frac{\text{Prob}(Y_i = 1)}{\text{Prob}(Y_i = 0)} = \frac{p_i}{1-p_i} = e^{(\alpha+\beta_{1i} X_{1i}+\ldots+\beta_k X_{ki})} \tag{4}$$

Taking the natural log in both sides of Equation (4) yields:

$$\ln\left(\frac{P_i}{1-P_i}\right) = \alpha + \beta_{1i} X_{1i} + \ldots + \beta_k X_{ki} \tag{5}$$

It is important to note that estimated coefficients do not directly indicate the effect of a change in the corresponding explanatory variables on probability (*P*), but the effect of individual explanatory variables on its log of odds $\ln(\frac{p_i}{1-p_i})$. A positive coefficient means that the log of odds increases as the corresponding independent variable increases. In addition, $\frac{P_i}{1-P_i}$ is a monotonically increasing function of *P*, and $\ln(\frac{P_i}{1-P_i})$ is a monotonically increasing function of $\frac{P_i}{1-P_i}$ (Rotherford and Choe, 1993). Thus, if the log of odds is positive or negatively related to an independent variable, both odds and probability of the outcome are also positively or negatively related to that variable. The only difference is that the relationship is linear for the log of odds and non-linear for odds and probability of the outcomes.

A major problem with the linear probability model is that probabilities are bounded by 0 and 1. Transforming the probability to odds removes the upper bound, while the logarithm of the odds can remove the lower bound (Allison, 2001). In this study, the coefficients in the logistic regression models were estimated using the Maximum Likelihood estimation method. The models were analyzed using SPSS version 19 (SPSS Inc., 2010).

Exponentiation of Estimated Regression Coefficients

Exp(β) in the SPSS logistic regression output is the exponentiation of the estimated coefficient or estimated odds ratio coefficient (Burns and Burns, 2008). It predicts the change in odds for a unit increase in the explanatory variable (Burns and Burns, 2008). When Exp(β) is less than 1, increasing values of the variable correspond to decreasing odds of the outcome. When Exp(β) is greater than 1, increasing values of the variable correspond to increasing odds of the outcome (Burns and Burns, 2008).

3.6 Empirical Regression Models

Two logistic regression models were developed and then used to investigate:

i) Regression Model I: important determinants of public acceptance of wind power technology and systems; and

ii) Regression Model II: factors influencing preference for electricity generated from renewable sources, with a focus on wind energy.

The dependent variables were assumed to be influenced by various explanatory variables, including demographic factors, attributes related to individual values and beliefs about environmental stewardship, and selected attributes of wind power systems.

Dependent Variables

Consumer acceptance of wind power technologies and systems was investigated in terms of a categorical variable, and coded as 1 if the respondent strongly supported "establishing land-based (as opposed to off-shore) wind turbines to generate electricity", and 0 otherwise. Among the 261 usable survey responses received, 103 (or 40%) indicated a strong support for establishing wind turbines, while the remaining 158 (60%) indicated otherwise. Among respondents who indicated a strong support for installing wind turbines to generate wind energy, the proportion was highest for respondents from PEI (about 47%), followed by NS (40%), and then NB (34.4%).

Consumer preference for "green" electricity generated using wind technology was evaluated in terms of a binary variable, and coded as 1 if the respondent indicated the he or she desired or strongly desired "green" electricity produced using on-shore or land-based wind turbines, and 0 otherwise. A total of 257 usable survey responses were analyzed in this model, with 169 (or 66%) of respondents indicating a desire or strong desire for such "green" energy, while the remaining 88 (or 34%) reported otherwise. Preference for electricity generated using wind turbines was highest for respondents from PEI (74% of respondents), and lowest for NB (58%).

Explanatory Variables

In general, the factors that influence consumer acceptance of using wind turbines to generate power, as well as key determinants of factors influencing production of electricity using renewable energy sources such as wind technology may be grouped into three categories: (1) socio-economic factors; (2) individual value and belief factors connected with the environment; and (3) environmental behaviour factors. Social and demographic factors considered in this study included age, gender, education level and income. Other family characteristics investigated included number of children in the household. In addition, individual attitudes towards the environment, knowledge about climate change and environmental quality, and environmental behaviour were important factors in the initial models. Furthermore, factors related to consumer concerns with wind turbines, and using coal for electricity generation were investigated.

AGE: The effect of age on consumer acceptance of wind turbines (H1) was evaluated and was coded as continuous variable. Older individuals are expected to have a lower probability of accepting wind turbines and power generated using such renewable energy technology than younger electricity consumers (Zarnikau, 2003; Poortinga et al., 2003).

EDUCATION: The effect of educational background was tested (H2) using a categorical variable. The first dummy variable (Education 1) was coded as 1 if the respondent completed primary or high school education. The second dummy variable (education 2) was equal to 1 for consumers who completed college or trade school. The third dummy variable (education 3) was equal to 1 for consumers who completed university or post-graduate education. Respondents with trade or community college

(Education 2) or university (education 3) were expected to have a higher probability of support for wind turbines, and electricity produced using wind technology than individuals with primary or high school education (education 1).

HOUSEHOLD INCOME: Income was measured in terms of reported total household income during 2011 tax year, and was investigated (H3) using dummy variables to capture two of three household income ranges. The first dummy variable (Income 1) was coded as 1 for respondents whose 2011 annual household income was less than $40,000. The second dummy variable (Income 2) was coded as 1 for respondents who reported annual income between $40,000 and $79,999. Respondents in both income categories were hypothesized to have lower probabilities of support for wind turbines and electricity generated using wind technology than respondents who reported annual household income of $80,000 or more. The effect of gender (H4) was tested using a dummy variable, and coded as 1 if the respondent is male, and 0 if female.

CHILDREN: The effect of children in the household (H5) was tested using a dummy variable which was coded as 1 if the household had one or more children aged below 18 years, and 0 otherwise.

ATTITUDE TOWARDS THE ENVIRONMENT: The effect of attitude towards the environment (H6) was investigated by using two explanatory variables. First, it was hypothesised that individuals who perceive the planet as a self-cleaning biosystem are less likely to make individual environmental conservation efforts (Poortinga et al., 2004; Olofsson and Öhman, 2006). Perceptions of the planet as a self-cleaning biosystem was tested using a binary dummy variable equal to 1 if respondents strongly disagreed that the planet is a self-cleaning biological system, and 0 otherwise. Respondents who strongly disagreed the planet is a self-cleaning biological system are expected have a higher probability of support for generating electricity from renewable energy sources such as wind. In addition, beliefs about individual effort in contributing to energy conservation and reduction of climate change were tested using a binary dummy variable, and coded as 1 if the respondent strongly agreed that individual effort can make real difference in the fight against pollution, and 0 otherwise. Electricity consumers who strongly agree that individual effort can make a real difference in environmental stewardship are more likely to translate the attitude into action and, therefore, have a higher probability of support for wind power technology and acceptance of wind turbines (Barr, 2003; Steg and Vlek, 2009).

KNOWLEDGE AND RESPONSIBLE ENVIRONMENTAL BEHAVIOR: Knowledge of environmental stewardship and "green" energy (H7) was investigated using a variable which captured consumers' awareness and understanding of global warming and climate change. The environmental stewardship variable was assessed as a dummy variable equal to 1 if the respondents agreed or strongly agreed that they sufficiently understood the causes of global warming and climate change, and 0 otherwise. The effect of environmental behavior (H8) was tested using a dummy variable which asked if respondents made a donation to an environmental or natural resource conservation organization within the last five years (Yen et al., 1997, de Groot and Steg, 2008; Champ and Bishop, 2001). The variable for donation for environmental conservation and protection was coded as 1 if the respondent reported making such a donation within the last five years, and 0 otherwise. In general, individuals who make such donations for environmental protection tend to be more concerned about the environment than those who do not (de Groot and Steg, 2008; Champ and Bishop, 2001). Thus, donors for environmental conservation are expected to have a higher probability of supporting production of electricity using wind technology and more accepting of wind turbines.

CONCERN WITH WIND TURBINE: Important concerns with wind turbines (H9) relate to visual intrusion and turbine noise, both linked to proximity of dwellings to wind turbine installations (Bond, 2008; Thomas, 2002; Hoen et al., 2010). Residents' concerns with visual intrusion was investigated using a dummy variable equal to 1 if respondent agreed or strongly agreed that visual intrusion caused by wind turbines is acceptable, and 0 otherwise. Similarly, concerns linked with turbine noise were investigated using a dummy variable equal to 1 if respondent agreed or strongly agreed that noise caused by wind turbines is acceptable, and 0 otherwise. Consumer concerns linked to proximity of wind turbines to residential dwellings was tested by recoding an original five-point Likert-scale[1] data into a binary dummy variable. Proximity was coded as 0 if the respondent reported this as "moderately important" or "extremely important" and 1 if respondent reported that it was "a little important" or "somewhat important" that the respondent's house is not close to wind turbines.

CONCERN WITH USING COAL: The effect of consumers' level of acceptance or desirability of using coal to generate electricity (H10) was tested using a dummy variable equal to 1 if the respondent reported that coal is strongly undesirable as a source for generating electricity, and 0 otherwise. Respondents who believe that coal is strongly undesirable for producing electricity are more likely to have a higher probability of

[1]A type of scaling where the respondents are presented with a series of statements, rather than questions, and asked to indicate the degree to which they agree or disagree, usually on a five-point scale (Alreck and Settle, 2003).

accepting wind turbines and generating electricity using wind technology (Bond, 2008; Ek, 2005). The variable on coal as a source for generating electricity was included in Regression Model II (i.e., determinants of factors influencing preference for electricity from wind technology), but not in Regression Model I (important determinants of public acceptance of wind turbines). Similarly, the variable related to concerns with wind turbine noise was included in regression model I only. In addition, the effects of the variable in wind turbine visual intrusion, and proximity to residential dwelling were tested in regression model I (but not in model II).

Table 3.4 Description of Explanatory Variables Used in Regression Models

Variable name	Description
a) Dummy variables	
Province (1)	Nova Scotia
Province (2)	Prince Edward Island
Province (3)*	New Brunswick
Gender	Coded 1 if the respondent is male; 0 if the respondent is female
Children	Coded 1 if respondent's household has children aged below 18 years; 0 if the household does not have children aged below 18years
Education (1)	Completed high school
Education (2)	Completed community college or trade school
Education (3)*	Completed university or post graduate degree
Income (1)	Total household income during 2011 tax year was under $40,000
Income (2)	Total household income during 2011 tax year was between $40,000 and $79,999
Income (3)*	Total household income during 2011 tax year was $80,000 or more
Knowledge about global warming	Coded 1 if the respondent agreed or strongly agreed s/he is sufficiently aware of global warming and climate change, and the factors that cause it; 0 otherwise
Plant does not self-clean	Coded 1 if the respondent strongly disagreed that the planet is a biological system in which everything eventually returns to normal, so there is no need to worry about its present environmental quality condition; 0 otherwise
Individual effort	Coded 1 if respondent strongly agrees that one's individual effort can make a real difference in the fight against pollution; 0 otherwise
Donation for environmental programs	Coded 1 if respondent made a donation to an environmental or natural resource conservation organization within the last five years; e 0 if respondent did not make a donation during that period
Opposition to coal	Coded 1 if respondent reported that coal is a strongly undesirable source for electricity generation; 0 otherwise
Visual intrusion tolerance	Coded 1 if respondent agreed or strongly agreed that visual intrusion caused by wind turbines is acceptable; value 0 otherwise
Tolerance of turbine noise	Coded 1 if respondent agreed or strongly agreed that noise caused by wind turbines is acceptable; 0 otherwise
Tolerance of existing set-back distance	Coded 1 if respondent rated as "not at all important", "a little important" or "somewhat important" if house is close to wind turbine or wind farm ; 0 otherwise
b) Continuous variable	
Age	Age of respondent

*Denotes scale or group used as reference in the regression model.

Table 3.5 Sample Statistics of Explanatory Variables Analyzed in Regression Model I

		NS			PEI			NB			Pooled		
Variable name	Binary variable value	Frequency (%)	Mean	Std. deviation	Frequency (%)	Mean	Std. deviation	Frequency (%)	Mean	Std. deviation	Frequency (%)	Mean	Std. deviation
Province (1)	1										110 (42.8)	1.92	0.878
Province (2)	2										58 (22.6)		
Province (3)	3										89 (34.6)		
Age	Number		62.91	12.360		63.02	14.079		61.33	13.192		62.39	13.023
Gender	1	67 (60.9)	0.61	0.490	38 (65.5)	0.66	0.479	68 (76.4)	0.76	0.427	173 (67.3)	0.67	0.470
	0	43 (39.1)			20 (34.5)			21 (23.6)			84 (32.7)		
Children	1	17 (15.5)	0.15	0.363	6 (10.3)	0.10	0.307	14 (15.7)	0.16	0.366	37 (14.4)	0.14	0.352
	0	93 (84.5)			52 (89.7)			75 (84.3)			220 (85.6)		
Education (1)	1	38 (34.5)	2.04	0.856	19 (32.8)	2.05	0.847	29 (32.6)	2.02	0.825	86 (33.5)	2.04	0.840
Education (2)	2	30 (27.3)			17 (29.3)			29 (32.6)			76 (29.6)		
Education (3)	3	42 (38.2)			22 (37.9)			31 (34.8)			95 (37.0)		
Income (1)	1	35 (31.8)	2.03	0.818	16 (27.6)	2.07	0.792	20 (22.5)	2.11	0.745	71 (27.6)	2.07	0.785
Income (2)	2	37 (33.6)			22 (37.9)			39 (43.8)			98 (38.1)		
Income (3)	3	38 (34.5)			20 (34.5)			30 (33.7)			88 (34.2)		
Knowledge about global warming	1	67 (60.9)	0.61	0.490	28 (48.3)	0.48	0.504	54 (60.7)	0.61	0.491	149 (58.0)	0.58	0.495
	0	43 (39.1)			30 (51.7)			35 (39.3)			108 (42.0)		
Planet does not self-clean	1	80 (72.7)	0.73	0.447	38 (65.5)	0.66	0.479	63 (70.8)	0.71	0.457	181 (70.4)	0.70	0.457
	0	30 (27.3)			20 (34.5)			26 (29.2)			76 (29.6)		
Individual effort	1	29 (26.4)	0.26	0.443	8 (13.8)	0.14	0.348	25 (28.1)	0.28	0.452	62 (24.1)	0.24	0.429
	0	81 (73.6)			50 (86.2)			64 (71.9)			195 (75.9)		
Donation for environmental programs	1	37(33.6)	0.34	0.475	17 (29.3)	0.29	0.459	31 (34.8)	0.35	0.479	85 (33.1)	0.33	0.471
	0	73 (66.4)			41 (70.7)			58 (65.2)			172 (66.9)		
Visual intrusion tolerance	1	71 (64.5)	0.65	0.481	45 (77.6)	0.78	0.421	57 (64.0)	0.64	0.483	173 (67.3)	0.67	0.470
	0	39 (35.5)			13 (22.4)			32 (36.0)			84 (32.7)		
Tolerance of turbine noise	1	41 (37.3)	0.37	0.486	31 (53.4)	0.53	0.503	37 (41.6)	0.42	0.496	109 (42.4)	0.42	0.495
	0	69 (62.7)			27 (46.6)			52 (58.4)			148 (57.6)		
Tolerance of existing set-back distance	1	155 (60.3)	0.60	0.490	68 (61.8)	0.62	0.488	39 (67.2)	0.67	0.473	48 (53.9)	0.54	0.501
	0	102 (39.7)			42 (38.2)			19 (32.8)			41 (46.1)		

Table 3.6 Sample Statistics of Explanatory Variables Analyzed in Regression Model II

		NS			PEI			NB			Pooled data		
Variable name	Variable value	Frequency (%)	Mean	Std. deviation	Frequency (%)	Mean	Std. deviation	Frequency (%)	Mean	Std. deviation	Frequency (%)	Mean	Std. deviation
Province (1)	1										113 (43.3)	1.91	0.879
Province (2)	2										58 (22.2)		
Province (3)	3										90 (34.5)		
Age	Number		63.06	12.237		63.84	14.054		61.19	13.054		62.59	12.933
Gender	1	70 (61.9)	0.62	0.488	38 (65.5)	0.66	0.479	68 (75.6)	0.76	0.432	85 (32.6)	0.67	0.470
	0	43 (38.1)			20 (34.5)			22 (24.4)			176 (67.4)		
Children	1	17 (15.0)	0.15	0.359	7 (12.1)	0.12	0.329	14 (15.6)	.16	0.364	38 (14.6)	0.15	0.353
	0	96 (85.0)			51 (87.9)			76 (84.4)			223 (85.4)		
Education (1)	1	39 (34.5)	2.04	0.860	20 (34.5)	2.05	0.867	30 (33.3)	2.00	0.821	89 (34.1)	2.03	0.845
Education (2)	1	30 (26.5)			15 (25.9)			30 (33.3)			75 (28.7)		
Education (3)	1	44 (38.9)			23 (39.7)			30 (33.3)			97 (37.2)		
Income (1)	1	34 (30.1)	2.04	0.806	18 (31.0)	2.03	0.816	21 (23.3)	2.11	0.756	73 (28.0)	2.07	0.789
Income (2)	1	40 (35.4)			20 (34.5)			38 (42.2)			98 (37.5)		
Income (3)	1	39 (34.5)			20 (34.5)			31 (34.4)			90 (34.5)		
Knowledge about global warming	1	70 (61.9)	0.62	0.488	29 (50.0)	0.50	0.504	53 (58.9)	0.59	0.495	152 (58.2)	0.58	0.494
	0	43 (38.1)			29 (50.0)			37 (41.1)			109 (41.8)		
Planet does not self-clean	1	83 (73.5)	0.73	0.444	7 (12.1)	0.64	0.485	65 (72.2)	0.72	0.450	185 (70.9)	0.71	0.455
	0	30 (26.5)			51 (87.9)			25 (27.8)			76 (29.1)		
Individual effort	1	32 (28.3)	0.28	0.453	37 (63.8)	0.12	0.329	27 (30.0)	0.30	0.461	66 (25.3)	0.25	0.435
	0	81 (71.7)			21 (36.2)			63 (70.0)			195 (74.7)		
Donation for environmental programs	1	37 (32.7)	0.33	0.471	18 (31.0)	0.31	0.467	31 (34.4)	0.34	0.478	86 (33.0)	0.33	0.471
	0	76 (67.3)			40 (69.0)			59 (65.6)			175 (67.0)		
Opposition to coal	1	42 (37.2)	0.37	0.485	27 (46.6)	0.47	0.503	43 (47.8)	0.48	0.502	112 (42.9)	0.43	0.496
	0	71 (62.8)			31 (53.4)			47 (52.2)			149 (57.1)		
Visual intrusion tolerance	1	75 (66.4)	0.66	0.475	44 (75.9)	0.76	0.432	58 (64.4)	0.64	0.481	177 (67.8)	0.43	0.468
	0	38 (33.6)			14 (24.1)			32 (35.6)			84 (32.2)		
Tolerance of existing set-back distance	1	70(61.9)	0.62	0.488	37 (63.8)	0.64	0.485	50 (55.6)	0.56	0.500	157 (60.2)	0.60	0.491
	0	43 (38.1)			21 (36.2)			40 (44.4)			104 (39.8)		

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Does Preference Rating of Alternative Power Sources Differ by Province?

Respondents were asked to indicate their preference for electricity generated using various renewable and non-renewable energy sources, based on a five-point Likert scale ranging from 1=strongly desirable to 5=strongly undesirable (Figure 4.1). The alternative sources of energy considered included important sources currently used in the Maritime provinces, such as traditional fossil fuels (i.e., coal), hydro and nuclear power, as well as renewable energy alternatives such as wind, solar, and tidal/wave (Figure 4.1).

In general, non-renewable sources of power were ranked the highest, compared with the renewable sources, as expected. Among the renewable energy sources which were “strongly desirable”, solar was rated the highest, followed by wind power, and then tidal/wave. In a mailed survey of residents’ attitudes toward power generation options in Albany, Australia, Bond (2008) reported that wind power was the most preferred power source, followed by solar and then tidal/wave. This finding on the preference ranking for solar relative to wind energy among the respondents in NS, PEI, and NB is somewhat surprising, given the dominance of wind farms across all three Maritime Provinces. Perhaps, the higher ranking of solar relative to wind in this Canadian study is linked to reported residents’ concerns with wind farm and wind turbine installations among local residents in the region (Álvarez-Farizo and Hanley, 2002; EDS Consulting, 2009; Wiser et al., 2006).

Electricity generated using coal and nuclear plants were the least preferred power sources both in Bond’s (2008) study and in this study. The dislike for coal and nuclear power among the Maritime residents surveyed may be linked in part to recent media

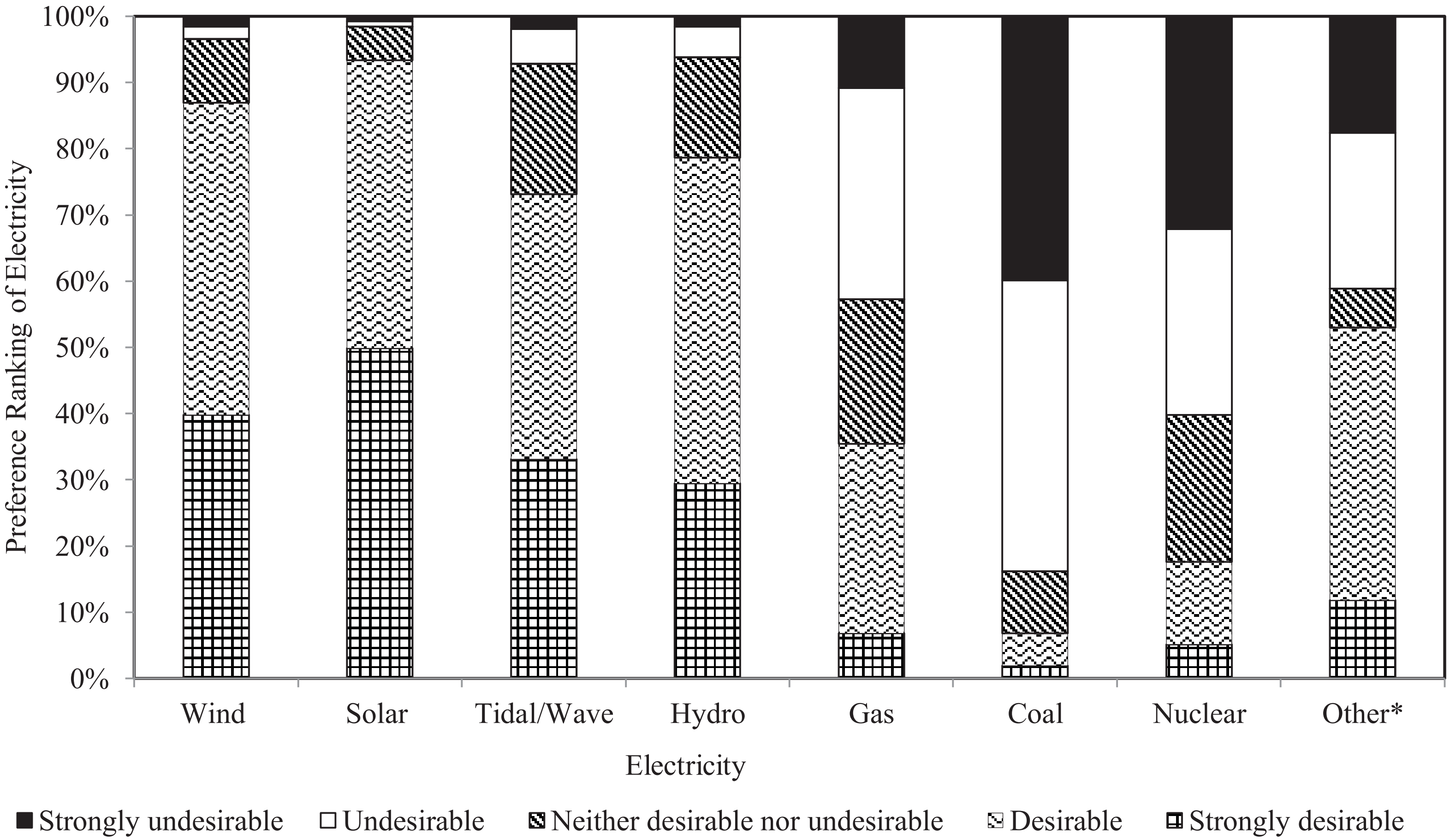

Figure 4.1 Preference of Electricity by Power Source, 2012 Survey
*Other includes biomass, oil, geothermal, and wood

publicity of coal tar ponds contamination clean-up problems in Sydney, NS (Furimsky, 2002; Haalboom et al., 2006), and potential problems with nuclear power plants in NB (Nguyen et al., 2008; Kaatsch et al., 2008).

To gain further insights into the "green" energy preferences, the pooled survey data was disaggregated by province (i.e., NS, PEI, and NB) (Table 4.1). Electricity generated from solar was consistently ranked the highest (i.e., as strongly desirable) in all three provinces, followed by wind, tidal/wave, and then hydro (Table 4.1). The proportion of respondents who rated solar power as "strongly desirable" was highest in NB (52%), and lowest for NS (48%). By comparison, the proportion of respondents who rated wind power as "strongly desirable" was highest in PEI (47%), and lowest for NB (35%). Overall, PEI respondents showed a higher preference for wind and solar power than respondents from NS and NB. For example, 93.4% of the respondents in PEI indicated that wind energy was "desirable" or "strongly desirable" compared with 88% in NS, and 81% in NB.

4.3 Concerns with Wind Turbine Systems

To investigate respondents' concerns with issues commonly associated with wind farms and wind turbines, respondents were asked to rate their level of tolerance or concern with wind turbines on a five-point scale, ranging from 1=strongly acceptable to 5=strongly unacceptable Figure 4.2) . The results suggest that (potential) bird mortality from collisions with wind turbines was the concern with the highest unacceptable rating among respondents (40.1%), followed by radio interference (37.8%) and noise concerns (33.9%). By comparison, visual intrusion caused by wind turbines was rated the

Table 4.1 Preference Ranking of Electricity by Power Source and Province, 2012 Survey

	Strongly desirable	Desirable	Neither desirable nor undesirable	Undesirable	Strongly undesirable	Total
Electricity source	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)	Total (%)
a) NS Respondents						
Wind	65 (39.4)	80 (48.5)	15 (9.1)	3 (1.8)	2 (1.2)	165 (100)
Solar	79 (48.2)	74 (45.1)	8 (4.9)	2 (1.2)	1 (0.6)	164 (100)
Tidal/Wave	63 (38.4)	71 (43.3)	20 (12.2)	9 (5.5)	1 (0.6)	164 (100)
Hydro	48 (30.0)	79 (49.4)	26 (16.3)	5 (3.1)	2 (1.2)	160 (100)
Gas	7 (4.3)	51 (31.7)	38 (23.6)	47 (29.2)	18 (11.2)	161 (100)
Coal	3 (1.9)	10 (6.2)	12 (7.4)	76 (47.2)	60 (37.3)	161 (100)
Nuclear	5 (3.1)	7 (4.4)	38 (23.7)	51 (31.9)	59 (36.9)	160 (100)
Other[1]	2 (18.2)	4 (36.3)	1 (9.1)	2 (18.2)	2 (18.2)	11 (100)
b) PEI Respondents						
Wind	43 (46.7)	43 (46.7)	4 (4.4)	1 (1.1)	1 (1.1)	92 (100)
Solar	47 (50.5)	41 (44.1)	4 (4.3)	1 (1.1)	0 (0)	93 (100)
Tidal/Wave	22 (24.7)	30 (33.7)	30 (33.7)	5 (5.6)	2(2.3)	89 (100)
Hydro	19 (21.6)	51 (58.0)	14 (15.9)	4 (4.5)	0 (0)	88 (100)
Gas	7 (7.9)	31 (34.8)	18 (20.2)	26 (29.2)	7 (7.9)	89 (100)
Coal	1 (1.1)	4 (4.5)	9 (10.1)	39 (43.8)	36 (40.5)	89 (100)
Nuclear	6 (6.6)	21 (23.1)	16 (17.6)	25 (27.4)	23 (25.3)	91 (100)
Other[2]	0 (0)	1 (16.7)	1 (16.7)	2 (33.3)	2 (33.3)	6 (100)
c) NB Respondents						
Wind	44 (35.2)	57 (45.6)	18 (14.4)	3 (2.4)	3 (2.4)	125 (100)
Solar	64 (51.6)	51 (41.1)	7 (5.7)	0 (0)	2 (1.6)	124 (100)
Tidal/Wave	39 (31.9)	49 (40.2)	24 (19.7)	6 (4.9)	4 (3.3)	122 (100)
Hydro	42 (34.4)	52 (42.6)	16 (13.1)	8 (6.6)	4 (3.3)	122 (100)
Gas	11 (9.2)	24 (20.0)	25 (20.8)	45 (37.5)	15 (12.5)	120 (100)
Coal	3 (2.5)	4 (3.3)	14 (11.6)	48 (39.6)	52 (43.0)	121 (100)
Nuclear	8 (6.5)	19 (15.4)	29 (23.6)	29 (23.6)	38 (30.9)	123 (100)
Other[3]	2 (11.8)	9 (52.9)	0 (0)	4 (23.5)	2 (11.8)	17 (100)

[1]other includes biomass, oil, geothermal, and wood.
[2]other includes oil and wood
[3]other includes biomass, oil and wood

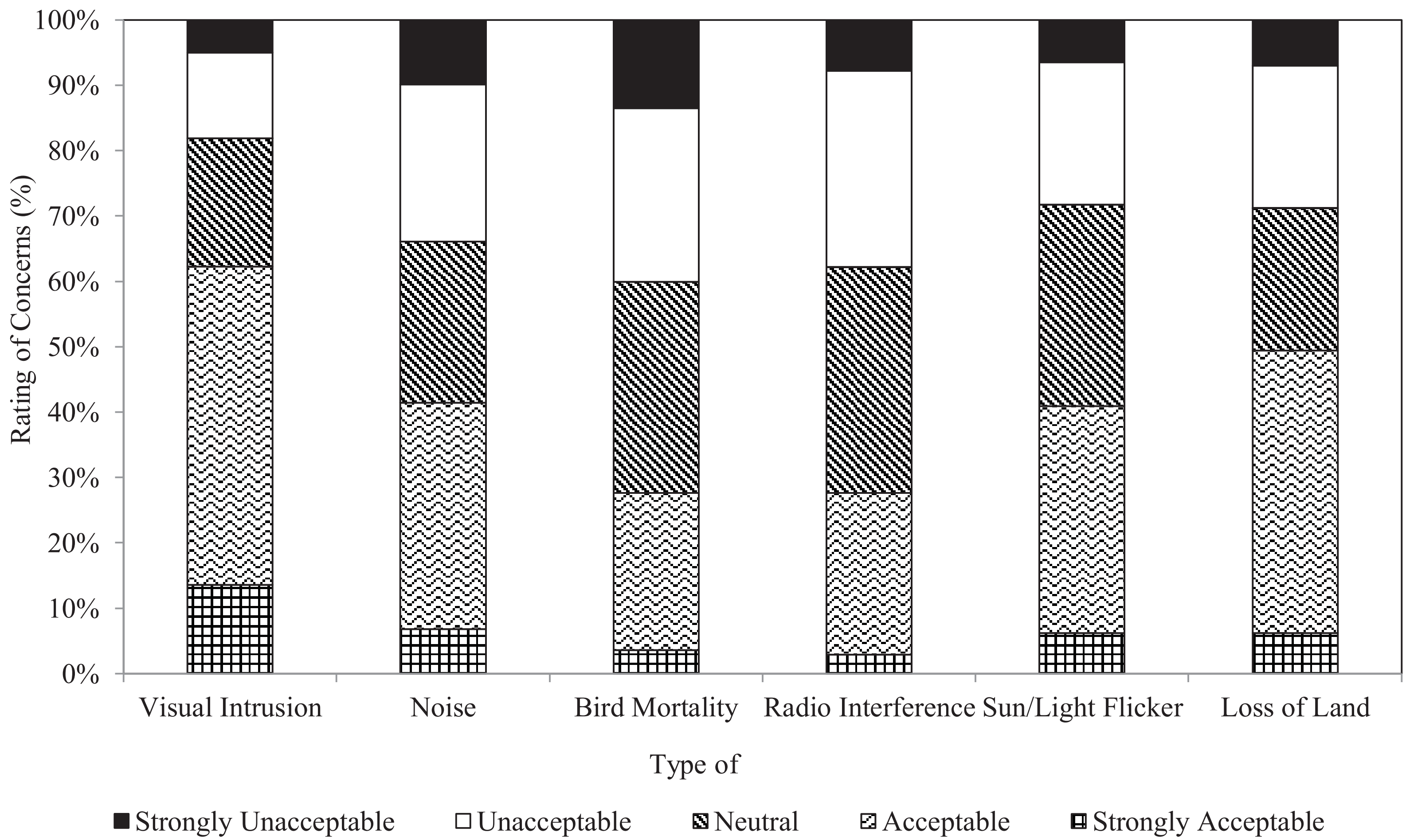

Figure 4.2 Ranking of Concerns Linked to Wind Turbines, 2012 Survey

lowest (18.1%). Similar findings were reported by Bond (2008) in a study for Australia, where respondents reported lower concerns with wind farms, especially the potential harmful impact on wildlife. Noise concerns with wind turbines have been reported to have negative effects on sleep, speech and learning (Rogers et al., 2006), and potential human health conditions such as anxiety, tinnitus and hearing loss (Rogers et al., 2006).

Respondents' rating of concerns with wind farms and turbines were generally similar across the three provinces (Table 4.2). The provincial-level results indicate that bird mortality and radio interference were two externalities with the highest unacceptable rating, and consistent across all three provinces. However, noise from wind turbines was ranked the third highest unacceptable negative effect among respondents from NS and NB, while respondents in PEI rated turbine sunlight flicker more unacceptable compared with noise. The unacceptable rating of radio interference was higher than for bird mortality among respondents from PEI, while respondents from NB were most worried about bird mortality, and respondents from NS ranked bird mortality and radio interference equally. Overall, the unacceptable rating of potential bird mortality caused by wind turbines was highest for NB (45.6%), followed by NS (39.7%) and PEI (33.4%) (Table 4.2).

4.4 Determinants of Consumer Acceptance of On-land Wind Turbine Systems

A logistic regression model was developed and then used to investigate important factors which influence consumer acceptance of on-land wind turbines and related wind technologies and systems. The Maximum Likelihood (ML) estimation method was used to evaluate the function that maximizes the ability to predict the probability of consumer

Table 4.2 Reported Ranking of Concerns with Wind Power Technology in NS, PEI, and NB, 2012 Survey

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	Total
Issue	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)	Total (%)
a) NS Respondents						
Visual intrusion caused by wind turbines is acceptable	22 (13.3)	75 (45.5)	36 (21.8)	24 (14.6)	8 (4.8)	165 (100)
Noise caused by wind turbines is acceptable	8 (4.8)	52 (31.3)	43 (25.9)	43 (25.9)	20 (12.1)	166 (100)
Bird mortality caused by wind turbines is acceptable	7 (4.2)	37 (22.3)	56 (33.8)	50 (30.1)	16 (9.6)	166 (100)
Radio interference caused by wind turbines is acceptable	5 (3.0)	32 (19.3)	63 (38.0)	52 (31.3)	14 (8.4)	166 (100)
Sun/light flicker from wind turbines is acceptable	10 (6.0)	50 (29.9)	54 (32.3)	40 (24.0)	13 (7.8)	167 (100)
Loss of natural land caused by wind turbines is acceptable	12 (7.2)	65 (38.9)	40 (23.9)	39 (23.4)	11 (6.6)	167 (100)
b) PEI Respondents						
Visual intrusion caused by wind turbines is acceptable	13 (14.1)	52 (56.5)	15 (16.3)	11 (12.0)	1 (1.1)	92 (100)
Noise caused by wind turbines is acceptable	7 (7.5)	41 (44.1)	20 (21.5)	22 (23.7)	3 (3.2)	93 (100)
Bird mortality caused by wind turbines is acceptable	2 (2.1)	29 (31.2)	31 (33.3)	21 (22.6)	10 (10.8)	93 (100)
Radio interference caused by wind turbines is acceptable	2 (2.1)	27 (29.0)	29 (31.2)	30 (32.3)	5 (5.4)	93 (100)
Sun/light flicker from wind turbines is acceptable	6 (6.4)	36 (38.3)	25 (26.6)	24 (25.5)	3 (3.2)	94 (100)
Loss of natural land caused by wind turbines is acceptable	5 (5.3)	43 (45.8)	22 (23.4)	22 (23.4)	2 (2.1)	94 (100)
c) NB Respondents						
Visual intrusion caused by wind turbines is acceptable	17 (13.6)	59 (47.2)	24 (19.2)	15 (12.0)	10 (8.0)	125 (100)
Noise caused by wind turbines is acceptable	11 (8.8)	40 (32.0)	32 (25.6)	27 (21.6)	15 (12.0)	125 (100)
Bird mortality caused by wind turbines is acceptable	5 (4.0)	26 (20.8)	37 (29.6)	31 (24.8)	26 (20.8)	125 (100)
Radio interference caused by wind turbines is acceptable	4 (3.2)	36 (28.8)	41 (32.8)	33 (26.4)	11 (8.8)	125 (100)
Sun/light flicker from wind turbines is acceptable	8 (6.4)	48 (38.4)	40 (32.0)	20 (16.0)	9 (7.2)	125 (100)
Loss of natural land caused by wind turbines is acceptable	7 (5.6)	59 (47.2)	22 (17.6)	23 (18.4)	14 (11.2)	125 (100)

acceptance of wind turbines and related wind technologies and systems, and the analysis conducted using SPSS version 19 (SPSS Inc., 2010). Model performance and goodness-of-fit statistics are discussed first, before the discussion on significant factors influencing consumer acceptance.

4.4.1 Goodness-of-Fit and Overall Model Performance

Criteria commonly used to evaluate the usefulness of estimated logistic regression models include: i) evaluation of model performance or how well the overall model works; ii) assessment of the level of confidence with which there is a relationship between all the independent variables included in the model (considered together), and the dependent variable, beyond what might be expected as coincidence due to random variation in the sample; and iii) frequency of correct, as opposed to incorrect, predictions of the exact value of the dependent variable (Menard, 1995: page 17).

The log likelihood ratio was 249. However, it is not very informative because there is no guidance on how big (or how small) this should be (Menard, 1995). A further test of the full model against a constant only model was statistically significant with a Model χ^2 statistic= 81.505($p < 0.000$, df = 16). In addition, the high *p* value for the Hosmer and Lemeshow test $\chi^2 = 6.918$ ($p = 0.545$; df = 8), suggests that we cannot reject the fitted model (see, for example, Allison, 2012). Furthermore, the proportion of observations correctly predicted as 1 = 89%, while the proportion of observations predicted as 0 = 58%. In addition, the overall proportion of observations correctly classified was satisfactory, at 79%. Consequently, the fitted model was used in this study for further investigations.

4.4.2 Factors Influencing Consumer Acceptance of On-land Wind Turbine Installations

The results support hypotheses that level of education (H2), size of household income (H3), knowledge about the causes of global warming and environmental stewardship issues (H7), environmental behavior and commitment in terms of monetary donation for a natural resource and environmental protection (H8), and selected indicators of concerns with wind turbine installation (H9) influence respondents' acceptance of wind turbines and wind farms (Table 4.3). In addition, age and province were marginally significant at 10%.

Age was marginally significant (at 10%) with a negative effect (also, see Olofsson and Öhman, 2006) on acceptance of wind turbines and technologies. This finding is consistent with various studies which found that younger consumers tend to be more environmentally-friendly (Engel and Pötschke, 1998; van Liere and Dunlap, 1980), and tend to support production of electricity from renewable sources, compared with older individuals (Wiser, 2007; Zarnikau, 2003). The marginal effect for age was 0.025 [=1 – 0.975] (see Table 4.3), and implies that a unit increase in average age of the respondents results in a 2.5% decrease in the odds of acceptance wind turbine systems. The variable for province was also marginally significant. This suggests that, compared with NB, residents in both NS and PEI showed a positive support for wind turbine systems.

In this study, the effect of level of education is consistent with the effect for several previous studies. The reference for the education variable was respondents with university and post-graduate education (i.e., Education 3). Thus, college and trade school graduates (Education (2)) had a positive effect on the odds of acceptance of on-land wind

Table 4.3 Logistic Regression Results of Determinants of Consumer Acceptance of on-land Wind Turbine Installations, Pooled Survey Data

Variable (hypothesis tested)	Regression Coefficient (β)	Standard Error	Probability (p)	Exp(β)
Constant	1.769	1.174	0.132	0.170
Province(1)	0.696*	0.367	0.058	2.005
Province(2)	0.797*	0.449	0.076	2.220
Age	-0.025*	0.015	0.098	0.975
Gender	0.521	0.361	0.149	1.684
Education(1)	0.569	0.403	0.158	1.766
Education(2)	0.951**	0.433	0.028	2.588
Income(1)	0.666	0.451	0.140	1.947
Income(2)	0.891**	0.407	0.028	2.438
Children	-0.047	0.560	0.932	0.954
Planet does not self-clean	-0.020	0.358	0.955	0.980
Individual effort	-0.331	0.408	0.417	0.719
Knowledge about global warming	0.990***	0.338	0.003	2.690
Donation for environmental programs	0.842**	0.382	0.027	2.321
Visual intrusion tolerance	0.924**	0.367	0.012	2.520
Tolerance of turbine noise	1.317***	0.387	0.001	3.732
Tolerance of existing set-back distance	0.839**	0.340	0.014	2.315
Model χ^2 Statistic				81.505 (p<0.000; df=16)
Log likelihood Ratio				248.803
Cox and Snell R^2				0.272
Nagelkerke R^2				0.376
Hosmer and Lemeshow Test χ^2				6.918 (p=0.545; df=8)
Proportion of observations correctly predicted as supporting on-land wind turbines				89.9
Proportion of observations correctly predicted as otherwise				58.0
Overall percentage of cases correctly classified				79.0
Total number of observations				257

Note: Statistical significance implies: *** Significant at 1% level; ** Significant at 5% level; and * Significant at 10% level turbines and associated technologies. The scholarly literature suggests that higher education correlates with individuals who act in more environmentally-friendly ways (Engel and Pötschke, 1998; Arcury and Christianson, 1990; Hungerford and Volk, 1990), and who tend to be more accepting of power produced using renewable technologies such as wind (Black et al., 1985; Bergmann et al., 2006).

Annual household income was coded into 3 levels or groups, with Income 3 (= respondents with total household income during 2011 tax year of $80,000 or more) used as the reference. Income (2) (i.e., respondents with annual household income between $40, 0000 and $79,999 during 2011 tax year) was significant, but not Income (1). This implies that respondents with higher income increased the odds of acceptance of wind turbines and wind farms.

Knowledge about global warming and its causes increased the probability of acceptance of wind turbines and technologies. A unit increase in such knowledge increased the odds of predicting acceptance of wind turbines and technologies by a factor of 2.7 (Table 4.3). In separate studies, Stern (1992) and Simmons and Widmar (1990) noted that knowledge of a technical environmental problem and its possible solutions strongly influence individual’s behavior and preference decisions. The result is also consistent with Mills and Schleich (2010) and Ek (2005) who reported that knowledge about environmental stewardship issues is an important factor which affects consumers’ preference for, and willingness to pay for, renewable energy.

Environmental behavior and concern for the environment was operationalized in this study using several indicators. Donation to natural resource and environmental protection programs was coded as a dichotomous choice (YES/NO) variable. Respondents who reported making such a donation within the past five years increased the probably of acceptance of wind turbines and technologies by a factor of 2.3. Thogersen and Grunert-Beckman (1997), Hopper and Nielsen (1991), Rokeach (1973) and Schwartz and Bilsky (1987) indicated that individual behavior is influenced by values, attitudes and awareness of the consequences of personal choices made.

The hypothesis (H9) that the probability of acceptance of wind turbines and associated technologies increases with tolerance of selected concerns with wind turbine externalities was strongly supported by the survey data. Tolerance of turbine noise was highly significant, and had the highest marginal effect of a factor of 3.7, compared with two other indicators of wind turbine concerns (Table 4.3). Visual intrusion and turbine noise are among the heightened concerns and reasons for local residents' opposition to siting of wind farms (Sibille et al., 2009; Tsoutsos et al., 2009; Harding et al., 2008; Oerlemans et al., 2007; Rogers et al., 2006). Magnitude of the marginal effects of visual intrusion tolerance (2.5) and tolerance of existing setback distance (2.3) were also relatively high. In summary, the results suggest that efforts to increase public support for wind power development should emphasize addressing and improving the negative public concerns particularly engineering improvements to reduce turbine noise and science on what is acceptable set-back distance for wind turbines.

4.5 Factors Influencing Preference for "Green" Electricity Produced Using Wind Technology

A second logistic regression model was developed and used to investigate important determinants of consumer preference for "green" electricity, generated using wind power technologies.

4.5.1 Goodness of Fit and Overall Model Performance

The overall regression model performance was satisfactory, with Model χ^2 Statistic = 66.12 (p=0.000, df=16). The logit model sensitivity (i.e., proportion of observations correctly predicted as 1=61%) and model specificity (i.e., proportion of observations correctly predicted as 0=82%) were also satisfactory. In addition, the overall percentage of observations correctly classified was 74%. Other model performance statistics such as the Nagelkerke's R^2, and the Cox and Snell R^2 are reported in Table 4.4. The Hosmer and Lemeshow Test χ^2 was 8.821 and not significant (p = 0.358, df = 8, N = 261). This implies that the fitted model cannot be rejected, and had a satisfactory model fit (Allison, 2012).

4.5.2 Determinants of Factors which Influence Preference for "Green" Electricity Produced Using Wind Technology

Overall, the regression results support several of the earlier hypotheses developed which influence residents' preference for electricity producing using renewable energy systems such as wind technology. Significant determinants of respondents' preference for

Table 4.4 Logistic Regression Results of Factors Influencing Preference for "Green" Electricity Generated Using Wind Technology, Pooled Survey Data

Variable (hypothesis tested)	Regression Coefficient (β)	Standard Error	Probability (p)	Exp(β)
Constant	4.041***	1.113	0.000	0.018
Province(1)	0.313	0.345	0.364	1.367
Province(2)	0.707*	0.405	0.081	2.028
Age	0.008	0.014	0.547	1.008
Gender	-0.075	0.332	0.821	0.928
Education(1)	0.442	0.387	0.254	1.556
Education(2)	0.837**	0.382	0.029	2.309
Income(1)	-0.351	0.414	0.397	0.704
Income(2)	-0.397	0.374	0.289	0.673
Children	0.069	0.477	0.885	1.071
Planet does not self-clean	1.119***	0.378	0.003	3.061
Individual effort	0.784**	0.350	0.025	2.191
Knowledge about global warming	-0.126	0.313	0.687	0.881
Donation for environmental programs	0.030	0.333	0.928	1.030
Opposition to coal	0.616**	0.312	0.049	1.851
Visual intrusion tolerance	1.165***	0.366	0.001	3.206
Tolerance of existing set-back distance	0.945***	0.328	0.004	2.572
Model χ^2 Statistic				66.118 (p<0.000; df=16)
Log likelihood Ratio				284.028
Cox and Snell R^2				.224
Nagelkerke R^2				.303
Hosmer and Lemeshow Test χ^2				8.821 (p=0.358; df=8)
Proportion of observations correctly predicted as preference for green electricity				61.2
Proportion of observations correctly predicted as otherwise				82.3
Overall percentage correctly classified				73.9
Total number of observations				261

Note: Statistical significance implies: *** Significant at 1% level; ** Significant at 5% level; and * Significant at 10% level electricity produced by using wind technology included educational background (H2), personal belief about the extent to which individual effort can help improve environmental quality, perceptions of the planet as a “self-cleaning” biological system (H6), tolerance of visual intrusion from wind turbines and existing set-back distance from wind turbines (H9), and concerns with using fossil fuels such as coal to generate electricity (H10). An interesting finding was that several positional factors (see, Olofsson and Öhman, 2006) included in the model (such as age, gender and income) were not significant. Olofsson and Öhman (2006) noted that gender tends to have an ambiguous effect on environmental behaviour and concern for the environment and, in some cases, the effect is not significant.

If we consider the 10%-level of significance, compared with respondents from NB, respondents in PEI (Province (2)) preferred electricity generated using wind power. However, compared with respondents from NB, NS (Province (1)) was not significant. This finding is consistent with the earlier results on preference ranking of the renewable energy sources in which 93% of PEI residents reported that wind power was “desirable” or “strongly desirable”, compared with NB (81%) and NS (88%). The finding is also consistent with the observed dominance of wind power in PEI, compared with the remaining two Maritime Provinces.

Respondents with college or trade school education (Education 2) had a positive preference for electricity produced using wind technology compared with the individuals who did not have college or trade school education, relative to university graduates. This finding is consistent with previous studies which reported that higher educational achievement increased individuals’ concerns with environmental quality, and tends to motivate such individuals to act in responsible ways toward the environment (Weber and Perrels, 2000; Barr et al., 2005; Arcury and Christianson, 1990; Black et al., 1985; Hungerford and Volk, 1990).

The general view of nature or the planet as a biological system, which over time naturally removes pollutants and other contaminants (see, for example, Santschi et al., 1990) was highly significant (p=0.003) in influencing preference for electricity producing using wind technology. Respondents who disagreed that there is no need to worry about existing global environmental problems because the planet is a self-cleaning biosystem positively supported development of "green" electricity. The estimated marginal effect indicates that when such perceptions about the planet increases by one unit, the odds ratio is 3 times as large. Thus, respondents are 3 times more likely to belong to the group who prefer such green electricity. In addition, beliefs about the contribution of individual effort to environmental protection positively influenced the probability of preference for electricity producing using wind technology. The results also suggest that a one unit increase in such perception about individual effort and contribution to environmental conservation and stewardship increased the odds ratio by a factor of 2.2. The results are consistent with the findings of Ek (2005) and Shen and Saijo (2009) who investigated consumer attitude and concerns towards purchase decisions of "green" energy. Attitude toward environment were strong predictors of environmentally-friendly behaviour in Ajzen (1988), Heberlein (1989), and Ajzen and Driver (1992).

Tolerance of visual intrusion and of set-back distance of residential dwelling from wind turbines were indicators used in the analysis to capture concerns with wind turbine externalities. Kaldellis (2005) noted that negative concerns with (tolerance of) wind turbines negatively (positively) affect public support for wind power development. Visual intrusion is one of the most important issues related to wind farm siting issues (Sibille et al., 2009; Tsoutsos et al., 2009; Harding et al., 2008). In this analysis, both variables were highly significant determinants of preference for “green” electricity produced using wind technology.

Respondents who disliked coal as a power source was a significant and positive determinant of preference for electricity from low carbon energy systems such as wind. When such dislike about coal is increased by one unit, the green electricity preference odds ratio increases by a factor of 1.9. Individuals who dislike coal as as power source tend to be more concerned about environmental quality (Ek, 2005), and tend to show more preference for electricity generated from low carbon energy sources (Greenberg, 2009).

CHAPTER 5: SUMMARY AND CONCLUSIONS

5.1 Background

Wind energy development has seen rapid growth in recent years, and considered by provincial and federal governments in Canada as part of an effective strategy to achieve "green" energy production targets, while also helping to reduce global warming and GHG emissions from climate change. On the other hand, studies for other countries suggest that residents are concerned with wind farms and wind power installations. There are also reports of a similar backlash of not-in-my-backyard perceptions in some areas in Canada.

Government policy analysts and prospective entrepreneurs are interested in better understanding the negative concerns and strategies to increase wind power projects. Provincial government strategies and policies that do not adequately address any negative public perceptions and attitudes can have negative consequences for growth of renewable energy and ultimately, on success with developing a sustainable energy sector. This study investigated public attitudes and preference for electricity generated from various renewable and non-renewable sources. The study also investigated important factors which influence consumer support for wind power systems. Data for the analysis was based on a mail survey of residents from NS, NB, and PEI.

5.2 Summary of Major Results

Major findings from the study are summarized for each research objective below.

Objective 1: To compare attitudes of Maritime residents towards selected attributes of renewable energy systems.

Overall, there was a high survey respondent support for renewable energy, compared with electricity from coal and nuclear power. A somewhat surprising finding was that, among the renewable energy sources, solar was rated higher than wind energy among respondents in all three Maritime Provinces. Preference for wind power was highest for respondents in PEI, and lowest for respondents in NB. This finding mirrors the observed dominance of wind power, especially in PEI. Threats of bird mortality from collisions with wind turbines had the highest unacceptable rating among the negative concerns with wind turbines and wind farms.

Objective 2: To evaluate important determinants of consumers' support (i.e. acceptance) of on-land wind turbines and associated technologies.

The findings using a discrete regression model indicate that important determinants of residents' acceptance of on-land (as opposed to off-shore) wind turbines and associated systems included education background, annual household income, knowledge of environmental issues, environmental behavior, and tolerance of selected wind turbine concerns reported in the literature.

Objective 3: To investigate the factors influencing consumer preferences for "green" electricity generated using wind technology.

The regression results indicate that preference for green energy from low carbon sources such as wind is influenced by level of education, perceptions that the planet is not a biological system that self-cleans itself, belief about the contribution of individual effort towards environmental protection, important measures or indicators of concerns with wind turbines and wind farms, and opposition to coal as a source for generating power.

5.3 Contribution of the Study

The contributions of this study are mainly empirical in nature. This study is the first to comprehensively document Atlantic Canadian consumers' preference for electricity generated from different power sources. Previous studies on wind power development have not investigated public perceptions and key issues based on the viewpoint of consumers in the Maritimes Provinces. As a result, the findings contribute to a better understanding of the overall pattern of consumers' attitude toward "green" energy and important determinants of electricity from renewable energy systems in Atlantic Canada.

In addition, the study is also the first to compare key environmental and health concerns associated with wind turbines among residents in the Maritime Provinces. The findings of rating of concerns with wind turbines can allow government energy planners to prioritize and focus on the most relevant wind power issues. For example, bird mortality and radio interference had the highest unacceptable ratings among the respondents for all three provinces, followed by turbine noise (in NS and NB), and sunlight flicker (in PEI).

5.5 Recommendations for Further Research

The research was conducted during a period when wind farms and the wind energy sector are relatively new, especially for the provinces of NS and NB. Consumer perceptions and support for wind energy and wind farms will likely change over time. For example, public acceptance of wind turbine systems may improve with public education and more widespread development of renewable energy in other parts of Canada. Thus, it is important to have a follow-up study to investigate any changes in consumers' acceptance of wind turbines and preference for wind power.

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